Final Report – Volume II

Assessment of Long-Term, System-Wide Potential for Demand-Side and Other Supplemental Resources: Appendices

Prepared for PacifiCorp

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In Collaboration with Summit Blue Consulting and Nexant, Inc.

Raising the bar in analytics™

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Appendix A-1. Surveys Results, Overview

C&I and CHP Survey Summaries

To assess PacifiCorp commercial and industrial customers' perception of energy efficiency, capacity focused (demand response), and cogeneration programs, Quantec completed a total of 252 interviews, including 215 completed surveys small and large commercial and industrial (C&I) customers and 37 interviews focused on likely users of combined heat and power (CHP). These interviews drew upon a pool of approximately 3,000 commercial and industrial customer provided by PacifiCorp.

The primary objective of this survey was to provide better and more reliable estimates of C&I customers' willingness and ability to participate in capacity-focused and energy efficiency programs under alternative incentive levels. These results provide robust information regarding customer preferences within the PacifiCorp territory, which were compared with actual past experiences of PacifiCorp and other national utilities to examine the relationship between the survey participants' stated preferences and actual behavior in program participation. Additional surveys were conducted with a focus on understanding interest in installing combined heat and power (CHP).

C&I Survey Sample

Quantec drew a sample using an extract of data from the PacifiCorp database of commercial and industrial customers, which included a unique identifier,[1] annual energy usage, SIC code, state, zip code, rate class, maximum annual demand (2006), and annual energy usage (2006). Quantec used these data to randomly draw a sample of approximately 3,000 customers, stratified by rate class, state, and SIC code. The resulting sample was provided to PacifiCorp, which was matched by unique identifier to customer contact information and historic participation in DSM programs (both capacity-focused and energy efficiency).

In an effort to ensure representative results of the C&I survey, Quantec stratified its sampling of commercial and industrial customers by rate class, location (i.e., urban vs. rural), and state. Of the 215 respondents, 79% were >1MW customers. The sampling goal was to complete 75% of surveys with small C&I customers (less than 1 MW). Secondarily, every attempt was made to stratify surveys by building type; therefore, only those customers with an SIC-code specification were kept in the sample. In addition to the general C&I surveys, an additional 37 surveys targeted CHP-likely sectors such as dairy farms, wastewater treatment facilities, and municipal solid waste (MSW) facilities. The sample was drawn in a similar way to the C&I survey.

Since the location of a commercial or industrial customer may impact their willingness or ability to participant in a particular type of utility program, Quantec also tracked respondents according their location in urban and rural areas. Of the customers interviewed, 58% were located in rural

[1] To protect customer privacy, PacifiCorp transformed account numbers prior to provision to Quantec.

portions of PacifiCorp's service territory while the remainder were located in urban areas. Quantec also sought to ensure a representative sample by balancing respondents by state. As evident in Table A.1, most respondents were from Utah and Oregon. All frequencies are shown in following sections of this appendix.

Table A.1.C&I Respondents by State

State	Respondents	Percent of Total Respondents
Utah	71	33%
Oregon	68	32%
Wyoming	50	23%
Washington	16	7%
Idaho	10	5%
Overall	215	100%

Key Results of C&I Survey: Energy Efficiency

Program Participation and Awareness. Only ten of the respondents (5%) stated that their organization had participated in a utility energy efficiency program. This result is not surprising considering that only a quarter of respondents (28%) described themselves as either very or somewhat familiar with their utility's energy efficiency program offerings.

Interest in Efficiency. Despite limited participation in and familiarity with utility programs, slightly more than half the respondents (55%) claimed to have either extensively or somewhat evaluated possible energy-efficiency upgrades for their facility.

Actions Taken. Correspondingly, 58% of the respondents reported their organization had installed some type of energy-efficiency equipment in the past five years. Lighting was the most commonly cited equipment upgrade by the aforementioned respondents (52%), followed by space heating (31%) and air conditioning (22%).

Market Acceptance. To assess the potential impact of various program incentive levels for common efficiency equipment, respondents were asked how likely they would be to install specific equipment independently (i.e., no utility incentive) in the next five years, and then the likelihood if their utility paid 50% or 75% of the upgrade cost. As evident in Table A.2, with the exception of lighting, none of measures exhibited independent installation rates greater than 22%. In addition, while the availability of a 50% incentive caused acceptance rates to increase dramatically, the marginal benefit from offering a larger (75%) incentive is relatively small. Analysis did not show any statistically significant differences in market acceptance rates at the end-use level by sector, state or urban/rural location.

Table A.2. Market Acceptance Rates by Hypothetical Incentive Level

Incentive Level	Lighting Systems	Air Conditioning	Space Heating	Ventilation	Refrigeration	Industrial
0%	30%	16%	19%	13%	8%	22%
50%	81%	59%	60%	56%	63%	64%
75%	87%	67%	66%	62%	65%	66%

Barriers to Participation. The two most commonly cited barriers to participation in a utility efficiency program were awareness (44%) and lack of time (22%).

Key Results of C&I Survey: Capacity-Focused Programs

Capacity-Focused Program Options. Although only 25% of respondents commented that they either frequently or sometimes take actions to minimize their demand charges, 62% stated they would consider taking short-term, voluntary reductions or shifts of energy usage without a utility incentive if asked during a power emergency. Interestingly, a very similar percentage of respondents said they would consider such actions if paid a direct incentive. The similarity between these results appear to indicate that business operations, not financial incentive, dictate ability to participant in either a voluntary or incentive-based capacity-focused program.

Organizational Attitude toward Various Capacity-Focused Program Options. Respondents were each asked about their organization's attitude toward a series of capacity-focused program options. Table A.3 captures these opinions. As evident in the table respondents generally exhibited more positive attitudes toward energy or demand buy-back program and critical peak pricing programs than the other program alternatives.

Table A.3. Attitude toward Individual Program Alternatives

Attitude	Energy or Demand Buy-Back Type Program	Critical Peak Pricing	Hourly Pricing	Curtailment Contracts	Direct Load Control
Very Positive	11%	12%	3%	5%	2%
Somewhat Positive	36%	45%	22%	33%	11%
Somewhat Negative	18%	14%	27%	21%	16%
Very Negative	9%	18%	33%	34%	59%
Don't Know	27%	10%	15%	7%	11%

Program Preference. After asking respondents about their organization's attitude toward each program in isolation, each respondent was asked which program – assuming all the previously discussed programs were available – they would be most likely to participant in, including the option of participating in no program. The results of this inquiry, by segment, are provided in Table A.4, which is used to estimate expected levels of achievable potential.

Table A.4. Program Preference

Attitude	Energy or Demand Buy-Back Type Program	Critical Peak Pricing	Hourly Pricing	Curtailment Contracts	Direct Load Control
Grocery	20%	12%	2%	13%	0%
Health	0%	0%	0%	0%	0%
Large Office	20%	8%	0%	21%	0%
Large Retail	20%	16%	0%	8%	0%
Lodging	0%	0%	0%	0%	0%
Miscellaneous	20%	12%	2%	13%	0%
Restaurant	15%	25%	0%	25%	0%
School	0%	18%	5%	23%	0%
Small Office	20%	8%	0%	21%	0%
Small Retail	20%	16%	0%	8%	0%
Warehouse	20%	12%	2%	13%	0%
Industrial	20%	24%	4%	6%	0%

Key Results of C&I & CHP Survey: Combined Heat and Power

Saturation of Onsite Generation. Approximately three-quarters of survey respondents indicated that they presently do not have any form of onsite generation capability. The most prevalent onsite generation technology is emergency standby, which 41 respondents (21%) reported having (Table A.5). Emergency standby represented 87% of All existing onsite generation technologies. Two respondents noted they generate their baseload power and one reported having CHP/Cogeneration. Only two of the respondents with onsite generation capabilities stated they recover and use heat from their system.

Table A.5. Existing Onsite Generation by Technology

Technology	Number Reporting	Percent
Emergency Standby	41	21%
CHP/Cogeneration	4	2%
Other Generation	2	1%
None	142	73%
Don't Know/Refused	5	3%
Total	194	100%

Awareness of CHP. The initial, and single largest, barrier to the adoption of combined heat and power (CHP) products is the low awareness of the technology. Self-reported awareness of CHP is 21% (39 respondents), with 77% of respondents (144) reporting that they are not aware of CHP and 2% (three respondents) either refusing to answer or responding that they "don't know."

Interest in CHP. All respondents were asked about their potential interest in CHP. Those who indicated that they were not aware of the technology were provided with a brief description, and

those who reported that they were aware of CHP were asked about interest without the description being read. Overall, 71 respondents (33%) reported that they believed that their company might be interested in CHP. Another 26 (12%) did not know or refused to answer the question, and 121 (55%) did not believe that they would be interested in CHP.

Envisioned Uses for CHP. When those respondents who indicated a potential interest in CHP were asked about the potential uses they saw for the technology in their own facilities, the most common response was to provide base-load power. While this answer from 18 respondents (41%) and an additional eight (19%) envisioning CHP to provide All electrical power indicate a reasonably high level of understanding of the potential application of CHP technology, the low responses for heat and hot water raises some questions.

Table A.6. Envisioned Uses for CHP Technology

Envisioned Use	Yes	No	Don't Know/ Refused
Base-load	41%	34%	25%
All power needs	8%	79%	2%
Heating	23%	74%	2%
Hot water	16%	81%	2%
Cooling	10%	88%	2%
Other	15%	83%	2%

These responses best highlight the need for more education regarding the potential applications for CHP technology in the regions surveyed.

Distributed Generation – Non CHP Interest. In addition to the fairly high level of interest in CHP, the survey effort also identified significant interest in non-CHP distributed generation (DG) technology. Forty-nine respondents (26%) indicated that they were interested in DG, while 117 (62%) reported that they would not be interested in DG, and 23 (12%) did not know.

Envisioned Uses for DG. The most commonly reported envisioned application for distributed generation was to take advantage of the increase power reliability relative to utility supplied power alone. While there was some additional interest was in providing peak-load shaving (as reported by three respondents, or 8%) or base-load only (six respondents, or 16%) power as well, these uses were greatly overshadowed by the desire for greater reliability (28, or 70%).

Table A.7. Envisioned Uses for DG Technology

Envisioned Use	Yes	No
Back-up/Increase reliability	70%	30%
Peak-load	8%	92%
Base-load	16%	84%
Other	3%	97%

Reasons Not Interested. For respondents indicating that they were not interested in any onsite generation technology (CHP or DG), the most frequent reason for not being interested was that they did not need onsite generation. Overall, 92 (57%) of respondents indicated that they do not need onsite generation, whereas 27 (17%) indicated that they were not interested because it is too expensive, and five (3%) because power generation is not the focus of their business.

Importance of Factors/Barriers. When asked to rank the importance of various factors, each on a scale of 1-5 (1=Irrelevant, 2=Somewhat Irrelevant, 3=Neutral, 4=Somewhat Important, 5=Most Important), respondents indicated that the most important factor is payback period (Table A.8). Energy efficiency, environmental benefits and permitting followed close behind. Although not applicable to almost half of respondents, for those that had a landowner, obtaining permission of the landowner was almost always the most important factor.

Table A.8. Importance of Various Factors on a Scale of 1-5

Factor	Mean	Median	Mode
Payback	4.0	4.5	5
Footprint	2.7	3	1
Energy Efficiency	3.9	4	4
Marketing Image	2.5	3	3
Environmental Benefits	3.4	4	5
Permitting	3.4	4	4,5
Property Owner Approval	3.3	3.5	5,N/A
Noise	3.9	4	4
Champion	3.6	4	4,5
Emissions Restrictions	3.6	5	4

1=Irrelevant, 3=Neutral, 5=Most Important

Payback Periods. Of those respondents who knew of a payback requirement at their company, both the median and the mode response was four to five years. Because this question obtained timeframes in ranges, a specific timeframe is not available for an average; however, the average payback period is clearly in excess of three years.

Table A.9. Required Payback Periods

Payback	Number Reporting	Percent
1 year or less	12	5%
2 years	21	9%
3 years	34	14%
4-5 years	47	20%
6-15 years	33	14%
Don't Know/Refused	88	37%
Total	235	100%

Appendix A-2. Survey Results, Detailed

C&I Survey Results: Overall

Table A.10. Respondent Type

	Frequency	Percent
RATE 2	170	79%
RATE 1	45	21%
	215	100%

Table A.11. State

	Frequency	Percent
UT	71	33%
OR	68	32%
WY	50	23%
WA	16	7%
ID	10	5%
	215	100%

Table A.12. Utility

	Frequency	Percent
RMP	142	66%
PP	73	34%
	215	100%

Table A.13. Urban/Rural Location

	Frequency	Percent
Rural	114	53%
Urban	101	47%
	215	100%

Table A.14. Job Title

	Frequency	Percent
Facilities Manager	23	11%
Energy Manager	6	3%
Other facilities management or maintenance position	32	15%
Chief Financial Officer	1	0%
Other financial or administrative position	30	14%
Proprietor or Owner	60	29%
President or CEO	17	8%
Other	39	19%
	208	100%

Table A.15. Organization Participated in Utility Energy Efficiency Conservation Program

	Frequency	Percent
Yes	10	91%
Don't know/Refused	1	9%
	11	100%

Table A.16. Evaluation of Possible Energy Efficiency Upgrades when Undertaking Facility Renovations or other Major Capital Improvement Projects in the Past

	Frequency	Percent
Extensively evaluated possible EE upgrades	45	22%
Somewhat evaluated possible EE upgrades	64	32%
not very extensively evaluated possible EE upgrades	46	23%
not at All evaluated possible EE upgrades	45	22%
Don't know/Refused	1	0%
	201	100%

Table A.17. How Familiar Are You with (Utility)'s Energy Efficiency Programs?

	Frequency	Percent
Very familiar	13	6%
Somewhat familiar	44	22%
not very familiar	47	23%
not at All familiar	95	47%
Have participated in the past	1	0%
Don't know/Refused	1	0%
	201	100%

Table A.18. Organization Installed any Energy Efficient Equipment in the Past Five Years

	Frequency	Percent
Yes	113	58%
No	77	39%
Don't know/Refused	5	3%
	195	100%

Table A.19. Installed Efficient Lighting System

	Frequency	Percent
Yes	77	52%
No	70	48%
	147	100%

Table A.20. Installed Efficient Air Conditioning

	Frequency	Percent
Yes	33	22%
No	114	78%
	147	100%

Table A.21. Installed Efficient Heating

	Frequency	Percent
Yes	45	31%
No	102	69%
	147	100%

Table A.22. Installed Efficient Ventilation

	Frequency	Percent
Yes	13	9%
No	134	91%
	147	100%

Table A.23. Installed Efficient Building Envelope Improvements

	Frequency	Percent
Yes	19	13%
No	128	87%
	147	100%

Table A.24. Installed Efficient Motors

	Frequency	Percent
Yes	19	13%
No	128	87%
	147	100%

Table A.25. Installed Efficient Refrigeration

	Frequency	Percent
Yes	9	6%
No	138	94%
	147	100%

Table A.26. Installed Efficient Air Compression

	Frequency	Percent
Yes	9	6%
No	138	94%
	147	100%

Table A.27. Installed Efficient Industrial Equipment

	Frequency	Percent
Yes	4	3%
No	143	97%
	147	100%

Table A.28. Installed Other Energy-Efficient Equipment

	Frequency	Percent
Yes	21	14%
No	126	86%
	147	100%

Table A.29. Plans or Expectations to Upgrade or Add Electrical Equipment at Facility in Next Five Years

	Frequency	Percent
Yes	103	50%
No	95	47%
Don't know/Refused	6	3%
	204	100%

Table A.30. With a Utility Incentive, How Likely Would You Be to Install Energy Efficient Lighting Systems in the Next Five Years?

	Frequency	Percent
Highly likely	44	43%
Somewhat likely	20	19%
Somewhat unlikely	9	9%
Very unlikely	20	19%
Did not Provide Response	8	8%
Don't know/Refused	2	2%
	103	100%

Table A.31. With a Utility Incentive, How Likely Would You Be to Install Energy Efficient Air Conditioning in the Next Five Years?

	Frequency	Percent
Highly likely	20	19%
Somewhat likely	12	12%
Somewhat unlikely	13	13%
Very unlikely	44	43%
Did not Provide Response	9	9%
Don't know/Refused	5	5%
	103	100%

Table A.32. With a Utility Incentive, How Likely Would You Be to Install Energy Efficient Space Heating in the Next Five Years?

	Frequency	Percent
Highly likely	25	24%
Somewhat likely	15	15%
Somewhat unlikely	8	8%
Very unlikely	41	40%
Did not Provide Response	9	9%
Don't know/Refused	5	5%
	103	100%

Table A.33. With a Utility Incentive, How Likely Would You Be to Install Energy Efficient Ventilation in the Next Five Years?

	Frequency	Percent
Highly likely	14	14%
Somewhat likely	14	14%
Somewhat unlikely	10	10%
Very unlikely	39	38%
Did not Provide Response	16	16%
Don't know/Refused	10	10%
	103	100%

Table A.34. With a Utility Incentive, How Likely Would You Be to Install Energy Efficient Building Envelope Improvements in the Next Five Years?

	Frequency	Percent
Highly likely	17	17%
Somewhat likely	9	9%
Somewhat unlikely	14	14%
Very unlikely	44	43%
Did not Provide Response	10	10%
Don't know/Refused	9	9%
	103	100%

Table A.35. With a Utility Incentive, How Likely Would You Be to Install Energy Efficient Motors in the Next Five Years? (Industrial Only)

	Frequency	Percent
Highly likely	13	39%
Somewhat likely	6	18%
Somewhat unlikely	1	3%
Very unlikely	3	9%
Did not Provide Response	8	24%
Don't know/Refused	2	6%
	33	100%

Table A.36. With a Utility Incentive, How Likely Would You Be to Install Energy Efficient Refrigeration in the Next Five Years? (Non-Office)

	Frequency	Percent
Highly likely	10	11%
Somewhat likely	2	2%
Somewhat unlikely	3	3%
Very unlikely	9	10%
Did not Provide Response	63	69%
Don't know/Refused	4	4%
	91	100%

Table A.37. With a Utility Incentive, How Likely Would You Be to Install Energy Efficient Compressed Air in the Next Five Years? (Industrial Only)

	Frequency	Percent
0.1	1	3%
Highly likely	6	18%
Somewhat likely	4	12%
Somewhat unlikely	2	6%
Very unlikely	9	27%
Did not Provide Response	11	33%
	33	100%

Table A.38. With a Utility Incentive, How Likely Would You Be to Install Energy Efficient Industrial Equipment in the Next Five Years? (Industrial Only)

	Frequency	Percent
Highly likely	5	15%
Somewhat likely	3	9%
Somewhat unlikely	1	3%
Very unlikely	7	21%
Did not Provide Response	17	52%
	33	100%

Table A.39. With a Utility Incentive, How Likely Would You Be to Install Some Other Energy Efficient Measure in the Next Five Years?

	Frequency	Percent
Highly likely	6	6%
Somewhat likely	4	4%
Very unlikely	1	1%
Did not Provide Response	83	81%
Don't know/Refused	9	9%
	103	100%

Table A.40. What if Utility Paid 50% of the Cost to Upgrade Lighting Systems?

	Frequency	Percent
Highly likely	66	71%
Somewhat likely	14	15%
Somewhat unlikely	1	1%
Very unlikely	7	8%
Did not Provide Response	3	3%
Don't know/Refused	2	2%
	93	100%

Table A.41. What if Utility Paid 50% of the Cost to Upgrade Air Conditioning?

	Frequency	Percent
Highly likely	39	44%
Somewhat likely	17	19%
Somewhat unlikely	7	8%
Very unlikely	20	22%
Did not Provide Response	5	6%
Don't know/Refused	1	1%
	89	100%

Table A.42. What if Utility Paid 50% of the Cost to Upgrade Space Heating?

	Frequency	Percent
Highly likely	45	51%
Somewhat likely	11	12%
Somewhat unlikely	4	4%
Very unlikely	21	24%
Did not Provide Response	7	8%
Don't know/Refused	1	1%
	89	100%

Table A.43. What if Utility Paid 50% of the Cost to Upgrade Ventilation?

	Frequency	Percent
Highly likely	32	42%
Somewhat likely	15	19%
Somewhat unlikely	3	4%
Very unlikely	22	29%
Did not Provide Response	3	4%
Don't know/Refused	2	3%
	77	100%

Table A.44. What if Utility Paid 50% of the Cost to Upgrade Building Envelope?

	Frequency	Percent
Highly likely	33	39%
Somewhat likely	11	13%
Somewhat unlikely	9	11%
Very unlikely	25	30%
Did not Provide Response	4	5%
Don't know/Refused	2	2%
	84	100%

Table A.45. What if Utility Paid 50% of the Cost to Upgrade Motors? (Industrial Only)

	Frequency	Percent
Highly likely	17	74%
Very unlikely	3	13%
Did not Provide Response	2	9%
Don't know/Refused	1	4%
	23	100%

Table A.46. What if Utility Paid 50% of the Cost to Upgrade Refrigeration? (Non-Office)

	Frequency	Percent
Highly likely	14	58%
Somewhat likely	1	4%
Somewhat unlikely	1	4%
Very unlikely	6	25%
Did not Provide Response	2	8%
	24	100%

Table A.47. What if Utility Paid 50% of the Cost to Upgrade Compressed Air? (Industrial Only)

	Frequency	Percent
Highly likely	11	52%
Somewhat likely	3	14%
Somewhat unlikely	1	5%
Very unlikely	5	24%
Don't know/Refused	1	5%
	21	100%

Table A.48. What if Utility Paid 50% of the Cost to Upgrade Industrial Equipment? (Industrial Only)

	Frequency	Percent
Highly likely	6	38%
Somewhat likely	2	13%
Somewhat unlikely	1	6%
Very unlikely	3	19%
Did not Provide Response	3	19%
Don't know/Refused	1	6%
	16	100%

Table A.49. What if Utility Paid 50% of the Cost to Upgrade Other Energy Efficient Measure You Mentioned?

	Frequency	Percent
Highly likely	8	73%
Did not Provide Response	3	27%
	11	100%

Table A.50. How about if the Incentive Were 75% of the Cost to Upgrade Lighting Systems?

	Frequency	Percent
Highly likely	78	84%
Somewhat likely	4	4%
Very unlikely	7	8%
Did not Provide Response	3	3%
Don't know/Refused	1	1%
	93	100%

Table A.51. How about if the Incentive Were 75% of the Cost to Upgrade Air Conditioning?

	Frequency	Percent
Highly likely	55	62%
Somewhat likely	6	7%
Somewhat unlikely	2	2%
Very unlikely	19	21%
Did not Provide Response	6	7%
Don't know/Refused	1	1%
	89	100%

Table A.52. How about if the Incentive Were 75% of the Cost to Upgrade Space Heating?

	Frequency	Percent
Highly likely	56	63%
Somewhat likely	4	4%
Very unlikely	19	21%
Did not Provide Response	9	10%
Don't know/Refused	1	1%
	89	100%

Table A.53. How about if the Incentive Were 75% of the Cost to Upgrade Ventilation?

	Frequency	Percent
Highly likely	44	57%
Somewhat likely	6	8%
Very unlikely	21	27%
Did not Provide Response	5	6%
Don't know/Refused	1	1%
	77	100%

Table A.54. How about if the Incentive Were 75% of the Cost to Upgrade Building Envelope?

	Frequency	Percent
Highly likely	44	52%
Somewhat likely	9	11%
Somewhat unlikely	2	2%
Very unlikely	24	29%
Did not Provide Response	4	5%
Don't know/Refused	1	1%
	84	100%

Table A.55. How about if the Incentive Were 75% of the Cost to Upgrade Motors? (Industrial Only)

	Frequency	Percent
Highly likely	18	78%
Very unlikely	3	13%
Did not Provide Response	2	9%
	23	100%

Table A.56. How about if the Incentive Were 75% of the Cost to Upgrade Refrigeration? (Non-Office)

	Frequency	Percent
Highly likely	15	63%
Somewhat likely	1	4%
Very unlikely	6	25%
Did not Provide Response	1	4%
Don't know/Refused	1	4%
	24	100%

Table A.57. How about if the Incentive Were 75% of the Cost to Upgrade Compressed Air? (Industrial Only)

	Frequency	Percent
Highly likely	12	57%
Somewhat likely	2	10%
Somewhat unlikely	1	5%
Very unlikely	5	24%
Don't know/Refused	1	5%
	21	100%

Table A.58. How about if the Incentive Were 75% of the Cost to Upgrade Industrial Equipment? (Industrial Only)

	Frequency	Percent
Highly likely	8	50%
Somewhat unlikely	1	6%
Very unlikely	3	19%
Did not Provide Response	3	19%
Don't know/Refused	1	6%
	16	100%

Table A.59. How about if the Incentive Were 75% of the Cost to Upgrade The Other Energy Efficient Measure You Mentioned?

	Frequency	Percent
Highly likely	9	82%
Did not Provide Response	2	18%
	11	100%

Table A.60. Main Reason Decided not to Participate in Utility Energy Efficiency Program

	Frequency	Percent
Lack of time	24	22%
Energy conservation is not a priority of my organization	4	4%
Existing equipment is fine	7	6%
Lack of money to purchase new equipment	4	4%
Efficient equipment is not sufficiently cost effective	3	3%
Was not aware of the program	48	44%
Other	17	15%
Don't know/Refused	3	3%
	110	100%

Table A.61. Most Effective Way for Utility to Increase Likeliness of Energy Efficiency Program Participation

	Frequency	Percent
Provide more information about the program	92	61%
Provide additional assistance to identify my organization's EE opportunities	12	8%
Increase the financial assistance (rebates) offered through the program	21	14%
Other	16	11%
No program changes are likely to increase my participation	5	3%
Don't know/Refused	5	3%
	151	100%

Table A.62. Take Actions to Lower or Shift Energy Use to Minimize the Demand Charges Associated with Energy Billing

	Frequency	Percent
Yes, frequently	14	7%
Yes, sometimes	39	18%
Yes, rarely	30	14%
No, never	127	60%
Comments	2	1%
	212	100%

Table A.63. Would Consider Making Short-Term, Voluntary Reductions or Shifts in Electricity Use if Requested Infrequently During a Power Emergency Absent a Direct Financial Incentive

	Frequency	Percent
Yes	129	62%
No	67	32%
Depends	10	5%
Don't know/Refused	1	0%
	207	100%

Table A.64. Without Direct Financial Incentives Facility Might Start Onsite or Emergency Backup Generation

	Frequency	Percent
Yes	8	5%
No	134	91%
Don't know/Refused	6	4%
	148	100%

Table A.65. Without Direct Financial Incentives Facility Might Ask Employees or Building Occupants to Reduce Electricity Use

	Frequency	Percent
Yes	33	22%
No	115	78%
	148	100%

Table A.66. Without Direct Financial Incentives Facility Might Turn Off or Dim Lights

	Frequency	Percent
Yes	72	49%
No	76	51%
	148	100%

Table A.67. Without Direct Financial Incentives Facility Might Reduce or Halt Use of Air Conditioning

	Frequency	Percent
Yes	40	27%
No	108	73%
	148	100%

Table A.68. Without Direct Financial Incentives Facility Might Reduce or Halt Use of Refrigeration

	Frequency	Percent
Yes	10	7%
No	138	93%
	148	100%

Table A.69. Without Direct Financial Incentives Facility Might Reduce or Halt Use of Water Heating

	Frequency	Percent
Yes	12	8%
No	136	92%
	148	100%

Table A.70. Without Direct Financial Incentives Facility Might Reduce Plug (Office Equipment) Loads

	Frequency	Percent
Yes	15	10%
No	133	90%
	148	100%

Table A.71. Without Direct Financial Incentives Facility Might Turn Off or Limit Use of Elevators and or Escalators

	Frequency	Percent
Yes	3	2%
No	145	98%
	148	100%

Table A.72. Without Direct Financial Incentives Facility Might Shut Down Plant(S) or Building(S)

	Frequency	Percent
Yes	2	1%
No	146	99%
	148	100%

Table A.73. Without Direct Financial Incentives Facility Might Completely Halt Major Production Processes

	Frequency	Percent
Yes	2	1%
No	146	99%
	148	100%

Table A.74. Without Direct Financial Incentives Facility Might Alter Major Production Processes

	Frequency	Percent
Yes	10	7%
No	138	93%
	148	100%

Table A.75. Without Direct Financial Incentives Facility Might Shut Down Equipment

	Frequency	Percent
Yes	9	6%
No	139	94%
	148	100%

Table A.76. Without Direct Financial Incentives Facility Might Nothing

	Frequency	Percent
Yes	14	9%
No	134	91%
	148	100%

Table A.77. Without Direct Financial Incentives Facility Might Tale other Actions

	Frequency	Percent
0.05	1	1%
Yes	28	19%
No	118	80%
Don't know/Refused	1	1%
	148	100%

Table A.78. Approximate Percentage of Normal Business-Day Operational Energy Loads Actions Might Represent

	Frequency	Percent
Less than 10 percent	31	30%
10 - 19 percent	18	17%
20 - 29 percent	10	10%
30 - 39 percent	2	2%
40 - 49 percent	3	3%
60 - 79 percent	1	1%
70 - 79 percent	2	2%
90 - 99 percent	5	5%
Don't Know	33	31%
	105	100%

Table A.79. Consider Participating in a Program if it Paid Direct Financial Incentives to Temporarily Reduce or Shift Electricity Use when Requested By Utility

	Frequency	Percent
Yes	123	62%
No	73	37%
Don't know/Refused	2	1%
	198	100%

Table A.80. With Direct Financial Incentives Facility Might Start Onsite or Emergency Backup Generation

	Frequency	Percent
Yes	9	6%
No	122	86%
Don't know/Refused	11	8%
	142	100%

Table A.81. With Direct Financial Incentives Facility Might Ask Employees or Building Occupants to Reduce Electricity Use

	Frequency	Percent
Yes	41	29%
No	101	71%
	142	100%

Table A.82. With Direct Financial Incentives Facility Might Turn Off or Dim Lights

	Frequency	Percent
Yes	72	51%
No	70	49%
	142	100%

Table A.83. With Direct Financial Incentives Facility Might Reduce or Halt Use of Air Conditioning

	Frequency	Percent
Yes	43	30%
No	99	70%
	142	100%

Table A.84. With Direct Financial Incentives Facility Might Reduce or Halt Use of Refrigeration

	Frequency	Percent
Yes	8	6%
No	134	94%
	142	100%

Table A.85. With Direct Financial Incentives Facility Might Reduce or Halt Use of Water Heating

	Frequency	Percent
Yes	10	7%
No	132	93%
	142	100%

Table A.86. With Direct Financial Incentives Facility Might Reduce Plug (Office Equipment) Loads

	Frequency	Percent
Yes	16	11%
No	126	89%
	142	100%

Table A.87. With Direct Financial Incentives Facility Might Turn Off or Limit Use of Elevators and or Escalators

	Frequency	Percent
Yes	3	2%
No	139	98%
	142	100%

Table A.88. With Direct Financial Incentives Facility Might Shut Down Plant(S) or Building(S)

	Frequency	Percent
Yes	4	3%
No	138	97%
	142	100%

Table A.89. With Direct Financial Incentives Facility Might Completely Halt Major Production Processes

	Frequency	Percent
Yes	5	4%
No	137	96%
	142	100%

Table A.90. With Direct Financial Incentives Facility Might Alter Major Production Processes

	Frequency	Percent
Yes	12	8%
No	130	92%
	142	100%

Table A.91. With Direct Financial Incentives Facility Might Shut Down Equipment

	Frequency	Percent
Yes	10	7%
No	132	93%
	142	100%

Table A.92. With Direct Financial Incentives Facility Might Do Something Else

	Frequency	Percent
Yes	16	11%
No	123	87%
Don't know/Refused	3	2%
	142	100%

Table A.93. With Direct Financial Incentive Facility Would Never at Any Level or Incentive Take Action

	Frequency	Percent
Yes	5	4%
No	137	96%
	142	100%

Table A.94. Portion of Annual Electricity Bill Needed as an Incentive to Reduce Facility Demand By 10% on Roughly Five Weekdays, for Six Hours Each Day

	Frequency	Percent
Yes	50	47%
No amount would be adequate	2	2%
Don't know	53	50%
999999	2	2%
	107	100%

Table A.95. Percent Specified

	Frequency	Percent
2	2	4%
2.5	1	2%
3	1	2%
4	1	2%
5	8	16%
7	2	4%
7.5	2	4%
10	12	24%
12	1	2%
12.5	2	4%
15	4	8%
17	1	2%
20	9	18%
50	1	2%
999999	3	6%
	50	100%

Table A.96. Portion of Annual Electricity Bill Needed as an Incentive to Reduce Facility Demand By 20% on Roughly Five Weekdays, for Six Hours Each Day

	Frequency	Percent
Yes	46	53%
No amount would be adequate	7	8%
Don't know	34	39%
	87	100%

Table A.97. Difference between 20% and 10% Reduction

	Frequency	Percent
2.5	2	5%
3	2	5%
5	9	23%
5.5	1	3%
6	1	3%
7.5	1	3%
8	2	5%
10	18	46%
15	1	3%
18	1	3%
25	1	3%
	39	100%

Table A.98. Would Consider Participating in an Alternative Program Providing Direct Incentives to Reduce or Shift Demand during Requested Periods

	Frequency	Percent
Yes	2	50%
No	2	50%
	4	100%

Table A.99. Familiarity with PacifiCorp's Time-of-Day Rates

	Frequency	Percent
Very familiar	14	8%
Somewhat familiar	38	21%
not very familiar	24	13%
not at All familiar	108	58%
Don't know/Refused	1	1%
	185	100%

Table A.100. Organization's Attitude toward Time-of-Day Rate

	Frequency	Percent
Very positive	7	8%
Somewhat positive	25	29%
Somewhat negative	12	14%
Very negative	30	35%
Don't Know/Refused	12	14%
	86	100%

Table A.101. What Is the Main Reason You Have Decided not to Participate in TOD Rates?

	Frequency	Percent
Lack of time to do so	5	13%
Do not think that TOD rates would benefit my organization	18	46%
Too complicated	2	5%
Other	13	33%
Don't Know/Refused	1	3%
	39	100%

Table A.102. Familiarity With Utility Demand or Energy Buyback Programs

	Frequency	Percent
Very familiar	7	4%
Somewhat familiar	19	11%
not very familiar	19	11%
not at All familiar	130	74%
	175	100%

Table A.103. Organization's Attitude toward Energy or Demand Buy-Back Programs

	Frequency	Percent
Very positive	5	11%
Somewhat positive	16	36%
Somewhat negative	8	18%
Very negative	4	9%
Don't Know/Refused	12	27%
	45	100%

Table A.104. Organization's Attitude toward a Voluntary Pricing Program that Offered Lower Overall Prices Year Round But Charged Higher Prices for Electricity Used during Designated "Critical Peak Periods"

	Frequency	Percent
Very positive	25	12%
Somewhat positive	92	45%
Somewhat negative	28	14%
Very negative	37	18%
Don't Know/Refused	21	10%
	203	100%

Table A.105. Organization's Attitude toward a Voluntary Pricing Program that Is Based on Real Time Prices Where Customers Are Charged Electricity Prices that Vary by Day and by Hour

	Frequency	Percent
Very positive	6	3%
Somewhat positive	44	22%
Somewhat negative	54	27%
Very negative	67	33%
Don't Know/Refused	31	15%
	202	100%

Table A.106. Organization's Attitude toward a Voluntary Curtailment Program that Pays a Fixed Incentive Annually in Exchange for the Utility's Ability to Call on You to Make Reductions in Your Electricity Use During Requested Peak Demand Periods

	Frequency	Percent
Very positive	11	5%
Somewhat positive	66	33%
Somewhat negative	42	21%
Very negative	68	34%
Don't Know/Refused	14	7%
	201	100%

Table A.107. Organization's Attitude toward A Direct Load Program That Pays A Fixed Incentive Annually in Exchange for Granting Your Utility The Ability to Directly Turn-Down or Cycle Selected Energy Consuming Equipment in Your Facility

	Frequency	Percent
Very positive	5	2%
Somewhat positive	23	11%
Somewhat negative	32	16%
Very negative	119	59%
Don't Know/Refused	22	11%
	201	100%

Table A.108. If All of these Programs Were to be Offered in the Future Likelihood of Participation

	Frequency	Percent
Highly likely	32	16%
Somewhat likely	82	42%
Somewhat unlikely	22	11%
Very unlikely	50	26%
Don't know/Refused	9	5%
	195	100%

Table A.109 Demand Response Program Most Likely to Participate in . . .

	Frequency	Percent
Energy or Demand Buy-Back Type Program	16	8%
Critical Peak Pricing	51	24%
Time of Day	3	1%
Hourly Pricing	4	2%
Curtaliment Contracts	27	13%
Direct Load Control	1	0%
Other	2	1%
None	101	48%
Don't Know/Refused	7	3%
	212	100%

Table A.110. Level of Incentive Necessary for Participation

	Frequency	Percent
Less than 10 percent	12	12%
10 - 19 percent	10	10%
30 - 39 percent	1	1%
Don't Know	81	78%
	104	100%

Table A.111. Currently Have any Onsite Power Generation Capabilities

	Frequency	Percent
Emergency standby generator	50	25%
Baseload power	2	1%
CHP/Cogeneration	1	1%
No onsite generation capabilities	144	72%
Don't know/Refused	2	1%
	199	100%

Table A.112. Heat From System Recovered and Used

	Frequency	Percent
Yes	2	4%
No	50	89%
Did not Provide Response	3	5%
999999	1	2%
	56	100%

Table A.113. Familiar with the Onsite Combined Heat and Power (CHP) or Cogeneration Systems

	Frequency	Percent
Yes	48	22%
No	149	69%
Don't know/Refused	18	8%
	215	100%

Table A.114. Believe Company Would Have an Interest in Installing A CHP System at any Point in the Future

	Frequency	Percent
Yes	59	27%
No	127	59%
Don't know/Refused	29	13%
	215	100%

Table A.115. Intend CHP System to Provide Base Load Power

	Frequency	Percent
Yes	25	42%
No	25	42%
Don't know/Refused	9	15%
	59	100%

Table A.116. Intend CHP System to Provide All Electricity Needs

	Frequency	Percent
Yes	13	22%
No	45	76%
Don't know/Refused	1	2%
	59	100%

Table A.117. Intend CHP System to Provide for All or Some Heating Needs

	Frequency	Percent
Yes	11	19%
No	47	80%
Don't know/Refused	1	2%
	59	100%

Table A.118. Intend CHP System to Provide for All or Some Hot Water Needs

	Frequency	Percent
Yes	7	12%
No	51	86%
Don't know/Refused	1	2%
	59	100%

Table A.119. Intend CHP System to Provide for All or Some Cooling Needs

	Frequency	Percent
Yes	6	10%
No	52	88%
Don't know/Refused	1	2%
	59	100%

Table A.120. Intend CHP System to Provide Some Other Use

	Frequency	Percent
Yes	3	5%
No	55	93%
Don't know/Refused	1	2%
	59	100%

Table A.121. Organization's Interested in Installing A Non-CHP On-Site Generation System at Any Point in the Future

	Frequency	Percent
Yes	43	22%
No	136	71%
Don't know/Refused	13	7%
	192	100%

Table A.122. Intend Non-CHP System to Provide Backup Power for Critical Equipment

	Frequency	Percent
Yes	32	74%
No	11	26%
	43	100%

Table A.123. Intend Non-CHP System to Provide Excess (Peak) Demand

	Frequency	Percent
Yes	2	5%
No	41	95%
	43	100%

Table A.124. Intend Non-CHP System to Provide Base Load Power

	Frequency	Percent
Yes	6	14%
No	37	86%
	43	100%

Table A.125. Intend Non-CHP System to Provide Other Service

	Frequency	Percent
Yes	1	2%
No	42	98%
	43	100%

Table A.126. Company not Be Interested in On-Site Generation Equipment because Don't Need

	Frequency	Percent
Yes	113	53%
No	88	41%
Don't know/Refused	14	7%
	215	100%

Table A.127. Company not be Interested in On-Site Generation Equipment because too Expensive

	Frequency	Percent
Yes	37	17%
No	177	82%
Don't know/Refused	1	0%
	215	100%

Table A.128. Company not Be Interested in On-Site Generation Equipment because not Focus of Business

	Frequency	Percent
Yes	5	2%
No	209	97%
Don't know/Refused	1	0%
	215	100%

Table A.129. Company not Be Interested in On-Site Generation Equipment for Other Reason

	Frequency	Percent
Yes	13	6%
No	201	93%
Don't know/Refused	1	0%
	215	100%

Table A.130. Typical Payback Period Required by Company When Considering a Major Capital Improvement or Equipment Purchase

	Frequency	Percent
1 year or less	17	9%
2 years	23	12%
3 years	36	18%
4-5 years	43	22%
6-15 years	17	9%
More than 15 years	1	1%
11	2	1%
Don't know/Refused	59	30%
	198	100%

Table A.131. Facility Type

	Frequency	Percent
Office	38	18%
Restaurant	16	8%
Retail	39	18%
Grocery	9	4%
Warehouse	11	5%
School	22	10%
Health	14	7%
Lodging	7	3%
Miscellaneous	6	3%
Food Manufacturing	4	2%
Lumber and Wood Products Paper Manufacturing	5	2%
Chemical Manufacturing	2	1%
Petroleum Refining Products	2	1%
Stone, Clay, Glass Products	3	1%
Primary Metal Manufacturing	3	1%
Industrial Machinery	1	0%
Electrical Equipment	1	0%
Manufacturing	2	1%
Mining	14	7%
Irrigation	4	2%
Other	10	5%
	213	100%

Table A.132. Use Natural Gas

	Frequency	Percent
Use Natural Gas	109	51%
Do not Use Natural Gas	30	14%
No Natural Gas Connection	12	6%
9	1	0%
Don't know/Refused	63	29%
	215	100%

Table A.133. Approximately Facility Square Footage

	Frequency	Percent
Less than 10,000 square feet	76	37%
10,000 but less than 20,000 square feet	27	13%
20,000 but less than 50,000 square feet	21	10%
50,000 but less than 100,000 square feet	16	8%
100,000 but less than 200,000 square feet	12	6%
200,000 but less than 300,000 square feet	5	2%
300,000 but less than 400,000 square feet	5	2%
400,000 but less than 500,000 square feet	2	1%
Over 500,000 square feet	11	5%
Ag/Non-facility – Outdoors	17	8%
Don't know/Refused	13	6%
	205	100%

Table A.134. How Many Sites Does Your Business Operate?

	Frequency	Percent
1 Site	104	55%
2 Sites	45	24%
3 - 5 Sites	18	9%
6 - 10 Sites	7	4%
More than 10 Sites	13	7%
Don't know/Refused	3	2%
	190	100%

Table A.135. Process Building Automation Systems in Operation at Facility

	Frequency	Percent
Yes	56	28%
No	141	69%
Don't know/Refused	6	3%
	203	100%

Table A.136. Real-Time Access to Interval Electricity Meter Data in Operation at Facility

	Frequency	Percent
Yes	23	11%
No	170	84%
Don't know/Refused	9	4%
	202	100%

Table A.137. Energy Information Systems in Operation at Facility

	Frequency	Percent
Yes	28	14%
No	168	83%
Don't know/Refused	6	3%
	202	100%

Table A.138. Control Devices On Specific Processes or Uses in Operation at Facility

	Frequency	Percent
Yes	91	46%
No	104	52%
Don't know/Refused	5	3%
	200	100%

Table A.139. Peak-Load Management Control Devices in Operation at Facility

	Frequency	Percent
Yes	18	9%
No	175	87%
Don't know/Refused	8	4%
	201	100%

Table A.140. Energy Efficient Lighting in Operation at Facility

	Frequency	Percent
Yes	111	55%
No	86	43%
Don't know/Refused	5	2%
	202	100%

Table A.141. Energy Efficient Hvac Systems or Equipment in Operation at Facility

	Frequency	Percent
Yes	65	33%
No	127	64%
Don't know/Refused	8	4%
	200	100%

Table A.142. Energy Efficient Motors, Pumps, Variable Frequency Drives in Operation at Facility

	Frequency	Percent
Yes	63	31%
No	131	65%
Don't know/Refused	7	3%
	201	100%

Table A.143. No Technologies in Operation at Facility

	Frequency	Percent
Yes	38	19%
No	155	78%
Don't know/Refused	6	3%
	199	100%

Table A.144 SIC Code

SIC Code	Frequency	Percent
8211	17	8%
5812	13	6%
6512	9	4%
6513	9	4%
4225	8	4%
5411	7	3%
6531	6	3%
8062	6	3%
5999	6	3%
7011	4	2%
6799	4	2%
8212	3	1%
4971	3	1%
6411	3	1%
2653	3	1%
1222	3	1%
7399	2	1%
8111	2	1%
2421	2	1%
5499	2	1%
5099	2	1%
1381	2	1%
5511	2	1%
6519	2	1%
5031	2	1%
1311	2	1%
1389	2	1%
7389	2	1%

SIC Code	Frequency	Percent
5063	2	1%
8021	2	1%
1499	2	1%
5074	2	1%
5251	2	1%
5399	2	1%
8051	2	1%
7378	1	0%
5813	1	0%
2063	1	0%
6036	1	0%
3275	1	0%
3595	1	0%
8031	1	0%
5082	1	0%
3366	1	0%
1094	1	0%
5211	1	0%
8059	1	0%
8748	1	0%
6025	1	0%
5422	1	0%
741	1	0%
1221	1	0%
1475	1	0%
5947	1	0%
5012	1	0%
2899	1	0%
2813	1	0%
5713	1	0%
7339	1	0%
7334	1	0%
5045	1	0%
3519	1	0%
5993	1	0%
2911	1	0%
2041	1	0%
8299	1	0%
5734	1	0%
5091	1	0%
5571	1	0%
2649	1	0%
219	1	0%
5712	1	0%
2434	1	0%
3714	1	0%
3344	1	0%
8221	1	0%
2037	1	0%
6062	1	0%

SIC Code	Frequency	Percent
3295	1	0%
921	1	0%
5261	1	0%
5699	1	0%
191	1	0%
5423	1	0%
5084	1	0%
7031	1	0%
139	1	0%
5541	1	0%
8052	1	0%
2026	1	0%
3357	1	0%
4222	1	0%
1442	1	0%
3612	1	0%
2951	1	0%
5912	1	0%
2621	1	0%
251	1	0%
3369	1	0%
7321	1	0%
5463	1	0%
7312	1	0%
723	1	0%
4221	1	0%
5083	1	0%
762	1	0%
8011	1	0%
5599	1	0%
	215	100%

CHP Survey Results: Overall

Table A.145. Utility

	Frequency	Percent
PP	17	46%
RMP	20	54%
	37	100%

Table A.146. Job Title

	Frequency	Percent
Other financial or administrative position	12	32%
Other	10	27%
Proprietor or Owner	6	16%
Other facilities management or maintenance position	6	16%
Facilities Manager	3	8%
	37	100%

Table A.147. Job Title - Other

	Frequency	Percent
Busi. Mgr.	1	3%
Asst. Treasurer	1	3%
Bldg. Owner	1	3%
President Of Corp.	1	3%
Town Clerk	1	3%
Business Manager	2	7%
Owner Family Farm	1	3%
Director Of Operations	1	3%
Secretary Treasurer	1	3%
Facilities Director	1	3%
Electric Engineer	1	3%
General Manager	2	7%
Property Manager	1	3%
Vp	1	3%
Plant Mgr.	1	3%
Finance Director	1	3%
Sec/Tres	1	3%
School District Superintendent	1	3%
Director Plant Operations	1	3%
Electric Engineer, Facilities Services	1	3%
Plant Electrician	1	3%
Operations Manager	2	7%
Branch Mgr	1	3%
Director Of Maintenance And Operations	1	3%
Project Manager	1	3%
Property Mgr	1	3%
Vp Finance	1	3%
	30	100%

Table A.148Table A.149F2_1. Type of Manufacturing Facility

	Frequency	Percent
Food	7	70%
Lumber/Wood Products	3	30%
	10	100%

Table A.150. Type of Medical Facility

	Frequency	Percent
Hospital	1	50%
Other	1	50%
	2	100%

Table A. 151.. Type of Medical Facility - Other

	Frequency	Percent
Office	1	100%
	1	100%

Table A.152. Type of School Education Facility

	Frequency	Percent
K-12	1	17%
Other	5	83%
	6	100%

Table A.153. Type of School Education Facility - Other

	Frequency	Percent
District	1	17%
Private High School	1	17%
School District	3	50%
Whole District	1	17%
	6	100%

Table A.154. Municipality

	Frequency	Percent
Municipality	1	100%
	1	100%

Table A.155. Farm and Agriculture

	Frequency	Percent
Farm/Agriculture	3	100%
	3	100%

Table A.156. Other Facility Specified

	Frequency	Percent
Commercial Call Ctr.	1	6%
Construction Co.	1	6%
Electric Utility	1	6%
Government Organization	1	6%
Local Government	1	6%
Local Town Government.	1	6%
Low-Income Senior Housing Complex	1	6%
Office	1	6%
Office - Property Management	1	6%
Office And Retail Mall (Office And Retail Restaurant)	1	6%
Restaurant Chain	1	6%
Retail Truck Stop	1	6%
School District	1	6%
Small Private Well Very Much In Favor Of Green Power Water District.	1	6%
Water Conservancy District.	1	6%
Water Pumping Station	1	6%
	16	100%

Table A.157. Facility Square Footage

	Frequency	Percent
Less than 10,000 square feet	6	17%
10,000 but less than 20,000 square feet	4	11%
20,000 but less than 50,000 square feet	6	17%
50,000 but less than 100,000 square feet	4	11%
100,000 but less than 200,000 square feet	3	8%
200,000 but less than 300,000 square feet	2	6%
300,000 but less than 400,000 square feet	1	3%
Over 500,000 square feet	3	8%
Don't know/Refused	7	19%
	36	100%

Table A.158. Buildings at Facility

	Frequency	Percent
1 Building	13	35%
2 Buildings	4	11%
3 - 5 Buildings	8	22%
6 - 10 Buildings	5	14%
More than 10 Buildings	5	14%
Don't know/Refused	2	5%
	37	100%

Table A.159. Employees at Facility

	Frequency	Percent
0 - 5 Employees	6	16%
6 - 25 Employees	9	24%
26 - 100 Employees	9	24%
101 - 500 Employees	7	19%
More than 500 Employees	4	11%
Volunteer Only	2	5%
	37	100%

Table A. 160. Facility Tenure

	Frequency	Percent
Own	27	73%
Lease	7	19%
Other	3	8%
	37	100%

Table A.161. Natural Gas

	Frequency	Percent
Use Natural Gas	13	35%
Do Not Use Natural Gas	4	11%
No Natural Gas Connection	3	8%
Don't know/Refused	17	46%
	37	100%

Table A.162. Natural Gas - Primary Uses

	Frequency	Percent
1 Power Generator Doses Gas Now Heat Is Primary Use.	1	8%
Boiler	1	8%
Boiler Systems/Heat.	1	8%
Drying The Product.	1	8%
For Heat	1	8%
Heat Primarily Also Elec. For Trucks.	1	8%
Heating	1	8%
Heating And Cooking On Stoves Fires.	1	8%
Heating And Water Heat.	1	8%
Heating And Water Heating	1	8%
Heating In Floor System Other.	1	8%
Heating Mostly (Space Some Water).	1	8%
	12	100%

Table A.163. Processes Produce Waste Gases

	Frequency	Percent
Yes	8	22%
No	25	68%
Don't know/Refused	4	11%
	37	100%

Table A.164. Waste Gases Combustibility

	Frequency	Percent
Combustible	2	25%
Non-Combustible	3	38%
Don't know/Refused	3	38%
	8	100%

Table A.165. Gas Mitigation - Comment

	Frequency	Percent
Did Not Specify	2	25%
It's Not A Lot Some Gas Also Used To Heat Steam.	1	13%
Large Fans And Open Doors.	1	13%
No, All Open Air.	1	13%
Not An Issue, We Have A Waste Management Plan	1	13%
Should Already Have Been Burned Don't Need To Be Concerned.	1	13%
Vent To Atmosphere.	1	13%
	8	100%

Table A.166. Amount of Gas Produced - Comment

	Frequency	Percent
Did Not Specify	1	13%
Don't know/Refused	6	75%
Not produced they need to buy it and vent extra as back-up for boiler.	1	13%
	8	100%

Table A.167. Rating of Facility's Need for Backup, or Redundant, Energy

	Frequency	Percent
Useless	2	5%
Not Very Important	11	30%
Somewhat Important	4	11%
Very Important	6	16%
Critical	14	38%
	37	100%

Table A.168. Onsite Power Generation Capabilities (Emergency Standby Generator)

	Frequency	Percent
Yes. Emergency standby generator	12	32%
Yes. CHP/Cogeneration	1	3%
Yes. Other onsite generation capabilities	2	5%
No	22	59%
	37	100%

Table A.169. System Description - Comment

	Frequency	Percent
10 Generators; Gasoline Power	1	7%
2 - 300 Kw; 2 - 450 Kw; Diesel Generators	1	7%
20 Years Old 700 Kw, Range 500-1000 Kw.	1	7%
20+ Years Old Gasoline Powered	1	7%
3 Sep. Branches Equipment System, Life Systems; 2 1000 Kw Cat Generators; 750 Kw. These Supply Main Hospital; 50 Kw Generator At Day Facility.	1	7%
4 Or 5 Generators Not Sure Capacity.	1	7%
5 Years Old Operated In Emergency Natural Gas Powered. Runs Gas Pumps And Some Inside Lights Only.	1	7%
Coiler Units, 750 Kw, 1.25 Mw, 1.75 Mw	1	7%
Common Facility For	1	7%
Diesel Backup To Keep Boilers Runnings.	1	7%
Few Large Ups Systems One High Capacity 50 Kva And Also Diesel Generators Onsite Largest Is 500 Kwh Enough To Run System And Building In Case Of Power Outage.	1	7%
Has 1 Generator Gasoline Powered 5 Kw	1	7%
I Right How Big Diesel Or N/G Getting Ready And Add Another For Critical Functions Only, Not Sure Of Capacity. Getting Ready To 2nd Add Backup Generator District.	1	7%
Police Dept. Also Has Back Up Generator.	1	7%
Portable, Take From Place To Place. 10 Years Old Diesel.	1	7%
	15	100%

Table A.170. Percent of Power Needs Met by Emergency Standby Generator

	Frequency	Percent
Less than 10%	2	67%
10 - 30%	1	33%
	3	100%

Table A.171. Heat Recovered and Utilized

	Frequency	Percent
Yes	1	33%
No	2	67%
	3	100%

Table A.172. Receive Incentives for Purchase or Installation

	Frequency	Percent
No	13	87%
Don't know/Refused	2	13%
	15	100%

Table A.173. Organizational Concerns about Installation

	Frequency	Percent
Yes	1	7%
No	7	47%
Don't know/Refused	7	47%
	15	100%

Table A.174. Familiarity with CHP or Cogeneration Systems

	Frequency	Percent
Yes	5	14%
No	29	78%
Don't know/Refused	3	8%
	37	100%

Table A.175. Believe Company Would be Interested in CHP in the Future

	Frequency	Percent
Yes	11	30%
No	9	24%
Don't know/Refused	17	46%
	37	100%

Table A.176. Interested in CHP to Provide Baseload Power

	Frequency	Percent
Don't know/Refused	3	100%
	3	100%

Table A.177. Interested in CHP to Provide All Electrical Needs

	Frequency	Percent
Yes	1	100%
	1	100%

Table A.178. Interested in CHP to Provide All or Some Heating Needs

	Frequency	Percent
Yes	2	100%
	2	100%

Table A.179. Interested in CHP to Provide All or Some Hot Water Needs

	Frequency	Percent
Yes	1	100%
	1	100%

Table A.180. Interested in CHP to Provide All or Some Other Needs

	Frequency	Percent
Yes	6	100%
	6	100%

Table A.181. Believe Company Would be Interested in non-CHP in the Future

	Frequency	Percent
Yes	6	24%
No	10	40%
Don't know/Refused	9	36%
	25	100%

Table A.182. Interested in non-CHP to Provide Backup Power for Critical Equipment

	Frequency	Percent
Yes	4	80%
Don't know/Refused	1	20%
	5	100%

Table A.183. Interested in non-CHP to Provide for Excess (Peak) Demand

	Frequency	Percent
Yes	1	100%
	1	100%

Table A.184. Interested in non-CHP to Provide Baseload Power

	Frequency	Percent
Yes	1	100%
	1	100%

Table A.185. Timeline for Potential Installation of non-CHP

	Frequency	Percent
3-5 years	1	9%
More than 5 years	2	18%
Don't know/Refused	8	73%
	11	100%

Table A.186. Importance of Payback Period in Purchasing Decision

	Frequency	Percent
Irrelevant	2	6%
Somewhat Irrelevant	2	6%
Neutral	7	19%
Somewhat Important	6	17%
Most Important	16	44%
Not Applicable	1	3%
Don't know/Refused	2	6%
	36	100%

Table A.187. Importance of Footprint in Purchasing Decision

	Frequency	Percent
Irrelevant	10	29%
Somewhat Irrelevant	5	14%
Neutral	9	26%
Somewhat Important	3	9%
Most Important	6	17%
Don't know/Refused	2	6%
	35	100%

Table A.188. Importance of Energy Efficiency in Purchasing Decision

	Frequency	Percent
Irrelevant	1	3%
Somewhat Irrelevant	3	9%
Neutral	6	18%
Somewhat Important	14	41%
Most Important	10	29%
	34	100%

Table A.189. Importance of Marketing Image in Purchasing Decision

	Frequency	Percent
Irrelevant	10	30%
Somewhat Irrelevant	5	15%
Neutral	11	33%
Somewhat Important	3	9%
Most Important	2	6%
Don't know/Refused	2	6%
	33	100%

Table A.190. Importance of Environmental Benefits in Purchasing Decision

	Frequency	Percent
Irrelevant	3	9%
Somewhat Irrelevant	6	18%
Neutral	9	27%
Somewhat Important	6	18%
Most Important	8	24%
Don't know/Refused	1	3%
	33	100%

Table A.191. Importance of Permitting Process in Purchasing Decision

	Frequency	Percent
Irrelevant	5	15%
Somewhat Irrelevant	6	18%
Neutral	5	15%
Somewhat Important	8	24%
Most Important	9	27%
	33	100%

Table A.192. Importance of Landlord Property Owner Approval in Purchasing Decision

	Frequency	Percent
Irrelevant	3	10%
Somewhat Irrelevant	3	10%
Neutral	2	7%
Somewhat Important	1	3%
Most Important	6	21%
Not Applicable	14	48%
	29	100%

Table A. 193. Importance of Operating Noise Sound Level in Purchasing Decision

	Frequency	Percent
Irrelevant	1	3%
Somewhat Irrelevant	4	12%
Neutral	3	9%
Somewhat Important	16	47%
Most Important	9	26%
Not Applicable	1	3%
	34	100%

Table A.194. Importance of Project Champion in Purchasing Decision

	Frequency	Percent
Irrelevant	5	15%
Somewhat Irrelevant	1	3%
Neutral	6	18%
Somewhat Important	9	27%
Most Important	8	24%
Not Applicable	3	9%
Don't know/Refused	1	3%
	33	100%

Table A.195. Importance of Emissions Restriction in Purchasing Decision

	Frequency	Percent
Irrelevant	6	18%
Somewhat Irrelevant	1	3%
Neutral	9	27%
Somewhat Important	5	15%
Most Important	12	36%
	33	100%

Table A.196. Typical Payback Period Required for Major Capital Improvements Equipment Purchases

	Frequency	Percent
2 years	1	3%
3 years	3	8%
4-5 years	7	19%
6-15 years	9	25%
Don't know/Refused	16	44%
	36	100%

Table A.197. Non-Energy Benefits Influence Required Payback Period

	Frequency	Percent
Yes	27	79%
No	4	12%
Don't know/Refused	3	9%
	34	100%

Table A.198. Impact of Non-Energy Benefits on Required Payback Period

	Frequency	Percent
Can have longer payback period	5	19%
Other	19	73%
Don't know/Refused	2	8%
	26	100%

Table A.199. View Management of Onsite Electrical Power Production as a Fallback

	Frequency	Percent
Benefit	21	57%
Liability	8	22%
Other	5	14%
Don't know/Refused	3	8%
	37	100%

Appendix A-3. Survey Instruments

2007 PacifiCorp EE/DR/CHP
Survey of C&I Customers

Name: _____

Company: _____

Phone: _____

Survey Date: _____

Start Time: _____

End Time: _____

Interviewer: _____

Group (based on SIC Code): _____

Utility (Pacific Power or Rocky Mountain Power): _____

Energy FinAnswer Participation Dates: _____

Energy FinAnswer Measures Installed: _____

TOD Rate: _____

Energy Exchange Participation: _____

Introduction/Screening

My name is _____, and I am calling on behalf of (Utility). We are conducting a study on issues related to energy usage and peak power demand. This survey is for research purposes only and is not a marketing call. This survey's results will be used by your utility in their planning efforts.

[IF CONTACT NAME] May I please speak with _____?

[IF NO CONTACT NAME] May I speak with the person in your organization who is responsible for energy-related decisions for this facility?

- ❑ "Speaking"➔ Go to "Introduction to Respondent" section below
- ❑ Refers to proper contact: Record name/title:
  _____
- ❑ Unsure ➔ Use this description: "This would be the person who oversees spending on electricity and energy consuming equipment and systems such as lighting and heating. It could be the director of facilities or operations, engineer or operations manager, the senior financial officer, or the owner."
- ❑ No such person or still not certain ➔ "Could I speak to the person who is the primary decision-maker about any significant purchases in your organization?"
- ❑ Refused ➔ "Thanks for your time."

(If needed) This is a fact-finding survey only – we are NOT selling anything, and responses will not be connected with your firm in any way. (Utility) wants to better understand how businesses think about and manage their energy usage. Your input is very important to (Utility).

Introduction to Respondent

Great! To give you some background, we are speaking with selected businesses and organizations to learn about energy-efficiency preferences, demand management, and interest in onsite generation. The information you provide will be kept in strictest confidence. This information and your survey responses will be shared with the study team only in a form that does not allow the identification of any business, individual or facility. This interview should take about 15-20 minutes. Is this a good time for you or is there a better time I can call you back?

- ❑ Yes ➔ Continue
- ❑ No ➔ Schedule call back
- ❑ Refused ➔ Thanks!

1. First, what is your job title? [Don't read]

   1) Facilities Manager
   2) Energy Manager
   3) Other facilities management or maintenance position
   4) Chief Financial Officer
   5) Other financial or administrative position
   6) Proprietor or Owner
   7) President or CEO
   8) Other [specify]: _____
   -99) Don't know/Refused

Energy-Efficiency Practices

There are three sets of questions that I would like to ask you. This first set of questions focuses on energy-efficiency opportunities and relates to long-term capital investments in upgraded energy-efficient equipment.

2. [IF RECORDS INDICATE PARTICIPATION]
   Our records show that your organization participated in (Utility)'s energy efficiency conservation program in (Year)? Is this correct?

   1) Yes ➔ Go to 7
   2) No (ASK IF ANOTHER PERSON BE BETTER TO DISCUSS)
   -99) Don't know/Refused

3. How extensively would you say that your organization has evaluated possible energy efficiency upgrades when undertaking facility renovations or other major capital improvement projects in the past? Would you say that you:

   1) Extensively evaluated possible EE upgrades
   2) Somewhat evaluated possible EE upgrades
   3) Not very extensively evaluated possible EE upgrades
   4) Not at all evaluated possible EE upgrades

4. How familiar are you with (Utility)'s energy efficiency programs? (Programs that provide incentives to firms for installing energy-efficient equipment.)

   1) Very familiar
   2) Somewhat familiar
   3) Not very familiar
   4) Not at all familiar
   5) Have participated in the past ➔ Go to 7
   -99) Don't know/Refused

5. Has your organization installed any energy efficient equipment in the past five years?

1) Yes
2) No ➔Go to 7
-99) Don't know/Refused ➔Go to 7

6. What type of energy-efficient equipment was installed?

1) Efficient lighting systems [specify]:_____
2) Efficient air conditioning [specify]:_____
3) Efficient heating [specify]:_____
4) Efficient ventilation [specify]:_____
5) Efficient building envelope improvements [specify]:_____
6) Efficient motors [specify]:_____
7) Efficient refrigeration [specify]:_____
8) Efficient air compression [specify]:_____
9) Efficient industrial equipment [specify]:_____
10) Other [specify]:_____
-99) Don't know/Refused

7. In the next five years do you have plans or expect to upgrade or add electrical equipment at your facility?

1) Yes
2) No ➔Go to 9
-99) Don't know/Refused ➔Go to 9

8. [Surveyor: For each option (listed in the leftmost column of the table), you will ask the three questions, A, B and C (comprising the topmost row of the table). Fill in the answer in the appropriate box using the scale below.]
SCALE:

1) Highly likely
2) Somewhat likely
3) Somewhat unlikely
4) Very unlikely
-99) Don't know/Refused
-98) Not Applicable

Options	A. Without a utility incentive, how likely would you be to install energy efficient [Option] in the next five years? [If response 2-4, continue to B]	B. What if (Utility) paid 50% of the cost to upgrade? [If response 2-4, continue to C] [If necessary, provide the related approximate payback, separate matrix]	C. How about if the incentive were 75% of the cost to upgrade? [If necessary, provide the related approximate payback.]	*% Cost Premium over Base – EE equip. is typically more expensive to purchase, but in the ongoing operations cost less due to reduced energy usage*
Lighting systems				*5 - 15*
Air conditioning				*10 - 25*
Space heating				*5 - 20*
Ventilation				*2 - 5*
Building envelope improvements				*5 - 20*
Motors (Industrial only)				*1 - 5*
Refrigeration (not office)				*10 - 20*
Compressed Air (Industrial only)				*10 - 20*
Industrial equipment (Industrial only)				*5 - 30*
Other [specify]:_____				*2 - 25*

9. [IF NOT FINANSWER PARTICIPANT, BUT FAMILIAR]
What is the main reason you decided not to participate in the (Utility) energy efficiency program?

1) Lack of time
2) Energy conservation is not a priority of my organization
3) Existing equipment works fine
4) Lack of money to purchase new equipment
5) Efficient equipment isn't sufficiently cost effective
6) Was not aware of the program
7) Other [specify]: _____

10. [IF NEVER PARTICIPATED IN FINANSWER]
What would be the most effective way for (Utility) to increase your organization's likeliness to participate in available energy efficiency programs?

1) Provide more information about the program
2) Provide additional assistance to identify my organization's EE opportunities
3) Increase the financial incentives (rebates) offered through the program
4) Other [specify]:_____
5) No program changes are likely to increase my participation
-99) Don't know/Refused

Demand Response

Now we're moving to the second set of questions, which relate to short-term reductions in electricity use, known as "demand response."

11. Does your company take actions to lower or shift energy use to minimize the demand charges associated with your (Utility) energy billing?

    1) Yes, frequently
    2) Yes, sometimes
    3) Yes, rarely
    4) No, never
    5) Comments (record verbatim) _____
    -99) Don't know/Refused

12. Would you consider making short-term, voluntary reductions or shifts in your electricity use if requested infrequently by (Utility) during a power emergency absent a direct financial incentive to do so?

    1) Yes
    2) No ➔ Go to 15
    3) Depends on _____

13. Without direct financial incentives, what actions could and might your facility take to reduce or shift your electricity usage? [Do not prompt]

    1) Start onsite or emergency/backup generation
    2) Ask employees or building occupants to reduce electricity use
    3) Turn off or dim lights
    4) Reduce or halt use of air conditioning
    5) Reduce or halt use of refrigeration
    6) Reduce or halt use of water heating
    7) Reduce plug (office equipment) loads
    8) Turn off or limit use of elevators and/or escalators
    9) Shut down plant(s) or building(s)
    10) Completely halt major production processes
    11) Alter major production processes
    12) Shut down equipment
    13) Nothing ➔ Go to 15
    14) Others (Please explain) _____

14. And approximately what percentage of your normal business-day operational energy loads might these actions represent? [Do not prompt]

    1) _____ percent
    2) Refused
    3) Comments (Verbatim) _____
    -99) Don't know/Refused

15. Would you consider participating in a (Utility) program if it paid you direct financial incentives to temporarily reduce or shift electricity use when requested by (Utility)?

    1) Yes
    2) No ➔ Go to start of Strategy Acceptance section (Q19)

16. Given a direct financial incentive, what actions could your facility likely take to reduce or shift electricity usage? [Do not prompt. Give examples if necessary.]

    1) Start onsite or emergency/backup generation
    2) Ask employees or building occupants to reduce electricity use
    3) Turn off or dim lights
    4) Reduce or halt use of air conditioning
    5) Reduce or halt use of refrigeration
    6) Reduce or halt use of water heating
    7) Reduce plug (office equipment) loads
    8) Turn off or limit use of elevators and/or escalators
    9) Shut down plant(s) or building(s)
    10) Completely halt major production processes
    11) Alter major production processes
    12) Shut down equipment
    13) Others (Please explain) _____
    14) Nothing, at any level or incentive ➔ Go to 19
    -99) Don't know/Refused

17. Approximately what portion of your annual electricity bill would you need as an incentive to reduce facility demand by 10% on roughly five weekdays, for six hours each day?

    1) _____Percent
    2) No amount would be adequate
    3) Refused➔ Go to 19
    4) Don't know➔ Go to 19

18. And to reduce facility demand by 20%?

    1) _____Percent

2) No amount would be adequate
3) Refused
4) Don't know

Strategy Acceptance

19. [IF PARTICIPANT IN ENERGY EXCHANGE OR IRRIGATION]
If (Utility) offered an alternative program providing direct incentives to reduce or shift demand during requested periods, would you consider participating?

1) Yes
2) No ➔ Go to start of CHP/Distributed Standby Generation section (Q33)

[IF CUSTOMER IS ON THE TOD RATE ➔ GO TO 23]

20. How familiar are you with PacifiCorp's Time-of-Day Rates (in which customers pay set rates that vary by season and on- and off-peak periods)?

1) Very familiar
2) Somewhat familiar
3) Not very familiar
4) Not at all familiar ➔ Go to 23
-99) Don't know/Refused

21. How would you describe your organization's attitude towards the Time of Day Rate?

1) Very positive
2) Somewhat positive
3) Somewhat negative
4) Very negative
-99) Don't know/Refused

21b. Why?: [Do not prompt]

_____

_____

22. [IF RESPONDED AS FAMILIAR IN Q20]
What is the main reason you have decided NOT to participate in TOD rates?

1) Lack of time to do so
2) Do not think that TOD rates would benefit my organization
3) Too complicated
4) Other [Specify]:_____

[IF CUSTOMER IS ENERGY EXCHANGE PARTICIPANT, SKIP TO Q25]

23. How familiar are you with utility demand or energy buyback programs (programs where utilities communicate a price they are willing to pay for customers to reduce or shift their usage – typically provided a day in advance of a program event – and your firm could choose to accept that price and voluntarily reduce a portion of its electricity usage during the specified time on the following day?)

1) Very familiar
2) Somewhat familiar
3) Not very familiar
4) Not at all familiar ➔ Go to 25
5) Already participant ➔ Go to 25
-99) Don't know/Refused

24. How would you describe your organization's attitude toward these types of energy or demand buy-back programs?

1) Very positive
2) Somewhat positive
3) Somewhat negative
4) Very negative
-99) Don't know/Refused

24b. Why?: [Do not prompt]

I will now briefly describe several different demand response strategies that are being researched by (Utility) for possible future offering. Please tell me if you view these options as very positive, somewhat positive, somewhat negative or very negative.

25. How would you describe your organization's attitude toward a voluntary pricing program that offered you lower overall prices year round but charged higher prices for electricity used during designated "critical peak periods," typically periods when system usage very high? On average, there would be less than 15 critical peak pricing days per year. Would you say the attitude is:

1) Very positive
2) Somewhat positive
3) Somewhat negative
4) Very negative
-99) Don't know/Refused

25 b. Why? [Record answer, Do not prompt]

_____

_____

26. How would you describe your organization's attitude toward a voluntary pricing program that is based on real time prices where customers are charged electricity prices that vary by day and by hour (according to the what the utility is paying at the overall system level)? Would you say the attitude is:

1) Very positive
2) Somewhat positive
3) Somewhat negative
4) Very negative
-99) Don't know/Refused

26b. Why? [Record answer, Do not prompt]

_____

_____

27. How would you describe your organization's attitude toward a voluntary curtailment program that pays a fixed incentive annually in exchange for the utility's ability to call on you (require you) to make reductions in your electricity use during requested peak demand periods? Would you say the attitude is:

1) Very positive
2) Somewhat positive
3) Somewhat negative
4) Very negative
-99) Don't know/Refused

27 b. Why? [Record answer, Do not prompt]

_____

_____

28. How would you describe your organization's attitude toward a Direct Load Program that pays a fixed incentive annually in exchange for granting your utility the ability to directly turn-down or cycle selected energy consuming equipment in your facility? (e.g., reduce lighting in certain areas, increase the set point on cooling or decrease the set point on heating equipment). Would you say the attitude is:

1) Very positive
2) Somewhat positive
3) Somewhat negative
4) Very negative
-99) Don't know/Refused

28 b. Why? [Record answer, Do not prompt]

_____

_____

29. [IF NOT ALREADY PARTICIPANT]
If (Utility) were to offer all of these programs in the future, how likely would you say your organization would be to participate?

1) Highly likely
2) Somewhat likely
3) Somewhat unlikely ➔ Go to 32
4) Very unlikely ➔ Go to 32
-99) Don't know/Refused

29 b. And why is that? [Record answer]

_____

_____

30. Which demand response program are you most likely to participate in?

1) Energy or demand buy-back type program
2) Critical Peak Pricing
3) Time of day
4) Hourly Pricing
5) Curtailment Contracts
6) Direct Load Control
7) Other (Record answer) _____
-99) Don't know/Refused

31. What level of incentive would be necessary for you to participate?

1) Verbatim: _____

_____

_____

-99) Don't know/Refused

32. What barriers, if any, would prevent you from participating in a demand response program?

1) Verbatim: _____

_____

_____

-99) Don't know/Refused

CHP/Distributed Standby Generation

33. Do you currently have any onsite power generation capabilities? (Prompt if necessary)

1) Yes, emergency standby generator
2) Yes, baseload power
3) Yes, peaking power
4) Yes, CHP/Cogeneration
5) Yes, other onsite power generation capabilities.
6) No ➔ Go to 36

-99) Don't know/Refused ➔ Go to 36

34. Would you please describe the type of system you have in place, including the brand, size in kW, age, and the fuel type if known.

1) Verbatim:_____

_____

_____

-99) Don't know/Refused

35. Is the heat from this system recovered and used for any purpose?

1) Yes
2) No

-99) Don't know/Refused

36. Are you familiar with the onsite generation system called combined heat and power (CHP) or cogeneration systems?

1) Yes ➔ Go to 36b below
2) No ➔ Go to "***Description"*** below

-99) Don't know/Refused ➔ Go to "***Description"*** below

Description. Combined heat and power systems, also called CHP or cogeneration systems, generate both electricity and heat. A CHP system can provide up to 100% of your electric power needs, and heat to meet your space heating, hot water, and/or air-conditioning needs. These systems are typically also connected to the grid to ensure nearly 100% reliability – that is, if the system should ever fail, you still have your local power connection to keep everything running without interruption. ➔ Go to 36b

36b. Do you believe that your company would have an interest in installing a CHP system at any point in the future?

1) Yes
2) No➔ Skip to 38
-99) Don't know/Refused ➔ Skip to 38

37. What intended usage would the CHP system provide? [Check all that apply]

1) To provide base load power
2) To provide all electricity needs
3) To provide for all or some heating needs
4) To provide for all or some hot water needs
5) To provide for all or some cooling needs
6) Other _____
-99) Don't Know/Refused

38. Do you think your company would be interested in installing a non-CHP on-site generation system at any point in the future?

1) Yes
2) No ➔ Skip to 40
-99) Don't Know/Refused ➔ Skip to 40

39. What intended usage would this system provide? [Check all that apply]

1) Backup power for critical equipment
2) To provide for excess (peak) demand
3) To provide base load power
4) Other _____
-99) Don't Know/Refused

40. Why might your company not be interested in on-site generation equipment? [Check all that apply]

1) Don't need
2) Too expensive
3) Not focus of business
4) Other [specify]:_____
-99) Don't know/Refused

41. When considering a major capital improvement or equipment purchase, what is the typical payback period required by your company?

1) 1 year or less
2) 2 years
3) 3 years
4) 4-5 years
5) 6-15 years
6) More than 15 years
-99) Don't know/Refused

Firmographics

Finally, I'd like to ask you about this facility. Unless otherwise stated, all questions pertain to this facility, located at [Address from list below].

42. Our records indicate your facility is a (Group). Do you agree?

1) Yes [Mark appropriate category]
2) No ➔ How would you describe your facility? [Mark appropriate category]
   1) Office
   2) Restaurant
   3) Retail
   4) Grocery
   5) Warehouse
   6) School
   7) Health
   8) Lodging
   9) Miscellaneous
   10) Food Manufacturing
   11) Lumber & Wood Products Paper Manufacturing
   12) Chemical Manufacturing
   13) Petroleum Refining Products
   14) Stone, Clay, Glass Products
   15) Primary Metal Manufacturing
   16) Industrial Machinery
   17) Electrical Equipment
   18) Manufacturing
   19) Transportation Equipment
   20) Manufacturing
   21) Mining
   22) Irrigation
   23) Industrial Manufacturing
   24) Other
   -99) Don't know/Refused

43. On an annual basis, approximately how much natural gas do you consume at this facility? (dollars per month, dollars per year or therms)

1) Verbatim _____
2) Do not use natural gas
3) No natural gas connection
-99) Don't know/Refused

44. Approximately how many square feet does your organization occupy in **this** facility? [Do not prompt]

1) Less than 10,000 square feet
2) 10,000 but less than 20,000 square feet
3) 20,000 but less than 50,000 square feet
4) 50,000 but less than 100,000 square feet
5) 100,000 but less than 200,000 square feet
6) 200,000 but less than 300,000 square feet
7) 300,000 but less than 400,000 square feet
8) 400,000 but less than 500,000 square feet
9) More than 500,000 square feet
10) Ag/Non-facility – Outdoors
-99) Don't know/Refused

45. How many sites does your business operate?

1) 1
2) 2-5
3) 6-10
4) 11-20
5) More than 20

46. Which of the following technologies are in operation at your facility? [Check all that apply]

1)	Process/building automation systems	? Yes	? No
2)	Real-time access to interval electricity meter data	? Yes	? No
3)	Energy information systems	? Yes	? No
4)	Control devices on specific processes or uses	? Yes	? No
5)	Peak-load management control devices	? Yes	? No
6)	Energy efficient lighting	? Yes	? No
7)	Energy efficient HVAC systems or equipment	? Yes	? No
8)	Energy efficient motors, pumps, variable frequency drives	? Yes	? No

9) None
-99) Don't know/Refused

Thank you very much for your time today! Would it be OK if I were to call you back in case I need to confirm or clarify any of this information?

1) Yes
2) No

2007 PacifiCorp CHP Potential Study
End User Survey

Name: _____

Company: _____

Phone: _____

Survey Date: _____

Start Time: _____

End Time: _____

Interviewer: _____

Utility (Pacific Power or Rocky Mountain Power): _____

Group or company type:_____

Introduction/Screening

My name is _____, and I am calling on behalf of (Utility). I am trying to reach the person who is the most familiar with facilities and major electrical equipment operations and/or the person who makes financial decisions regarding the purchase of this type of equipment. Are you the individual who best fits this role?

- ❑ Yes ➔ Proceed.
- ❑ No ➔ Who is the person that I should speak to? _____ (Transfer and restart.)

I am calling on behalf of (Utility) and am speaking with a small number of businesses that we think may be potential candidates for or benefit from an energy program under consideration. This survey is for research purposes only and is not a marketing call. If you have about 15-20 minutes, I would really appreciate your input in order to help us understand the market and help us design the program effectively. Is this a convenient time for you?

- ❑ Yes ➔ Continue with survey.
- ❑ No ➔ Schedule a time to call back: _____ AM/PM, on _____ Date.

(If needed:) This is a fact-finding survey only – we are NOT selling anything, and responses will not be connected with your firm in any way. (Utility) wants to better understand how businesses think about and manage their energy usage. Your input is very important to (Utility).

1. First, what is your job title? [Don't read]

   1) Facilities Manager
   2) Energy Manager
   3) Other facilities management or maintenance position
   4) Chief Financial Officer
   5) Other financial or administrative position
   6) Proprietor or Owner
   7) President or CEO
   8) Other: [Specify] _____

   -99) Don't know/Refused

Firmographics

2. Our records indicate your facility is a (Group). Do you agree? [Mark appropriate category]

    1) Manufacturing
        i. Food
        ii. Pulp & Paper
        iii. Lumber/Wood Products
        iv. Petroleum Refining
    2) Medical
        i. Hospital
        ii. Hospice
        iii. Out-patient
        iv. Other _____
    3) School/Education
        i. K-12
        ii. Higher
        iii. Other _____
    4) Municipality (waste processing)
    5) Lodging
    6) Farm/Agriculture
    7) Other _____

    -99) Don't know/Refused

3. Approximately how many square feet does your organization occupy in this facility? [DO NOT PROMPT]

    1) Less than 10,000 square feet
    2) 10,000 but less than 20,000 square feet
    3) 20,000 but less than 50,000 square feet
    4) 50,000 but less than 100,000 square feet
    5) 100,000 but less than 200,000 square feet
    6) 200,000 but less than 300,000 square feet
    7) 300,000 but less than 400,000 square feet
    8) 400,000 but less than 500,000 square feet
    9) Over 500,000 square feet
    10) Ag/Non-facility – Outdoors

    -99) Don't know/Refused

4. How many buildings do you have at this facility?

    1) Verbatim _____

    -99) Don't know/Refused

5. How many employees work at this facility?

   1) Number of Employees _____
   -99) Don't know/Refused

6. Do you own or lease your facility?

   1) Own
   2) Lease
   3) Other _____
   -99) Don't know/Refused

Background

7. On an annual basis, approximately how much natural gas do you consume at this facility?

   1) Verbatim _____
   2) Do not use natural gas ➔ Go to 9
   3) No natural gas connection ➔ Go to 9
   -99) Don't know/Refused

8. What are the primary processes and equipment that use natural gas?

   1) Verbatim _____
   -99) Don't know/Refused

9. Do any of your processes produce waste gases?

   1) Yes
   2) No ➔ Go to 13
   -99) Don't know/Refused ➔ Go to 13

10. Are the gasses combustible or non-combustible?

    1) Combustible (e.g., methane)
    2) Non-combustible (e.g., $CO/CO_2/NO_X$)
    3) Other _____
    -99) Don't know/Refused

11. How do you currently deal with the gasses?

    1) Verbatim _____
    -99) Don't know/Refused

12. Approximately how much gas is produced?

    1) Verbatim _____
    -99) Don't know/Refused

Decision Making

13. How would you rate you facility's need for backup, or redundant, energy on a scale of 1-5, where 1=Useless and 5=Critical?

    1) Useless
    2) Not very important
    3) Somewhat important
    4) Very important
    5) Critical
    -99) Don't know/Refused

14. Do you currently have any onsite power generation capabilities? (Prompt if necessary)

    1) Yes, Emergency standby generator
    2) Yes, Baseload power
    3) Yes, Peaking power
    4) Yes, CHP/Cogeneration
    5) Yes, Other onsite power generation capabilities.
    6) No ➔ Go to 22
    -99) Don't know/Refused ➔ Go to 22

15. Would you please describe the type of system you have in place, including the brand, size in kW, age, and the fuel type if known.

    1) Verbatim: _____

    _____

    -99) Don't know/Refused

16. [If customer has Emergency Standby Generator (Yes on 14 (1)), Skip to 18]
    What percent of your power needs are presently met by this system?

    1) Less than 10%
    2) 10%-30%
    3) 30%-50%
    4) More than 50%
    5) Backup/standby only
    -99) Don't know/Refused

17. Is the heat from this system recovered and used for any purpose?

    1) Yes
    2) No
    -99) Don't know/Refused

18. Did you receive any incentives for the purchase and/or installation of this equipment?

1) Yes
2) No ➔ Go to 20
-99) Don't know/Refused ➔ Go to 20

19. What was the source of this incentive?

1) Verbatim _____
-99) Don't know/Refused

20. Ultimately, what was the deciding factor to install the onsite generation equipment?

1) Verbatim _____
-99) Don't know/Refused

21. Did anyone in your organization express concerns about installing an on-site system?

1) Yes
2) No
-99) Don't know/Refused

21b. How were their concerns addressed?

Verbatim :_____

_____

22. Are you familiar with the onsite generation system called combined heat and power (CHP) or cogeneration systems?

1) Yes ➔ Go to "***22b"*** below
2) No ➔ Go to "***Description"*** below
-99) Don't know/Refused ➔ Go to "***Description"*** below

Description. Combined heat and power systems, also called CHP or cogeneration systems, generate both electricity and heat. A CHP system can provide up to 100% of your electric power needs, and heat to meet your space heating, hot water, and/or air-conditioning needs. These systems are typically also connected to the grid to ensure nearly 100% reliability—that is, if the system should ever fail, you still have your local power connection to keep everything running without interruption.

➔ Ask 22b.

22b. Do you believe that your company would have an interest in installing a CHP system at any point in the future?

1) Yes
2) No ➔ Skip to 24
-99) Don't know/Refused ➔ Skip to 24

23. What intended usage would the CHP system provide? [check all that apply]

1) To provide base load power
2) To provide all electricity needs
3) To provide for all or some heating needs
4) To provide for all or some hot water needs
5) To provide for all or some cooling needs
6) Other _____
-99) Don't Know/Refused

➔Skip to 26

24. Do you think your company would be interested in installing a non-CHP on-site generation system at any point in the future?

1) Yes
2) No ➔ Skip to 27
-99) Don't Know/Refused ➔ Skip to 27

25. What intended usage would this system provide? [check all that apply]

1) Backup power for critical equipment
2) To provide for excess (peak) demand
3) To provide base load power
4) Other _____
-99) Don't Know/Refused

26. When do you think you will install this new equipment?

1) Within 3 years
2) 3-5 years
3) More than 5 years
-99) Don't Know/Refused

27. On a scale of 1-5, where 1= Irrelevant and 5=Most Important, how important are the following factors in deciding whether to purchase equipment?

	←Irrelevant | Neutral | Important→						
Payback period	1	2	3	4	5	DK (Don't know)	
Footprint	1	2	3	4	5	DK	
Energy efficiency	1	2	3	4	5	DK	
Marketing image	1	2	3	4	5	DK	
Environmental benefits	1	2	3	4	5	DK	
Permitting process	1	2	3	4	5	DK	
Landlord/property owner approval	1	2	3	4	5	DK	N/A
Noise/sound level (operating)	1	2	3	4	5	DK	
Project champion	1	2	3	4	5	DK	
Emissions restriction	1	2	3	4	5	DK	

28. When considering a major capital improvement or equipment purchase, what is the typical payback period required by your company?

    1) 1 year or less
    2) 2 years
    3) 3 years
    4) 4-5 years
    5) 6-15 years
    6) More than 15 years
    -99) Don't know/Refused

29. Would non-energy benefits (e.g. environmental benefits, reliability, etc.) influence the required payback periods?

    1) Yes
    2) No ➔ Go to 31
    -99) Don't know/Refused ➔ Go to 31

30. How so?

1) Can have a longer payback period
2) Depends on boss/owner
3) Other _____

-99) Don't know/Refused

31. Do you think that the ability to manage your own electrical power production, while still being able to rely on the grid as a fallback, is a benefit or a liability?

1) Benefit
2) Liability
3) Other _____

-99) Don't know/Refused

I need to confirm or clarify any of this information?

- ❑ Yes
- ❑ No

Have a great day.

Appendix B-1. Capacity-Focused Resource Materials: Detailed Assumptions by Program Option

DLC Residential – Air Conditioning Only

Table B.1. Program Basics

Program Name	DLC - RES - AC
Customer Sectors Eligible	All Residential and Commercial market segments, except health and lodging
End Uses Eligible for Program	Central Cooling and Heat Pumps
Customer Size Requirements, if any	Residential and Small Commercial with cooling less than 7.5 tons (proxy of max demand <30 kW)
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	No Winter

Table B.2. Inputs and Sources Not Varying by State or Sector

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	7%	Rocky Mountain Power 5% change of electrical service plus 2% removals Xcel Energy (MN) Saver's Switch, MidAmerican (IA) Summer Saver, Eon US (LG&E) Demand Conservation Program, SMUD Peak Corps, PSE&G Cool Customer, FP&L Residential On-Call - Ranging from 1 to 3% Removals from Program
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new participant)	$175	CEC, 2004 - installed cost of ratio frequency load control devices
Marketing Cost (per new participant)	$25	Conservative estimate per customer of marketing (1/2 hour of staff time valued at $50/hour). Eon US (LG&E) Demand Conservation Program MidAmerican (IA) Summer Saver $48
Incentives (annual costs per participant)	$20	Residential Utah Cool Keeper Incentive amount of $20, consistent with other programs across the country; Commercial Utah Cool Keeper Incentive of $40 per customer year, consistent with other national programs
Communications (annual costs per participant)	$7	Accounts for monthly per-customer communications of a one-way transmission system. Assumed to be half of the costs experienced by PacifiCorp Idaho Irrigation system, which utilizes a two-way system.
Overhead: First Costs (2007$)	$400,000	Standard Program Development Assumption, including necessary internal labor, research and IT/billing system changes
Technical Potential as % of Load Basis	100%	Assumes all central AC units can be retrofit
Program Participation	25% Res. 1% Comm.	The average participation rate for national programs is between 15% and 20% of all residential customers, which translates into 20% to 30% of eligible customers (those with central air conditioning, which is the load basis for this program). For example, Rocky Mountain Power runs an air conditioning DLC program (Cool Keeper) in Utah, which currently has 11% of residential customers, but 30% of eligible customers on the program (those with central cooling). Therefore, this analysis assumes there is potential to sign up 40% of eligible customers (an additional 10% beyond currently achieved levels) in Utah and 25% in other states (to be consistent with other national program achievements), but only 1% of small commercial customers, based on the experience of PacifiCorp and other national utilities and supported by C&I survey.
Event Participation	46%	Event participation is combination of portion of units that respond and cycling strategy. Utah Cool Keeper historic event participation is based on homeowners removing units and operational breakdowns (92%). This figure is consistent with Xcel, MidAm and EON. Lower rates were experienced by SMUD and PSE&G (80%). Also includes 50% cycling strategy.
Per Customer Impacts	varies	Single family per customer impacts based on PacifiCorp and other national utility experience. Commercial customers average demand reduction is (Load Basis / # of customers with Central AC) * Cycling Strategy of 50%

DLC Residential – Air Conditioning and Water Heating

Table B.3. Program Basics

Program Name	DLC - RES - AC and Water Heat
Customer Sectors Eligible	All Residential and Commercial segments, except health and lodging
End Uses Eligible for Program	Central Cooling (including Heat Pump) and Electric Hot Water Heating
Customer Size Requirements, if any	All Residential and Small Commercial cooling less than 7.5 tons, proxy of maximum demand <30 kW
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	Top 40 Winter Hours

Table B.4. Inputs and Sources not Varying by State or Sector

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	7%	Rocky Mountain Power 5% change of electrical service, 2% removals Xcel Energy (MN) Saver's Switch, MidAmerican (IA) Summer Saver, Eon US (LG&E) Demand Conservation Program, SMUD Peak Corps, PSE&G Cool Customer, FP&L Residential On-Call - Ranging from 1 to 3% Removals from Program
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new participant)	$175	CEC, 2004 - installed cost of ratio frequency load control devices, assumes same cost for cooling and hot water switches (therefore each end use would have a switch, not a gateway device)
Marketing Cost (per new participant)	$25	Same as AC DLC
Incentives (annual costs per participant)	$20	Assumes $20 per year for each end use in residential sector; $40 for cooling in commercial sector.
Communications Cost per Customer Per Year	$7	Same as AC DLC
Overhead: First Costs (2007$)	$500,000	Standard assumption of development costs, plus additional 25% for addition of hot water heating program option
Technical Potential as % of Load Basis	100%	Assumes all central AC units and electric hot water units customers can be retrofit
Program Participation (%)	Water Heating – See below	Assumes 25% of participating cooling load will sign up for program (same as DLC AC only, 40% in Utah). By state and segment, water heating program participation is assumed to be the same rate of program sign-up, but accounts for the saturation of electric hot water heating of customers with central AC. It is calculated as the (% of customers with electric hot water and central cooling / % of customers with electric hot water heating) * central AC participation rate.
Event Participation (%)	92%	Event participation is combination of portion of units that respond and cycling strategy. Utah Cool Keeper historic event participation is based on homeowners removing units and operational breakdowns (92%). This figure is consistent with Xcel, MidAm and EON. Lower rates were experienced by SMUD and PSE&G (80%). Also includes 50% cycling strategy. Hot water heating event participation utilizes 92% because no cycling strategy is employed.
per Customer Impacts (kW)	varies	Single family per customer cooling impacts based on PacifiCorp and other national utility experience. Commercial cooling customers and electric hot water heating for residential are calculated as (Load Basis / # of customers with Central AC) * Cycling Strategy of 50%

Table B.5. Inputs Varying By Market Segment

State/Market Segment	End Use	Program Participation (%)
California		
Single_Family	Water Heating	5%
Multi_Family	Water Heating	3%
Manufactured	Water Heating	7%
Idaho		
Single_Family	Water Heating	3%
Multi_Family	Water Heating	1%
Manufactured	Water Heating	7%
Oregon		
Single_Family	Water Heating	6%
Multi_Family	Water Heating	3%
Manufactured	Water Heating	10%
Utah		
Single_Family	Water Heating	16%
Multi_Family	Water Heating	16%
Manufactured	Water Heating	0%
Washington		
Single_Family	Water Heating	11%
Multi_Family	Water Heating	7%
Manufactured	Water Heating	15%
Wyoming		
Single_Family	Water Heating	7%
Multi_Family	Water Heating	4%
Manufactured	Water Heating	12%

DLC Commercial

Table B.6. Program Basics

Program Name	DLC - Commercial
Customer Sectors Eligible	All Commercial Market Segments
End Uses Eligible for Program	Cooling, Hot Water, Lighting, Plug load, Refrigeration
Customer Size Requirements, if any	Loads greater than 250 kW due to EMS system requirements
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	Top 40 Winter Hours

Table B.7. Inputs and Sources Not Varying by State or Sector

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	10%	Based on 5% change of electrical service, and assumes 5% removal rate based on commercial customer concerns about direct load control of end uses
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new participant)	see array	Cost estimates assume that the sites have centralized EMS systems and are based on costs Nexant has reviewed for participants in PG&E's Auto Critical Peak Pricing Program. These costs reflect a hierarchy of demand response measures that goes: 1) Cooling 2) Lighting 3)Hot Water 4) Process 5) Plug load. DLC projects require a costly interface with existing EMS controls. It is assumed that these controls will be linked to facilitate Cooling DR measures initially, with additional measures, most often lighting, added on once the system is connected. i.e. Lighting measures cannot be implemented at the lower cost without first incurring the costs associated with Cooling measures.
Marketing Cost (per new participant)	$500	Assumes marketing costs are $500 for new participants; Xcel pays $56/customer
Incentives (annual costs per participating kW)	$72	Assumes $6/kW per month based on need to pay customers higher incentives to have direct control over loads (see Curtailable Load Program incentive reference)
Overhead: First Costs (2007$)	$400,000	Standard Program Development Assumption, including necessary internal labor, research and IT/billing system changes
Technical Potential as % of Load Basis	Varies by Sector, see below	Based on detailed engineering audits of demand response potential of commercial and industrial customers throughout California by Nexant, with third-party verification of results. Findings are amalgamated by sector and end use category and supported by senior engineering analysis.
Program Participation (%)	1%	Survey results indicate zero achievable potential when combined with other programs; 10% high stand alone potential. Assuming most likely is 1%
Event Participation (%)	90%	Based on Xcel Energy Peak Controlled Rates; Consistent with other similar programs
per Customer Impacts (kW)	Varies by Sector	Product of technical potential and average kW of customers greater than 250 kW (PC database of C&I customers)

Table B.8. Inputs Varying by Market Segment

State/Market Segment	End Use	Eligible Load (% of Load >250 kW)	Technical Potential as % of Load Basis	per Customer First Cost
California				
Grocery	Cooling	22%	15%	$11,000
Grocery	Hot Water	22%	100%	$1,800
Grocery	Lighting	22%	10%	$3,000
Grocery	Plug Load	22%	0%	$2,400
Grocery	Refrigeration	22%	15%	$7,000
Health	Cooling	31%	10%	$11,000
Health	Hot Water	31%	0%	$1,800
Health	Lighting	31%	20%	$3,000
Health	Plug Load	31%	5%	$2,400
Health	Refrigeration	31%	15%	$7,000
Lodging	Cooling	14%	5%	$11,000
Lodging	Hot Water	14%	10%	$1,800
Lodging	Lighting	14%	10%	$3,000
Lodging	Plug Load	14%	10%	$2,400
Miscellaneous	Cooling	24%	15%	$11,000
Miscellaneous	Hot Water	24%	50%	$1,800
Miscellaneous	Lighting	24%	10%	$3,000
Miscellaneous	Plug Load	24%	5%	$2,400
Restaurant	Cooling	0%	10%	$11,000
Restaurant	Hot Water	0%	20%	$1,800
Restaurant	Lighting	0%	5%	$3,000
Restaurant	Plug Load	0%	0%	$2,400
Restaurant	Refrigeration	0%	15%	$7,000
School	Cooling	15%	15%	$11,000
School	Hot Water	15%	50%	$1,800
School	Lighting	15%	20%	$3,000
School	Plug Load	15%	10%	$2,400
School	Refrigeration	15%	15%	$7,000
Small_Office	Cooling	0%	18%	$11,000
Small_Office	Hot Water	0%	60%	$1,800
Small_Office	Lighting	0%	20%	$3,000
Small_Office	Plug Load	0%	10%	$2,400
Small_Retail	Cooling	0%	15%	$11,000
Small_Retail	Hot Water	0%	100%	$1,800
Small_Retail	Lighting	0%	10%	$3,000
Small_Retail	Plug Load	0%	0%	$2,400
Warehouse	Cooling	13%	15%	$11,000
Warehouse	Hot Water	13%	100%	$1,800
Warehouse	Lighting	13%	20%	$3,000
Warehouse	Plug Load	13%	10%	$2,400
Warehouse	Refrigeration	13%	80%	$7,000

State/Market Segment	End Use	Eligible Load (% of Load >250 kW)	Technical Potential as % of Load Basis	per Customer First Cost
Idaho				
Grocery	Cooling	51%	15%	$11,000
Grocery	Hot Water	51%	100%	$1,800
Grocery	Lighting	51%	10%	$3,000
Grocery	Plug Load	51%	0%	$2,400
Grocery	Refrigeration	51%	15%	$7,000
Health	Cooling	16%	10%	$11,000
Health	Hot Water	16%	0%	$1,800
Health	Lighting	16%	20%	$3,000
Health	Plug Load	16%	5%	$2,400
Health	Refrigeration	16%	15%	$7,000
Large_Office	Cooling	0%	18%	$11,000
Large_Office	Hot Water	0%	60%	$1,800
Large_Office	Lighting	0%	20%	$3,000
Large_Office	Plug Load	0%	10%	$2,400
Large_Retail	Cooling	0%	15%	$11,000
Large_Retail	Hot Water	0%	100%	$1,800
Large_Retail	Lighting	0%	10%	$3,000
Large_Retail	Plug Load	0%	0%	$2,400
Lodging	Cooling	0%	5%	$11,000
Lodging	Hot Water	0%	10%	$1,800
Lodging	Lighting	0%	10%	$3,000
Lodging	Plug Load	0%	10%	$2,400
Miscellaneous	Cooling	26%	15%	$11,000
Miscellaneous	Hot Water	26%	50%	$1,800
Miscellaneous	Lighting	26%	10%	$3,000
Miscellaneous	Plug Load	26%	5%	$2,400
Restaurant	Cooling	0%	10%	$11,000
Restaurant	Hot Water	0%	20%	$1,800
Restaurant	Lighting	0%	5%	$3,000
Restaurant	Plug Load	0%	0%	$2,400
Restaurant	Refrigeration	0%	15%	$7,000
School	Cooling	45%	15%	$11,000
School	Hot Water	45%	50%	$1,800
School	Lighting	45%	20%	$3,000
School	Plug Load	45%	10%	$2,400
School	Refrigeration	45%	15%	$7,000
Small_Office	Cooling	0%	18%	$11,000
Small_Office	Hot Water	0%	60%	$1,800
Small_Office	Lighting	0%	20%	$3,000
Small_Office	Plug Load	0%	10%	$2,400
Small_Retail	Cooling	0%	15%	$11,000
Small_Retail	Hot Water	0%	100%	$1,800
Small_Retail	Lighting	0%	10%	$3,000
Small_Retail	Plug Load	0%	0%	$2,400
Warehouse	Cooling	13%	15%	$11,000
Warehouse	Hot Water	13%	100%	$1,800
Warehouse	Lighting	13%	20%	$3,000
Warehouse	Plug Load	13%	10%	$2,400
Warehouse	Refrigeration	13%	80%	$7,000

State/Market Segment	End Use	Eligible Load (% of Load >250 kW)	Technical Potential as % of Load Basis	per Customer First Cost
Oregon				
Grocery	Cooling	45%	15%	$11,000
Grocery	Hot Water	45%	100%	$1,800
Grocery	Lighting	45%	10%	$3,000
Grocery	Plug Load	45%	0%	$2,400
Grocery	Refrigeration	45%	15%	$7,000
Health	Cooling	44%	10%	$11,000
Health	Hot Water	44%	0%	$1,800
Health	Lighting	44%	20%	$3,000
Health	Plug Load	44%	5%	$2,400
Health	Refrigeration	44%	15%	$7,000
Large_Office	Cooling	51%	18%	$11,000
Large_Office	Hot Water	51%	60%	$1,800
Large_Office	Lighting	51%	20%	$3,000
Large_Office	Plug Load	51%	10%	$2,400
Large_Retail	Cooling	6%	15%	$11,000
Large_Retail	Hot Water	6%	100%	$1,800
Large_Retail	Lighting	6%	10%	$3,000
Large_Retail	Plug Load	6%	0%	$2,400
Lodging	Cooling	29%	5%	$11,000
Lodging	Hot Water	29%	10%	$1,800
Lodging	Lighting	29%	10%	$3,000
Lodging	Plug Load	29%	10%	$2,400
Miscellaneous	Cooling	31%	15%	$11,000
Miscellaneous	Hot Water	31%	50%	$1,800
Miscellaneous	Lighting	31%	10%	$3,000
Miscellaneous	Plug Load	31%	5%	$2,400
Restaurant	Cooling	1%	10%	$11,000
Restaurant	Hot Water	1%	20%	$1,800
Restaurant	Lighting	1%	5%	$3,000
Restaurant	Plug Load	1%	0%	$2,400
Restaurant	Refrigeration	1%	15%	$7,000
School	Cooling	48%	15%	$11,000
School	Hot Water	48%	50%	$1,800
School	Lighting	48%	20%	$3,000
School	Plug Load	48%	10%	$2,400
School	Refrigeration	48%	15%	$7,000
Small_Office	Cooling	0%	18%	$11,000
Small_Office	Hot Water	0%	60%	$1,800
Small_Office	Lighting	0%	20%	$3,000
Small_Office	Plug Load	0%	10%	$2,400
Small_Retail	Cooling	0%	15%	$11,000
Small_Retail	Hot Water	0%	100%	$1,800
Small_Retail	Lighting	0%	10%	$3,000
Small_Retail	Plug Load	0%	0%	$2,400
Warehouse	Cooling	39%	15%	$11,000
Warehouse	Hot Water	39%	100%	$1,800
Warehouse	Lighting	39%	20%	$3,000
Warehouse	Plug Load	39%	10%	$2,400
Warehouse	Refrigeration	39%	80%	$7,000

State/Market Segment	End Use	Eligible Load (% of Load >250 kW)	Technical Potential as % of Load Basis	per Customer First Cost
Utah				
Grocery	Cooling	64%	15%	$11,000
Grocery	Hot Water	64%	100%	$1,800
Grocery	Lighting	64%	10%	$3,000
Grocery	Plug Load	64%	0%	$2,400
Grocery	Refrigeration	64%	15%	$7,000
Health	Cooling	62%	10%	$11,000
Health	Hot Water	62%	0%	$1,800
Health	Lighting	62%	20%	$3,000
Health	Plug Load	62%	5%	$2,400
Health	Refrigeration	62%	15%	$7,000
Large_Office	Cooling	23%	18%	$11,000
Large_Office	Hot Water	23%	60%	$1,800
Large_Office	Lighting	23%	20%	$3,000
Large_Office	Plug Load	23%	10%	$2,400
Large_Retail	Cooling	13%	15%	$11,000
Large_Retail	Hot Water	13%	100%	$1,800
Large_Retail	Lighting	13%	10%	$3,000
Large_Retail	Plug Load	13%	0%	$2,400
Lodging	Cooling	43%	5%	$11,000
Lodging	Hot Water	43%	10%	$1,800
Lodging	Lighting	43%	10%	$3,000
Lodging	Plug Load	43%	10%	$2,400
Miscellaneous	Cooling	49%	15%	$11,000
Miscellaneous	Hot Water	49%	50%	$1,800
Miscellaneous	Lighting	49%	10%	$3,000
Miscellaneous	Plug Load	49%	5%	$2,400
Restaurant	Cooling	1%	10%	$11,000
Restaurant	Hot Water	1%	20%	$1,800
Restaurant	Lighting	1%	5%	$3,000
Restaurant	Plug Load	1%	0%	$2,400
Restaurant	Refrigeration	1%	15%	$7,000
School	Cooling	67%	15%	$11,000
School	Hot Water	67%	50%	$1,800
School	Lighting	67%	20%	$3,000
School	Plug Load	67%	10%	$2,400
School	Refrigeration	67%	15%	$7,000
Small_Office	Cooling	0%	18%	$11,000
Small_Office	Hot Water	0%	60%	$1,800
Small_Office	Lighting	0%	20%	$3,000
Small_Office	Plug Load	0%	10%	$2,400
Small_Retail	Cooling	0%	15%	$11,000
Small_Retail	Hot Water	0%	100%	$1,800
Small_Retail	Lighting	0%	10%	$3,000
Small_Retail	Plug Load	0%	0%	$2,400
Warehouse	Cooling	35%	15%	$11,000
Warehouse	Hot Water	35%	100%	$1,800
Warehouse	Lighting	35%	20%	$3,000
Warehouse	Plug Load	35%	10%	$2,400
Warehouse	Refrigeration	35%	80%	$7,000

State/Market Segment	End Use	Eligible Load (% of Load >250 kW)	Technical Potential as % of Load Basis	per Customer First Cost
Washington				
Grocery	Cooling	54%	15%	$11,000
Grocery	Hot Water	54%	100%	$1,800
Grocery	Lighting	54%	10%	$3,000
Grocery	Plug Load	54%	0%	$2,400
Grocery	Refrigeration	54%	15%	$7,000
Health	Cooling	47%	10%	$11,000
Health	Hot Water	47%	0%	$1,800
Health	Lighting	47%	20%	$3,000
Health	Plug Load	47%	5%	$2,400
Health	Refrigeration	47%	15%	$7,000
Large_Office	Cooling	17%	18%	$11,000
Large_Office	Hot Water	17%	60%	$1,800
Large_Office	Lighting	17%	20%	$3,000
Large_Office	Plug Load	17%	10%	$2,400
Large_Retail	Cooling	3%	15%	$11,000
Large_Retail	Hot Water	3%	100%	$1,800
Large_Retail	Lighting	3%	10%	$3,000
Large_Retail	Plug Load	3%	0%	$2,400
Lodging	Cooling	32%	5%	$11,000
Lodging	Hot Water	32%	10%	$1,800
Lodging	Lighting	32%	10%	$3,000
Lodging	Plug Load	32%	10%	$2,400
Miscellaneous	Cooling	37%	15%	$11,000
Miscellaneous	Hot Water	37%	50%	$1,800
Miscellaneous	Lighting	37%	10%	$3,000
Miscellaneous	Plug Load	37%	5%	$2,400
Restaurant	Cooling	8%	10%	$11,000
Restaurant	Hot Water	8%	20%	$1,800
Restaurant	Lighting	8%	5%	$3,000
Restaurant	Plug Load	8%	0%	$2,400
Restaurant	Refrigeration	8%	15%	$7,000
School	Cooling	59%	15%	$11,000
School	Hot Water	59%	50%	$1,800
School	Lighting	59%	20%	$3,000
School	Plug Load	59%	10%	$2,400
School	Refrigeration	59%	15%	$7,000
Small_Office	Cooling	0%	18%	$11,000
Small_Office	Hot Water	0%	60%	$1,800
Small_Office	Lighting	0%	20%	$3,000
Small_Office	Plug Load	0%	10%	$2,400
Small_Retail	Cooling	0%	15%	$11,000
Small_Retail	Hot Water	0%	100%	$1,800
Small_Retail	Lighting	0%	10%	$3,000
Small_Retail	Plug Load	0%	0%	$2,400
Warehouse	Cooling	76%	15%	$11,000
Warehouse	Hot Water	76%	100%	$1,800
Warehouse	Lighting	76%	20%	$3,000
Warehouse	Plug Load	76%	10%	$2,400
Warehouse	Refrigeration	76%	80%	$7,000

State/Market Segment	End Use	Eligible Load (% of Load >250 kW)	Technical Potential as % of Load Basis	per Customer First Cost
Wyoming				
Grocery	Cooling	46%	15%	$11,000

Irrigation

Table B.9. Program Basics

Program Name	Irrigation
Customer Sectors Eligible	Irrigation only
End Uses Eligible for Program	Irrigation Pumping
Customer Size Requirements, if any	All irrigation customers
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	No Winter

Table B.10. Inputs and Sources not Varying by State or Sector

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	5%	Based on changes in electrical service
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new participant)	$1,000	Technology costs assume $1000 per new participant for installation costs
Marketing Cost (per new participant)	$500	Both Idaho Power and PacifiCorp marketing costs are approximately $500 per new participant
Incentives (annual costs per participating kW)	$20	Idaho Power currently pays $16/kW/year; although Rocky Mountain Power pays $11/kW, high program participation rates and acceptance by customers can be attained only with higher incentives, particularly in diverse geographic regions
Incentives (annual costs per participating kW)	$10	Ongoing Maintenance and Communications (per KW)
Overhead: First Costs (2007$)	$400,000	Standard Program Development Assumption, including necessary internal labor, research and IT/billing system changes
Technical Potential as % of Load Basis	100%	Assumes all loads can be controlled
Program Participation (%)	25%	Idaho Power and PacifiCorp have participation rates of 25% for the scheduled program. PacifiCorp has signed up an additional 45 MW for the DLC option, which totals 35% of the load basis. Assumes that more load is available (50%)
Event Participation (%)	75%	Assumes that one-half of participants will be on scheduled program where participants choose 2 days of each week to schedule reductions during peak times (50% event participation for 50% of program is an average of 75% event participation).
per Customer Impacts (kW)	Varies by Sector	Product of technical potential and average kW of customers greater than 250 kW (PC database of C&I customers)

Thermal Energy Storage

Table B.11. Program Basics

Program Name	Thermal Energy Storage
Customer Sectors Eligible	All Commercial Market Segments
End Uses Eligible for Program	Electric Cooling Loads
Customer Size Requirements, if any	All Commercial Customers with Load >30kW
Summer Load Basis	Average On-Peak Summer
Winter Load Basis	No Winter

Table B.12. Inputs and Sources not Varying by State or Sector

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	5%	Based on changes in electrical service
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new kW)	$800	Cost estimates assume a cost of $600/ton of cooling offset, which is slightly less than an estimate from the TES program manager at a rural electric utility in N. California. Assuming $600/ton due to proprietary knowledge by PacifiCorp. Higher costs quoted by Messenger, Mike. Technical Options Guidebook. Prepared for the California Energy Commission.
Marketing Cost (per new participant)	$500	Assuming 10 hours of effort by program staff valued at $50/hour.
Overhead: First Costs (2007$)	$200,000	Half of standard assumptions due to no changes in billing system
Technical Potential as % of Load Basis	Varies by Sector	Based on saturation of DX cooling by commercial market sector
Program Participation (%)	2.5%	Low participation rate based on Xcel and SCE programs
Event Participation (%)	100%	Highly reliable scheduling of pre-cooling
per Customer Impacts (kW)	Varies by Sector	Product of technical potential and average kW of customers greater than 250 kW (PC database of C&I customers)

Table B.13. Inputs Varying By Market Segment

State	Market Segment	**Eligible Load** (% of Load >30 kW)	**Tech Pot Savings as % of Gross**
CA	Grocery	87%	46%
ID	Grocery	89%	46%
OR	Grocery	90%	46%
UT	Grocery	95%	61%
WA	Grocery	90%	46%
WY	Grocery	90%	16%
ID	Large_Office	0%	57%
OR	Large_Office	77%	16%
UT	Large_Office	77%	73%
WA	Large_Office	48%	65%
WY	Large_Office	56%	73%
ID	Large_Retail	26%	73%
OR	Large_Retail	30%	73%
UT	Large_Retail	57%	73%
WA	Large_Retail	42%	73%
WY	Large_Retail	39%	30%
CA	School	88%	30%
ID	School	95%	30%
OR	School	95%	30%
UT	School	98%	40%
WA	School	94%	30%
WY	School	96%	32%
CA	Small_Retail	13%	23%
ID	Small_Retail	10%	21%
OR	Small_Retail	7%	23%
UT	Small_Retail	4%	28%
WA	Small_Retail	8%	33%
WY	Small_Retail	7%	62%
CA	Small_Office	49%	16%
ID	Small_Office	37%	57%
OR	Small_Office	46%	16%
UT	Small_Office	49%	73%
WA	Small_Office	37%	65%
WY	Small_Office	36%	65%

Curtailable Load

Table B.14. Program Basics

Program Name	Curtailable Load
Customer Sectors Eligible	All Industrial and Commercial Market Segments
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements, if any	Customers >250kW
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	Top 40 Winter Hours

Table B.15. Inputs Consistent Across Market Segments

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	5%	Based on electric service turn-over. MidAmerican and Minnesota Power reported 2% attrition.
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new participant)	$1,400	Technology Costs include communications, connectivity and meters, if necessary, based on California spending of $32m for 23,000 large C&I hardware after energy crisis
Marketing Cost (per new participant)	$500	Average marketing cost for Xcel was $1,300. We assume $500/customer
Incentives (annual costs per participating kW)	$48	Assumes $4/kW per month (PG&E pays $3-$7/kWMonth, SCE pays $7/kWMonth, Wisconsin pays $3.3/kWMonth, Mid-American pays $3.3, Duke pays $3.5/kW-Month, Alliant pays $4.7, Xcel pays $3.4)
Overhead: First Costs (2007$)	$400,000	Standard Program Development Assumption, including necessary internal labor, research and IT/billing system changes
Technical Potential as % of Load Basis	Varies by Sector, See Below	Based on detailed engineering audits of demand response potential of commercial and industrial customers throughout California by Nexant, with third-party verification of results. Findings are amalgamated by sector and end use category and supported by senior engineering analysis.
Program Participation (%)	Varies by Sector, See Below	Survey Results assuming other program offerings
Event Participation (%)	100%	MidAmerican and MN Power have 100% event participation rates
per Customer Impacts (kW)	Varies by Sector	Commercial customers average demand reduction is (Load Basis / # of customers) * Technical Potential

Table B.16. Inputs Varying By Market Segment

Sector	Market Segment	End Use	Eligible Load (% Load >250 kW)	Technical Potential as % of Load Basis	Program Participation (%)
CA	Grocery	Segment Total	22%	5%	13%
ID	Grocery	Segment Total	51%	5%	13%
OR	Grocery	Segment Total	45%	5%	13%
UT	Grocery	Segment Total	64%	5%	13%
WA	Grocery	Segment Total	54%	5%	13%
WY	Grocery	Segment Total	46%	5%	13%
CA	Health	Segment Total	31%	12%	0%
ID	Health	Segment Total	16%	12%	0%
OR	Health	Segment Total	44%	12%	0%
UT	Health	Segment Total	62%	12%	0%
WA	Health	Segment Total	47%	12%	0%
WY	Health	Segment Total	55%	12%	0%
ID	Large_Office	Segment Total	0%	16%	21%
OR	Large_Office	Segment Total	51%	16%	21%
UT	Large_Office	Segment Total	23%	16%	21%
WA	Large_Office	Segment Total	17%	16%	21%
WY	Large_Office	Segment Total	13%	16%	21%
ID	Large_Retail	Segment Total	0%	16%	8%
OR	Large_Retail	Segment Total	6%	16%	8%
UT	Large_Retail	Segment Total	13%	16%	8%
WA	Large_Retail	Segment Total	3%	16%	8%
WY	Large_Retail	Segment Total	0%	16%	8%
CA	Lodging	Segment Total	14%	17%	0%
ID	Lodging	Segment Total	0%	17%	0%
OR	Lodging	Segment Total	29%	17%	0%
UT	Lodging	Segment Total	43%	17%	0%
WA	Lodging	Segment Total	32%	17%	0%
WY	Lodging	Segment Total	31%	17%	0%
CA	Miscellaneous	Segment Total	24%	16%	13%
ID	Miscellaneous	Segment Total	26%	16%	13%
OR	Miscellaneous	Segment Total	31%	16%	13%
UT	Miscellaneous	Segment Total	49%	16%	13%
WA	Miscellaneous	Segment Total	37%	16%	13%
WY	Miscellaneous	Segment Total	40%	16%	13%
CA	Restaurant	Segment Total	0%	17%	25%
ID	Restaurant	Segment Total	0%	17%	25%
OR	Restaurant	Segment Total	1%	17%	25%
UT	Restaurant	Segment Total	1%	17%	25%
WA	Restaurant	Segment Total	8%	17%	25%
WY	Restaurant	Segment Total	0%	17%	25%
CA	School	Segment Total	15%	17%	23%
ID	School	Segment Total	45%	17%	23%
OR	School	Segment Total	48%	17%	23%
UT	School	Segment Total	67%	17%	23%
WA	School	Segment Total	59%	17%	23%
WY	School	Segment Total	59%	17%	23%

Sector	Market Segment	End Use	Eligible Load (% Load >250 kW)	Technical Potential as % of Load Basis	Program Participation (%)
CA	Small_Office	Segment Total	0%	7%	21%
ID	Small_Office	Segment Total	0%	7%	21%
OR	Small_Office	Segment Total	0%	7%	21%
UT	Small_Office	Segment Total	0%	7%	21%
WA	Small_Office	Segment Total	0%	7%	21%
WY	Small_Office	Segment Total	0%	7%	21%
CA	Small_Retail	Segment Total	0%	15%	8%
ID	Small_Retail	Segment Total	0%	15%	8%
OR	Small_Retail	Segment Total	0%	15%	8%
UT	Small_Retail	Segment Total	0%	15%	8%
WA	Small_Retail	Segment Total	0%	15%	8%
WY	Small_Retail	Segment Total	0%	15%	8%
CA	Warehouse	Segment Total	13%	16%	13%
ID	Warehouse	Segment Total	13%	16%	13%
OR	Warehouse	Segment Total	39%	16%	13%
UT	Warehouse	Segment Total	35%	16%	13%
WA	Warehouse	Segment Total	76%	16%	13%
WY	Warehouse	Segment Total	0%	16%	13%
ID	Chemical_Mfg	Segment Total	100%	17%	6%
UT	Chemical_Mfg	Segment Total	94%	17%	6%
WY	Chemical_Mfg	Segment Total	99%	17%	6%
UT	Electronic_Equipment_Mfg	Segment Total	84%	17%	6%
ID	Food_Mfg	Segment Total	92%	18%	6%
OR	Food_Mfg	Segment Total	87%	18%	6%
UT	Food_Mfg	Segment Total	90%	18%	6%
WA	Food_Mfg	Segment Total	81%	18%	6%
UT	Industrial_Machinery	Segment Total	59%	17%	6%
CA	Lumber_Wood_Products	Segment Total	92%	17%	6%
OR	Lumber_Wood_Products	Segment Total	94%	17%	6%
WA	Lumber_Wood_Products	Segment Total	79%	17%	6%
UT	Mining	Segment Total	95%	17%	6%
WY	Mining	Segment Total	97%	17%	6%
CA	Miscellaneous_Mfg	Segment Total	42%	17%	6%
ID	Miscellaneous_Mfg	Segment Total	84%	17%	6%
OR	Miscellaneous_Mfg	Segment Total	75%	17%	6%
UT	Miscellaneous_Mfg	Segment Total	82%	17%	6%
WA	Miscellaneous_Mfg	Segment Total	71%	17%	6%
WY	Miscellaneous_Mfg	Segment Total	91%	17%	6%
UT	Petroleum_Refining	Segment Total	97%	17%	0%
WY	Petroleum_Refining	Segment Total	97%	17%	0%
OR	Primary_Metal_Mfg	Segment Total	96%	17%	6%
UT	Primary_Metal_Mfg	Segment Total	99%	17%	6%

Sector	Market Segment	End Use	**Eligible Load** (% Load >250 kW)	**Technical Potential as % of Load Basis**	**Program Participation** (%)
UT	Stone_Clay_Glass_ Products	Segment Total	92%	17%	6%
UT	Stone_Clay_Glass_ Products	Segment Total	92%	17%	6%
UT	Transportation_Equi pment_Mfg	Segment Total	93%	17%	6%

Demand Bidding

Table B.17. Program Basics

Program Name	Demand Bidding
Customer Sectors Eligible	All Commercial and Industrial Market Segments
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements, if any	Customers >250kW
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	Top 40 Winter Hours

Table B.18. Inputs and Sources not Varying by State or Sector

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	5%	Based on rate of electric turnover
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new participant)	$1,400	Technology Costs include communications, connectivity and meters, if necessary, based on California spending of $32m for 23,000 large C&I hardware after energy crisis
Marketing Cost (per new participant)	$500	Assumes $500 per customer for marketing.
Incentives (annual costs per participating kW)	$10	Estimate of $10 per kW from 2000-2002 Demand Exchange Program based on average market prices of $100/MWh
Overhead: First Costs (2007$)	$400,000	Standard Program Development Assumption, including necessary internal labor, research and IT/billing system changes
Technical Potential as % of Load Basis	Varies by Sector, See Below	Based on detailed engineering audits of demand response potential of commercial and industrial customers throughout California by Nexant, with third-party verification of results.
Program Participation (%)	Varies by Sector, See Below	Survey Results assuming other program offerings
Event Participation (%)	36%	Event participation based on 2006 PacifiCorp results of average of 12 MW per event (18% event participation), with average price paid of $130/MWh -- assuming that increased focus on program could double event participation
per Customer Impacts (kW)	Varies by Sector	Product of technical potential and average kW of customers greater than 250 kW (PC database of C&I customers)

Table B.19. Inputs Varying By Market Segment

Sector	Market Segment	End Use	Eligible Load (% Load >250 kW)	Technical Potential as % of Load Basis	Program Participation (%)
CA	Grocery	Segment Total	22%	5%	20%
ID	Grocery	Segment Total	51%	5%	20%
OR	Grocery	Segment Total	45%	5%	20%
UT	Grocery	Segment Total	64%	5%	20%
WA	Grocery	Segment Total	54%	5%	20%
WY	Grocery	Segment Total	46%	5%	20%
CA	Health	Segment Total	31%	12%	0%
ID	Health	Segment Total	16%	12%	0%
OR	Health	Segment Total	44%	12%	0%
UT	Health	Segment Total	62%	12%	0%
WA	Health	Segment Total	47%	12%	0%
WY	Health	Segment Total	55%	12%	0%
ID	Large_Office	Segment Total	0%	16%	20%
OR	Large_Office	Segment Total	51%	16%	20%
UT	Large_Office	Segment Total	23%	16%	20%
WA	Large_Office	Segment Total	17%	16%	20%
WY	Large_Office	Segment Total	13%	16%	20%
ID	Large_Retail	Segment Total	0%	16%	20%
OR	Large_Retail	Segment Total	6%	16%	20%
UT	Large_Retail	Segment Total	13%	16%	20%
WA	Large_Retail	Segment Total	3%	16%	20%
WY	Large_Retail	Segment Total	0%	16%	20%
CA	Lodging	Segment Total	14%	17%	0%
ID	Lodging	Segment Total	0%	17%	0%
OR	Lodging	Segment Total	29%	17%	0%
UT	Lodging	Segment Total	43%	17%	0%
WA	Lodging	Segment Total	32%	17%	0%
WY	Lodging	Segment Total	31%	17%	0%
CA	Miscellaneous	Segment Total	24%	16%	20%
ID	Miscellaneous	Segment Total	26%	16%	20%
OR	Miscellaneous	Segment Total	31%	16%	20%
UT	Miscellaneous	Segment Total	49%	16%	20%
WA	Miscellaneous	Segment Total	37%	16%	20%
WY	Miscellaneous	Segment Total	40%	16%	20%
CA	Restaurant	Segment Total	0%	17%	15%
ID	Restaurant	Segment Total	0%	17%	15%
OR	Restaurant	Segment Total	1%	17%	15%
UT	Restaurant	Segment Total	1%	17%	15%
WA	Restaurant	Segment Total	8%	17%	15%
WY	Restaurant	Segment Total	0%	17%	15%
CA	School	Segment Total	15%	17%	0%
ID	School	Segment Total	45%	17%	0%
OR	School	Segment Total	48%	17%	0%
UT	School	Segment Total	67%	17%	0%
WA	School	Segment Total	59%	17%	0%
WY	School	Segment Total	59%	17%	0%

Sector	Market Segment	End Use	Eligible Load (% Load >250 kW)	Technical Potential as % of Load Basis	Program Participation (%)
CA	Small_Office	Segment Total	0%	7%	20%
ID	Small_Office	Segment Total	0%	7%	20%
OR	Small_Office	Segment Total	0%	7%	20%
UT	Small_Office	Segment Total	0%	7%	20%
WA	Small_Office	Segment Total	0%	7%	20%
WY	Small_Office	Segment Total	0%	7%	20%
CA	Small_Retail	Segment Total	0%	15%	20%
ID	Small_Retail	Segment Total	0%	15%	20%
OR	Small_Retail	Segment Total	0%	15%	20%
UT	Small_Retail	Segment Total	0%	15%	20%
WA	Small_Retail	Segment Total	0%	15%	20%
WY	Small_Retail	Segment Total	0%	15%	20%
CA	Warehouse	Segment Total	13%	16%	20%
ID	Warehouse	Segment Total	13%	16%	20%
OR	Warehouse	Segment Total	39%	16%	20%
UT	Warehouse	Segment Total	35%	16%	20%
WA	Warehouse	Segment Total	76%	16%	20%
WY	Warehouse	Segment Total	0%	16%	20%
ID	Chemical_Mfg	Segment Total	100%	17%	20%
UT	Chemical_Mfg	Segment Total	94%	17%	20%
WY	Chemical_Mfg	Segment Total	99%	17%	20%
UT	Electronic_Equipment_Mfg	Segment Total	84%	17%	20%
ID	Food_Mfg	Segment Total	92%	18%	20%
OR	Food_Mfg	Segment Total	87%	18%	20%
UT	Food_Mfg	Segment Total	90%	18%	20%
WA	Food_Mfg	Segment Total	81%	18%	20%
UT	Industrial_Machinery	Segment Total	59%	17%	20%
CA	Irrigation	Segment Total	10%	15%	20%
ID	Irrigation	Segment Total	42%	15%	20%
OR	Irrigation	Segment Total	41%	15%	20%
UT	Irrigation	Segment Total	11%	15%	20%
WA	Irrigation	Segment Total	43%	15%	20%
WY	Irrigation	Segment Total	3%	15%	20%
CA	Lumber_Wood_Products	Segment Total	92%	17%	20%
OR	Lumber_Wood_Products	Segment Total	94%	17%	20%
WA	Lumber_Wood_Products	Segment Total	79%	17%	20%
UT	Mining	Segment Total	95%	17%	20%
WY	Mining	Segment Total	97%	17%	20%
CA	Miscellaneous_Mfg	Segment Total	42%	17%	20%
ID	Miscellaneous_Mfg	Segment Total	84%	17%	20%
OR	Miscellaneous_Mfg	Segment Total	75%	17%	20%
UT	Miscellaneous_Mfg	Segment Total	82%	17%	20%
WA	Miscellaneous_Mfg	Segment Total	71%	17%	20%
WY	Miscellaneous_Mfg	Segment Total	91%	17%	20%

Sector	Market Segment	End Use	Eligible Load (% Load >250 kW)	Technical Potential as % of Load Basis	Program Participation (%)
OR	Paper_Mfg	Segment Total	100%	17%	20%
WA	Paper_Mfg	Segment Total	99%	17%	20%
UT	Petroleum_Refining	Segment Total	97%	5%	0%
WY	Petroleum_Refining	Segment Total	97%	5%	0%
OR	Primary_Metal_Mfg	Segment Total	96%	17%	20%
UT	Primary_Metal_Mfg	Segment Total	99%	17%	20%
UT	Stone_Clay_Glass_Products	Segment Total	92%	17%	20%
UT	Transportation_Equipment_Mfg	Segment Total	93%	17%	20%

Residential Time of Use Rates

Table B.20. Program Basics

Program Name	Time Of Use Rates
Customer Sectors Eligible	All Residential Market Segments
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements, if any	Residential
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	Top 40 Winter Hours

Table B.21. Inputs and Sources not Varying by State or Sector

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	5%	Consistent with PacifiCorp electric turnovers. Rate of 3.5% reported by Rosemary Morley of FPL.
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new participant)	$100	Incremental cost of a TOU meter, APS and FERC 2006
Marketing Cost (per new participant)	$25	APS reported incremental costs of $20-$30 per new participant, including marketing costs and support.
Incentives (annual costs per participant)	$0	Bill savings may accrue for some customers, equating to lost revenues for the utility. This analysis assumes revenue neutrality for the utility.
Overhead: First Costs (2007$)	$400,000	Standard Program Development Assumption, including necessary internal labor, research and IT/billing system changes
Technical Potential as % of Load Basis	5%	California residential pricing programs results from CA SPP , fixed TOU show 5% average peak demand reduced (Charles River Associates, 2005). Results from Puget Sound Energy's cancelled TOU program are similar.
Program Participation (%)	10%	APS has the highest TOU enrollment of any utility in the country at nearly 400,000 participants or 45% of residential customers (Chuck Miessner, APS, 2007; FERC report of 2006). The participation rate of the top 10 highest-enrolled TOU programs in the country is on average 16% (excluding the mandatory rates by PS Oklahoma. Yet, these programs do not represent the experience of all national programs; many TOU programs around the country have participation rates of <1% (but many of these are legacy programs that are not being promoted). Even among the top 10 highest enrollment programs (according to FERC), half have single digit participation rates. If a reasonable effort is made, the reasonable low range might be 2%, which is the lowest participation rate among the top 10 programs, and an expected participation rate of 10%.
Event Participation (%)	100%	There are no "events" with TOU rates. Participation can be viewed as 100%.
per Customer Impacts (kW)		Product of technical potential and average kW of customers based on load basis. Consistent with national studies.

Residential and Small Commercial Critical Peak Pricing

Table B.22. Program Basics

Program Name	Critical Peak Pricing - Residential
Customer Sectors Eligible	All Residential Market Segments and Commercial Segments (Load <30 kW)
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements, if any	Load <30 kW
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	Top 40 Winter Hours

Table B.23. Inputs and Sources not Varying by State or Sector

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	5%	Based on PacifiCorp electrical turn over. Consistent with that experienced by Gulf Power, which has the only full-scale Res CPP program. Source: Jim Thompson of Gulf Power reported "<5%" annual churn, presentation to PURC Energy Policy Roundtable, October 31, 2006
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new participant)	$300	Smart Thermostat: $100 installation and $200 for the meter
Marketing Cost (per new participant)	$50	Assumes more significant marketing efforts than TOU to sign customers onto the program. PSEG's annual pilot marketing costs were $190 per customer, which was likely a high value since it was for a pilot and did not have economies of scale.
Incentives (annual costs per participant)	n/a	There are no customer incentives, but the utility may not design the rate to be revenue neutral, which could prove to be a cost in terms of lost revenues.
Overhead: First Costs (2007$)	$600,000	Assumes 50% more than standard assumption due to additional labor and IT of combination of TOU rate and enabling technology in the home
Technical Potential as % of Load Basis	27%	California residential pilot CPP programs for statewide average(Charles River Associates, 2005).
Program Participation (%)	5%	Gulf Power has the only full-scale residential CPP program. The company reported 8500 participants as of October 2006, out of 350,000 residential customers (2.4%). Sources: Jim Thompson presentation to PURC Energy Policy Roundtable, October 31, 2006; and FERC Form 861 data, 2005. They expect to reach at least 10% penetration. Source: Dynamic Pricing, Advanced Metering and Demand Response in Electricity Markets, Severin Borenstein, Michael Jaske, and Arthur Rosenfeld, October 2002.
Event Participation (%)	95%	Opt-outs are typically less than 5% now that utilities are requiring customers to use the internet or call center to opt out of a CPP event (source: Comverge). With 2-way communications (through AMI or Zigbee gateway for example) utilities can identify and replace malfunctioning thermostats, so event participation is much higher than in older one-way switch based DLC programs.
per Customer Impacts (kW)	Varies by Sector	Product of technical potential and average kW of customers based on load basis. Consistent with national studies.

Commercial and Industrial: Critical Peak Pricing

Table B.24. Program Basics

Program Name	Critical Peak Pricing - C&I
Customer Sectors Eligible	All Commercial and Industrial Market Segments
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements, if any	Commercial and Industrial greater than 30 kW
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	Top 40 Winter Hours

Table B.25. Inputs and Sources not Varying by State or Sector

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	5%	Based on PacifiCorp electrical turn over
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new participant)	$1,400	Technology Costs include communications, connectivity and meters, if necessary, based on California spending of $32m for 23,000 large C&I hardware after energy crisis
Marketing Cost (per new participant)	$500	Assumes 10 hours of effort by staff valued at $50/hour
Incentives (annual costs per participant)	n/a	There are no customer incentives, but the utility may not design the rate to be revenue neutral, which could prove to be a cost in terms of lost revenues.
Overhead: First Costs (2007$)	$400,000	Standard Program Development Assumption, including necessary internal labor, research and IT/billing system changes
Technical Potential as % of Load Basis	Varies by Sector	Based on detailed engineering audits of demand response potential of commercial and industrial customers throughout California by Nexant, with third-party verification of results. Studies of CPP results show that 8% was saved on average (LBNL Fully Automated CPP study, 2006), which is comparable to taking this technical potential and the event participation combined.
Program Participation (%)	Varies by Sector	Survey Results assuming other program offerings
Event Participation (%)	56%	Based on 2006 California C&I results for CPP Pilot
per Customer Impacts (kW)	Varies by Sector	Product of technical potential and average kW of customers (PC database of C&I customers)

Table B.26. Inputs Varying By Market Segment

Sector	Market Segment	Tech Pot Savings as % of Gross	Program Participation (%)
CA	Grocery	5%	12%
ID	Grocery	5%	12%
OR	Grocery	5%	12%
UT	Grocery	5%	12%
WA	Grocery	5%	12%
WY	Grocery	5%	12%
CA	Health	12%	0%
ID	Health	12%	0%
OR	Health	12%	0%
UT	Health	12%	0%
WA	Health	12%	0%
WY	Health	12%	0%
ID	Large_Office	16%	8%
OR	Large_Office	16%	8%
UT	Large_Office	16%	8%
WA	Large_Office	16%	8%
WY	Large_Office	16%	8%
ID	Large_Retail	16%	16%
OR	Large_Retail	16%	16%
UT	Large_Retail	16%	16%
WA	Large_Retail	16%	16%
WY	Large_Retail	16%	16%
CA	Lodging	17%	0%
ID	Lodging	17%	0%
OR	Lodging	17%	0%
UT	Lodging	17%	0%
WA	Lodging	17%	0%
WY	Lodging	17%	0%
CA	Miscellaneous	16%	12%
ID	Miscellaneous	16%	12%
OR	Miscellaneous	16%	12%
UT	Miscellaneous	16%	12%
WA	Miscellaneous	16%	12%
WY	Miscellaneous	16%	12%
CA	Restaurant	17%	25%
ID	Restaurant	17%	25%
OR	Restaurant	17%	25%
UT	Restaurant	17%	25%
WA	Restaurant	17%	25%
WY	Restaurant	17%	25%
CA	School	17%	18%
ID	School	17%	18%
OR	School	17%	18%
UT	School	17%	18%
WA	School	17%	18%
WY	School	17%	18%

Sector	Market Segment	Tech Pot Savings as % of Gross	Program Participation (%)
CA	Small_Office	7%	8%
ID	Small_Office	7%	8%
OR	Small_Office	7%	8%
UT	Small_Office	7%	8%
WA	Small_Office	7%	8%
WY	Small_Office	7%	8%
CA	Small_Retail	15%	16%
ID	Small_Retail	15%	16%
OR	Small_Retail	15%	16%
UT	Small_Retail	15%	16%
WA	Small_Retail	15%	16%
WY	Small_Retail	15%	16%
CA	Warehouse	16%	12%
ID	Warehouse	16%	12%
OR	Warehouse	16%	12%
UT	Warehouse	16%	12%
WA	Warehouse	16%	12%
WY	Warehouse	16%	12%
ID	Chemical_Mfg	17%	24%
UT	Chemical_Mfg	17%	24%
WY	Chemical_Mfg	17%	24%
UT	Electronic_Equipment_Mfg	17%	24%
ID	Food_Mfg	18%	24%
OR	Food_Mfg	18%	24%
UT	Food_Mfg	18%	24%
WA	Food_Mfg	18%	24%
UT	Industrial_Machinery	17%	24%
CA	Irrigation	15%	24%
ID	Irrigation	15%	24%
OR	Irrigation	15%	24%
UT	Irrigation	15%	24%
WA	Irrigation	15%	24%
WY	Irrigation	15%	24%
CA	Lumber_Wood_Products	17%	24%
OR	Lumber_Wood_Products	17%	24%
WA	Lumber_Wood_Products	17%	24%
UT	Mining	17%	24%
WY	Mining	17%	24%
CA	Miscellaneous_Mfg	17%	24%
ID	Miscellaneous_Mfg	17%	24%
OR	Miscellaneous_Mfg	17%	24%
UT	Miscellaneous_Mfg	17%	24%
WA	Miscellaneous_Mfg	17%	24%
WY	Miscellaneous_Mfg	17%	24%
OR	Paper_Mfg	17%	24%
WA	Paper_Mfg	17%	24%
UT	Petroleum_Refining	17%	0%
WY	Petroleum_Refining	17%	0%

Sector	Market Segment	Tech Pot Savings as % of Gross	Program Participation (%)
OR	Primary_Metal_Mfg	17%	24%
UT	Primary_Metal_Mfg	17%	24%
UT	Stone_Clay_Glass_Products	17%	24%
UT	Transportation_Equipment_Mfg	17%	24%

Real Time Pricing

Table B.27. Program Basics

Program Name	Real Time Pricing Com
Customer Sectors Eligible	All Commercial and Industrial Market Segments
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements, if any	Greater than 250 kW
Summer Load Basis	Top 40 Summer Hours
Winter Load Basis	Top 40 Winter Hours

Table B.28. Inputs and Sources not Varying by State or Sector

Inputs	Value	Sources or Assumptions
Annual Attrition (%)	5%	Based on PacifiCorp electrical turn over
Annual Administrative Costs (%)	15%	All resource classes assume admin adder of 15%
Technology Cost (per new participant)	$1,400	Technology Costs include communications, connectivity and meters, if necessary, based on California spending of $32m for 23,000 large C&I hardware after energy crisis
Marketing Cost (per new participant)	$500	Assumes 10 hours of effort by staff valued at $50/hour
Incentives (annual costs per participant)	n/a	There are no customer incentives, but the utility may not design the rate to be revenue neutral, which could prove to be a cost in terms of lost revenues.
Overhead: First Costs (2007$)	$400,000	Standard Program Development Assumption, including necessary internal labor, research and IT/billing system changes
Technical Potential as % of Load Basis	Varies by Sector	Based on detailed engineering audits of demand response potential of commercial and industrial customers throughout California by Nexant, with third-party verification of results. Studies of CPP results show that 8% was saved on average (LBNL Fully Automated CPP study, 2006), which is comparable to taking this technical potential and the event participation combined.
Program Participation (%)	Varies by Sector	Survey Results assuming other program offerings
Event Participation (%)	100%	NA
per Customer Impacts (kW)	Varies by Sector	Product of technical potential and average kW of customers greater than 250 kW (PC database of C&I customers)

Table B.29. Inputs Varying By Market Segment

Sector/Market Segment	Eligible Load (% of Load >250 kW)	Tech Pot Savings as % of Gross	Program Participation (%)
California			
Small_Office	0%	7%	0%
Restaurant	0%	17%	0%
Small_Retail	0%	15%	0%
Grocery	22%	5%	2%
Warehouse	13%	16%	2%
School	15%	17%	5%
Health	31%	12%	0%
Lodging	14%	17%	0%
Miscellaneous	24%	16%	2%
Lumber_Wood_Products	92%	17%	4%
Irrigation	10%	15%	4%
Miscellaneous_Mfg	42%	17%	4%
Idaho			
Small_Office	0%	7%	0%
Large_Office	0%	16%	0%
Restaurant	0%	17%	0%
Large_Retail	0%	16%	0%
Small_Retail	0%	15%	0%
Grocery	51%	5%	2%
Warehouse	13%	16%	2%
School	45%	17%	5%
Health	16%	12%	0%
Lodging	0%	17%	0%
Miscellaneous	26%	16%	2%
Food_Mfg	92%	18%	4%
Chemical_Mfg	100%	17%	4%
Irrigation	42%	15%	4%
Miscellaneous_Mfg	84%	17%	4%
Oregon			
Small_Office	0%	7%	0%
Large_Office	51%	16%	0%
Restaurant	1%	17%	0%
Large_Retail	6%	16%	0%
Small_Retail	0%	15%	0%
Grocery	45%	5%	2%
Warehouse	39%	16%	2%
School	48%	17%	5%
Health	44%	12%	0%
Lodging	29%	17%	0%
Miscellaneous	31%	16%	2%
Food_Mfg	87%	18%	4%
Lumber_Wood_Products	94%	17%	4%
Paper_Mfg	100%	17%	4%
Primary_Metal_Mfg	96%	17%	4%
Irrigation	41%	15%	4%
Miscellaneous_Mfg	75%	17%	4%

Sector/Market Segment	Eligible Load (% of Load >250 kW)	Tech Pot Savings as % of Gross	Program Participation (%)
Utah			
Small_Office	0%	7%	0%
Large_Office	23%	16%	0%
Restaurant	1%	17%	0%
Large_Retail	13%	16%	0%
Small_Retail	0%	15%	0%
Grocery	64%	5%	2%
Warehouse	35%	16%	2%
School	67%	17%	5%
Health	62%	12%	0%
Lodging	43%	17%	0%
Miscellaneous	49%	16%	2%
Food_Mfg	90%	18%	4%
Chemical_Mfg	94%	17%	4%
Petroleum_Refining	97%	5%	0%
Stone_Clay_Glass_Products	92%	17%	4%
Primary_Metal_Mfg	99%	17%	4%
Industrial_Machinery	59%	17%	4%
Electronic_Equipment_Mfg	84%	17%	4%
Transportation_Equipment_Mfg	93%	17%	4%
Mining	95%	17%	4%
Irrigation	11%	15%	4%
Miscellaneous_Mfg	82%	17%	4%

Sector/Market Segment	Eligible Load (% of Load >250 kW)	Tech Pot Savings as % of Gross	Program Participation (%)
Wyoming			
Small_Office	0%	7%	0%
Large_Office	17%	16%	0%
Restaurant	8%	17%	0%
Large_Retail	3%	16%	0%
Small_Retail	0%	15%	0%
Grocery	54%	5%	2%
Warehouse	76%	16%	2%
School	59%	17%	5%
Health	47%	12%	0%
Lodging	32%	17%	0%
Miscellaneous	37%	16%	2%
Food_Mfg	81%	18%	4%
Lumber_Wood_Products	79%	17%	4%
Paper_Mfg	99%	17%	4%
Irrigation	43%	15%	4%
Miscellaneous_Mfg	71%	17%	4%
Small_Office	0%	7%	0%
Large_Office	13%	16%	0%
Restaurant	0%	17%	0%
Large_Retail	0%	16%	0%
Small_Retail	0%	15%	0%
Grocery	46%	5%	2%
Warehouse	0%	16%	2%
School	59%	17%	5%
Health	55%	12%	0%
Lodging	31%	17%	0%
Miscellaneous	40%	16%	2%
Chemical_Mfg	99%	17%	4%
Petroleum_Refining	97%	5%	0%
Mining	97%	17%	4%
Irrigation	3%	15%	4%
Miscellaneous_Mfg	91%	17%	4%

Appendix B-2. Capacity-Focused Resource Materials: Load Basis and Calibration

California

Figure B.1. California Residential Load Shape

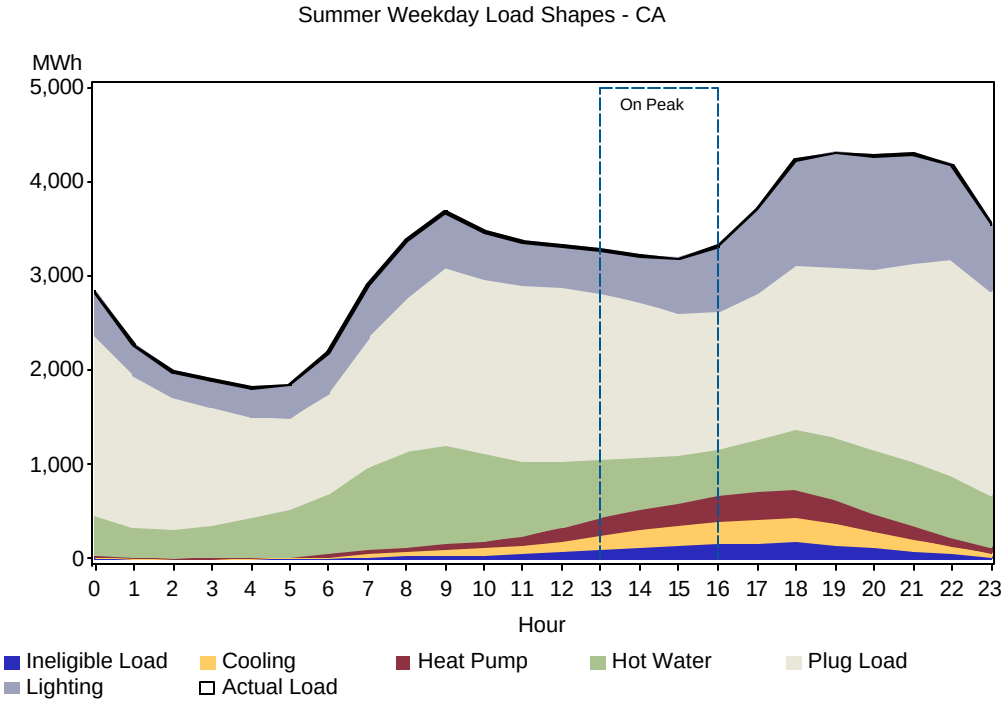


Figure B.2. California C&I Load Shape

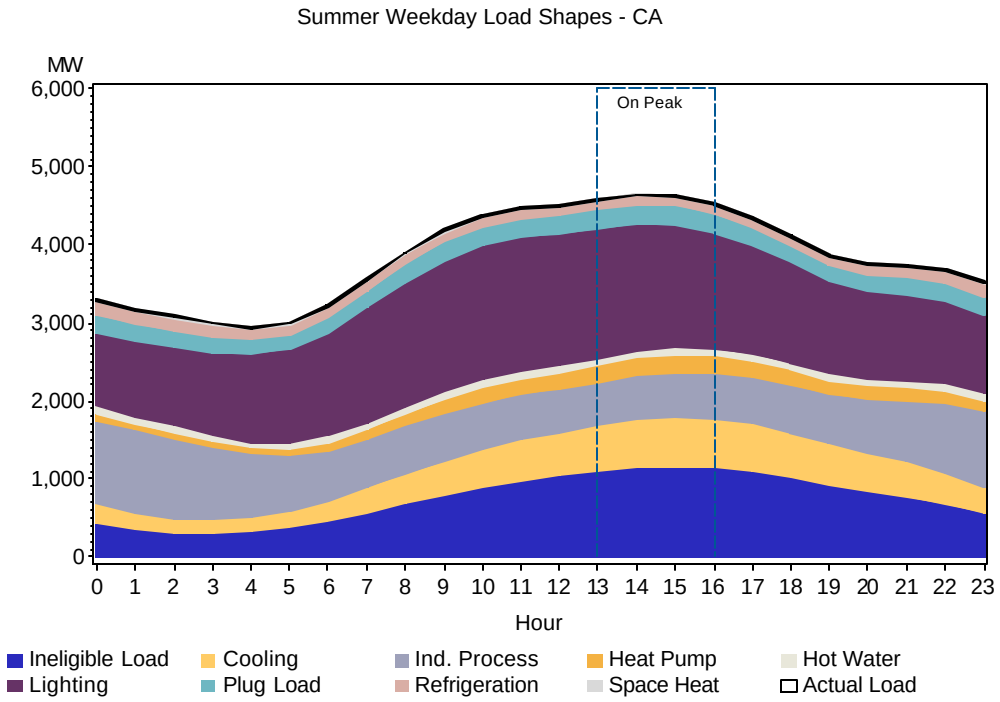
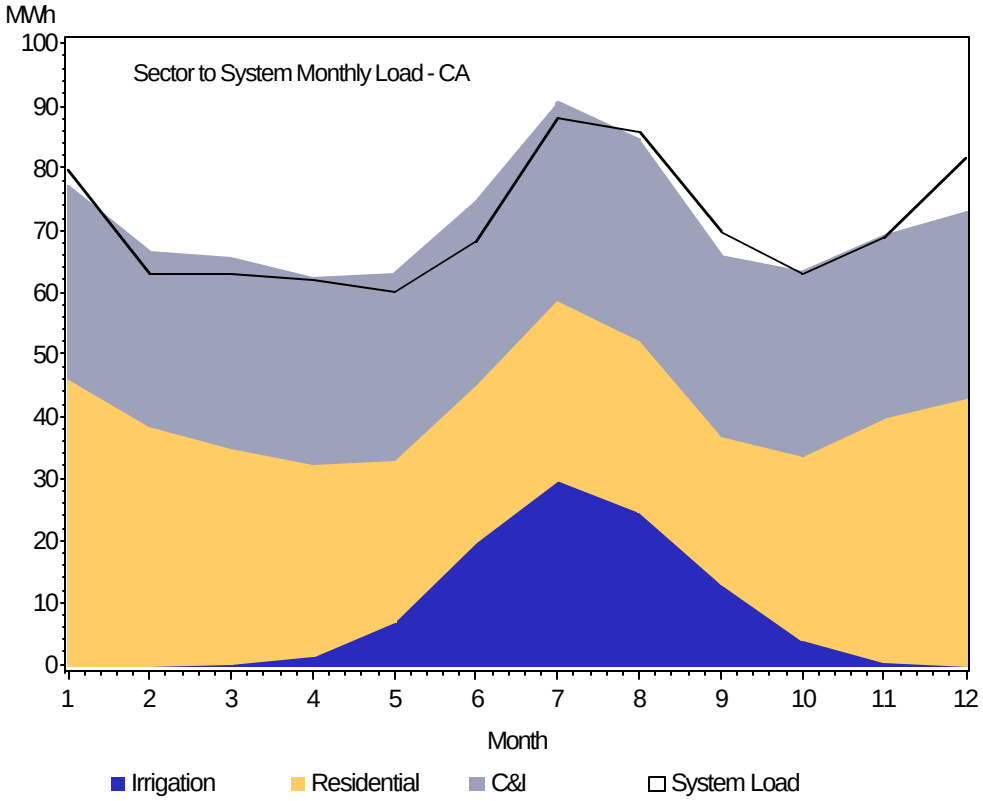


Figure B.3. California System Monthly Load Shape



Idaho

Figure B.4. Idaho Residential Load Shape

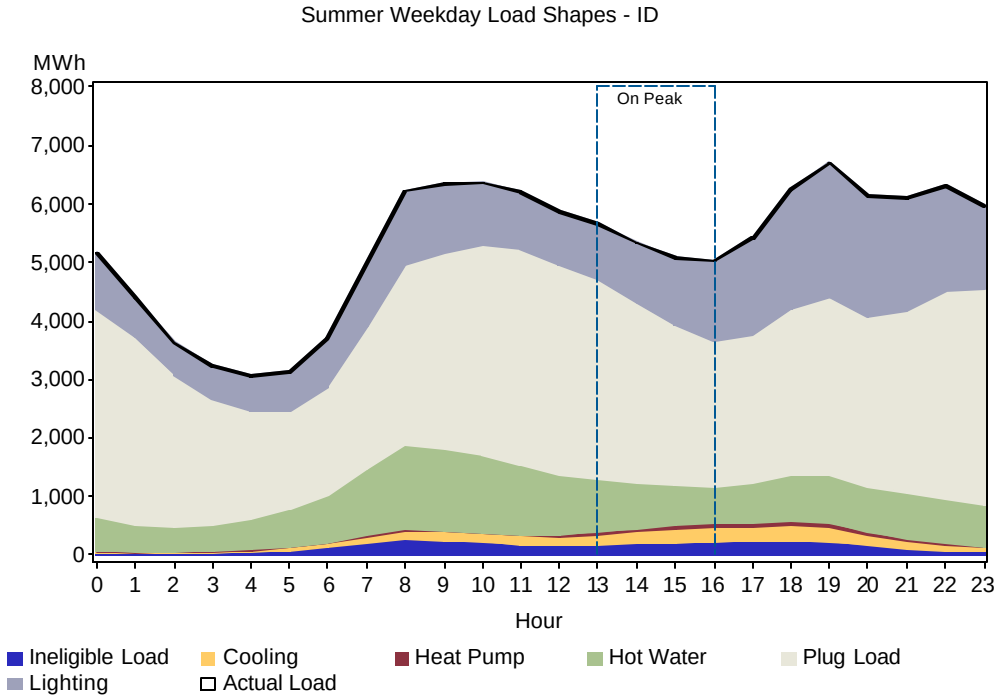


Figure B.5. Idaho C&I Load Shape

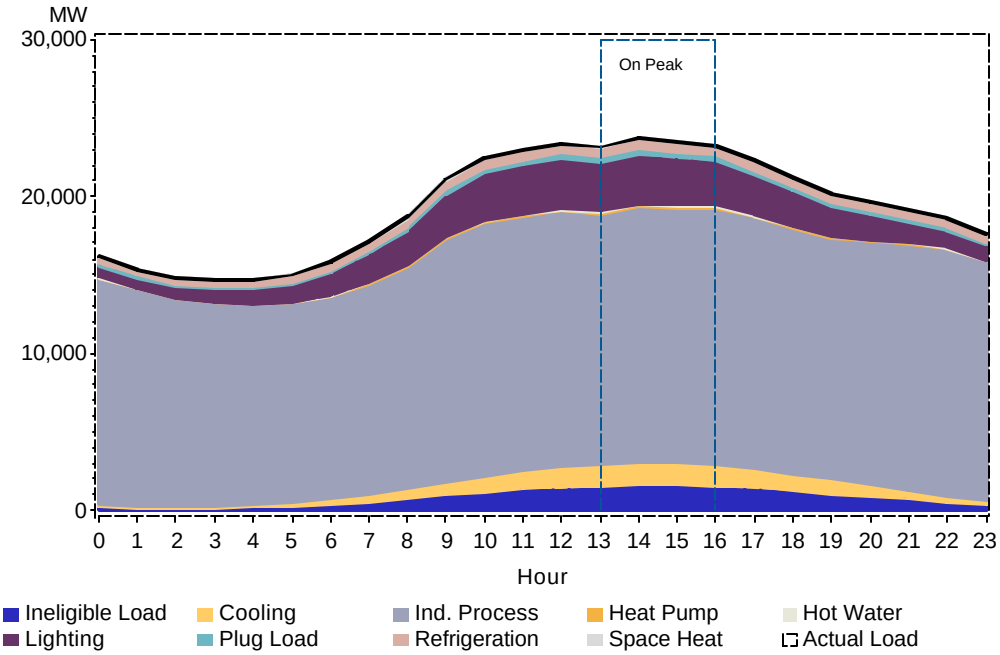
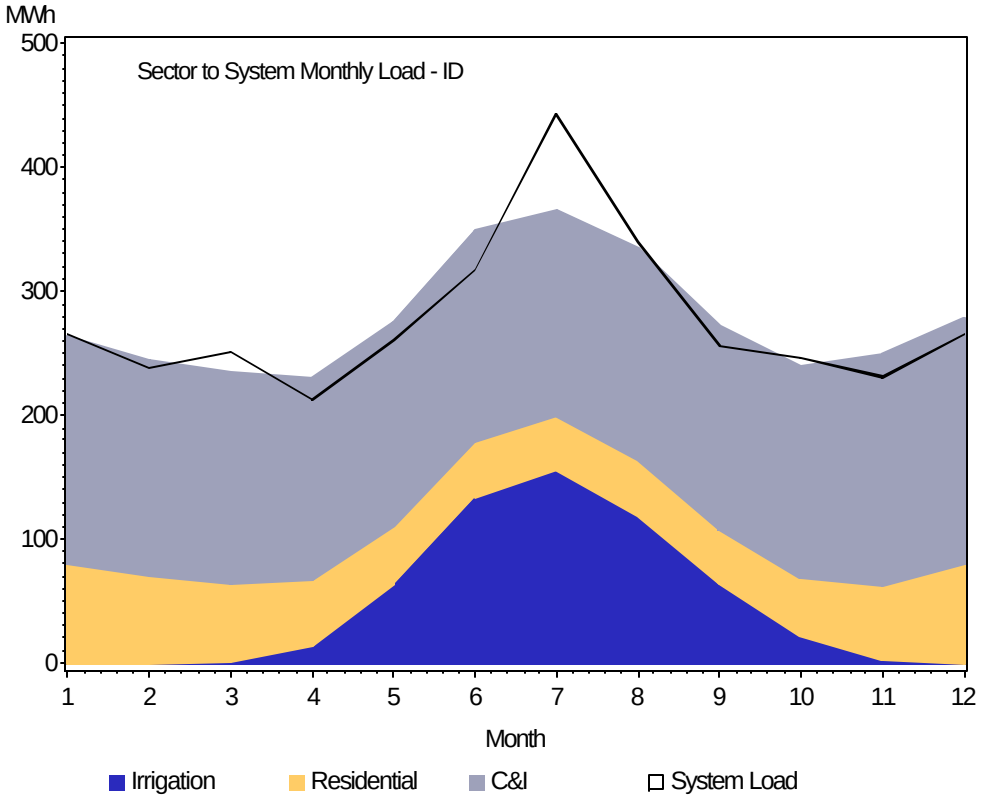


Figure B.6. Idaho System Monthly Load Shape



Oregon

Figure B.7. Oregon Residential Load Shape

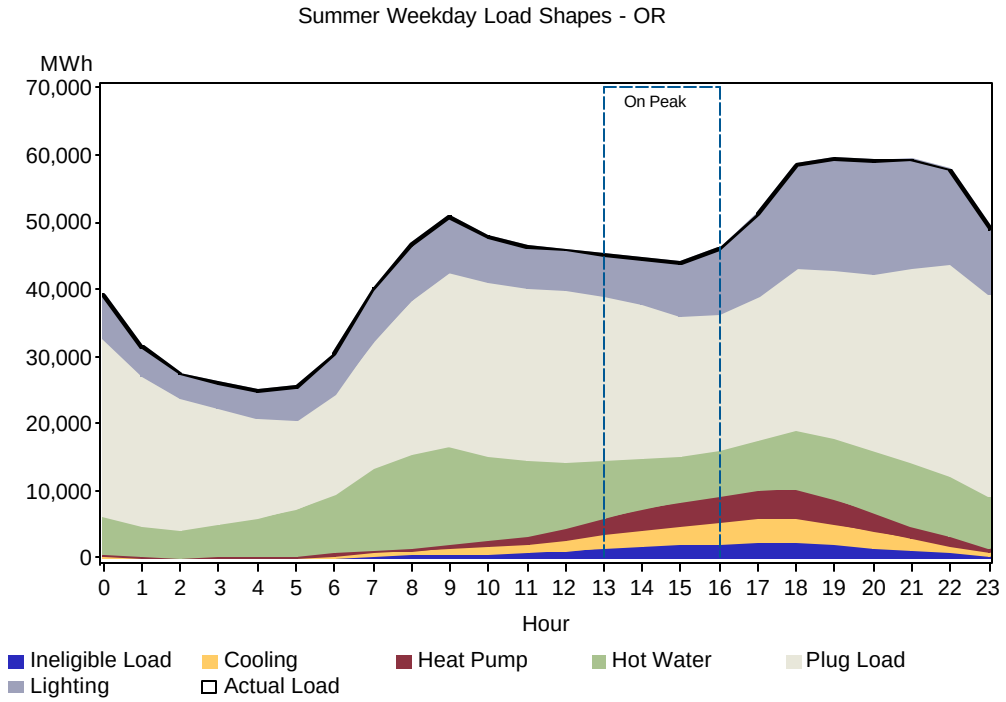


Figure B.8. Oregon C&I Load Shape

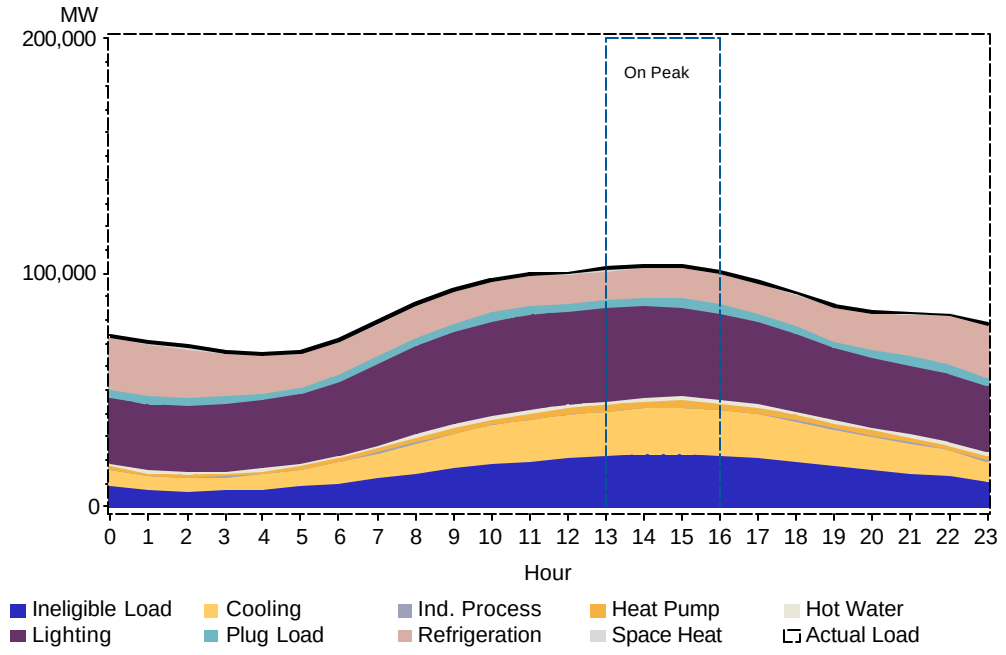
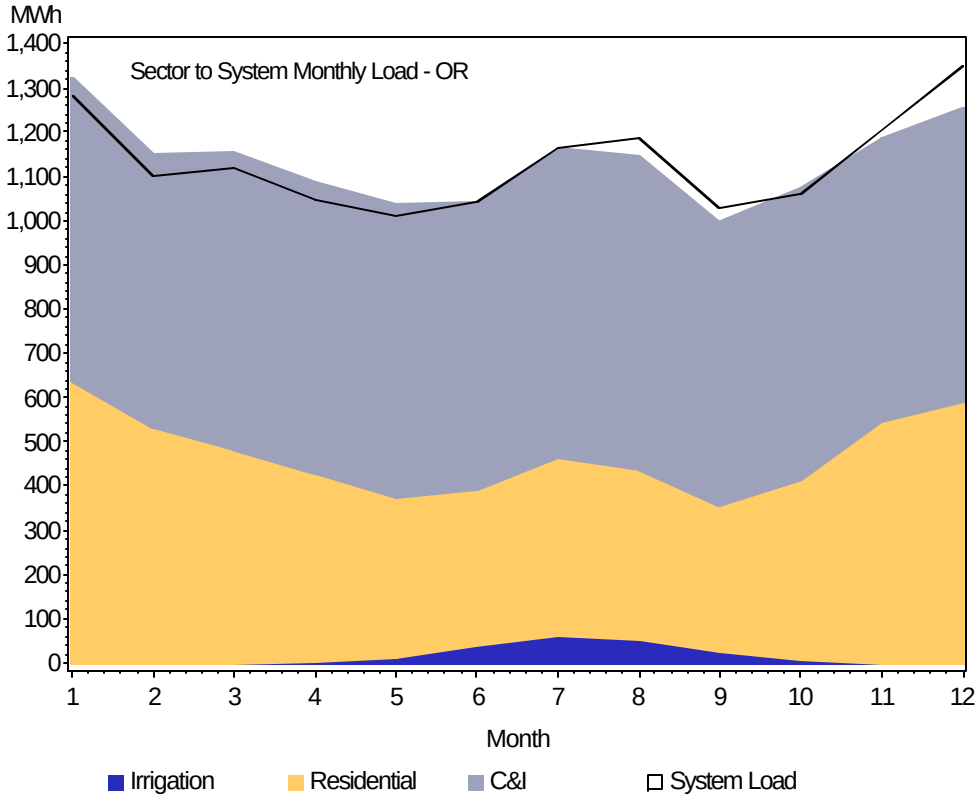


Figure B.9. Oregon System Monthly Load Shape



Utah

Figure B.10. Utah Residential Load Shape

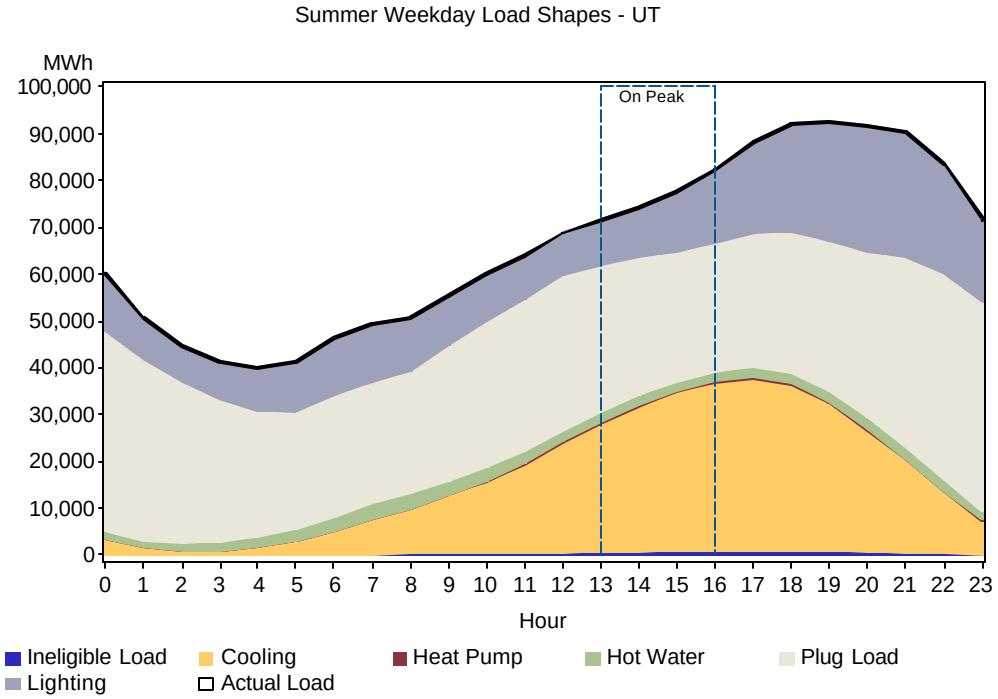


Figure B.11. Utah C&I Load Shape

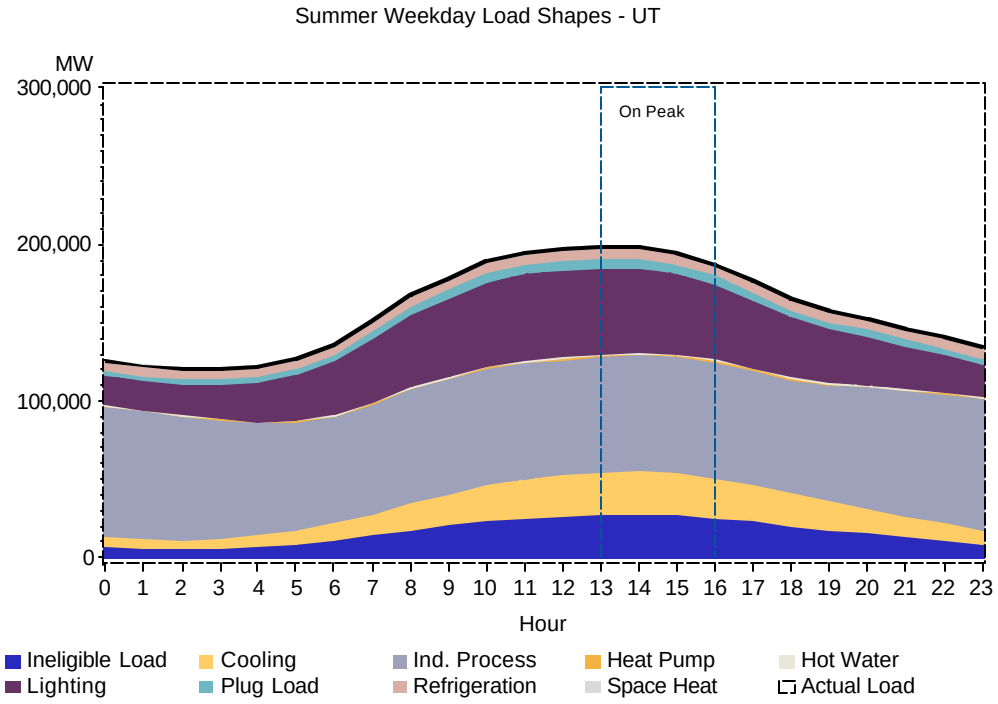
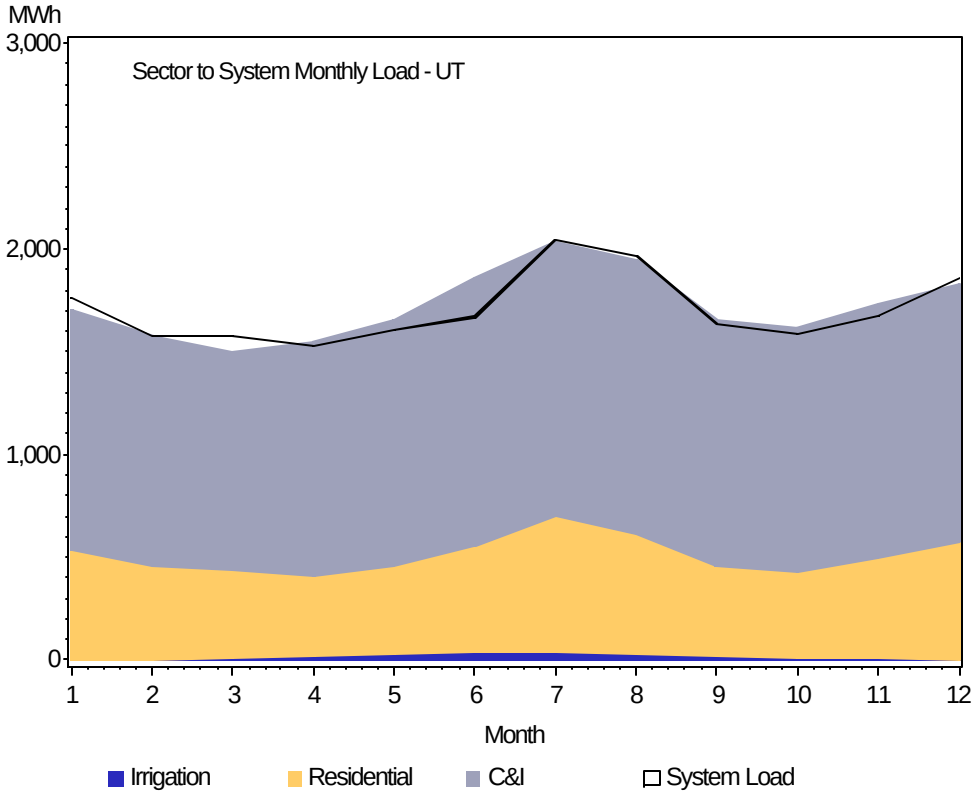


Figure B.12. Utah System Monthly Load Shape



Washington

Figure B.13. Washington Residential Load Shape

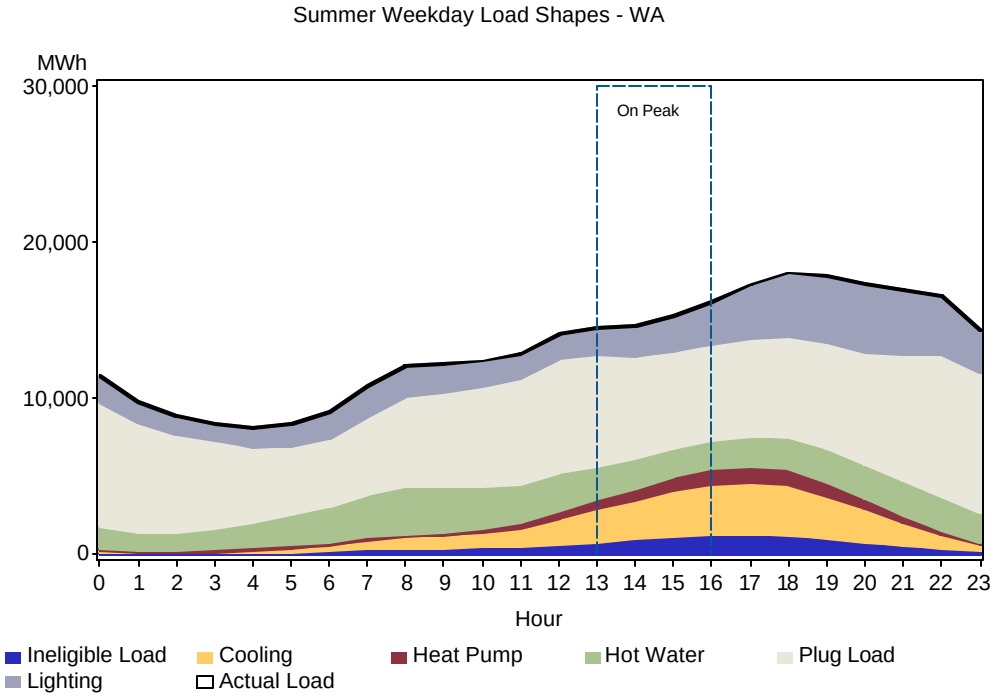


Figure B.14. Washington C&I Load Shape

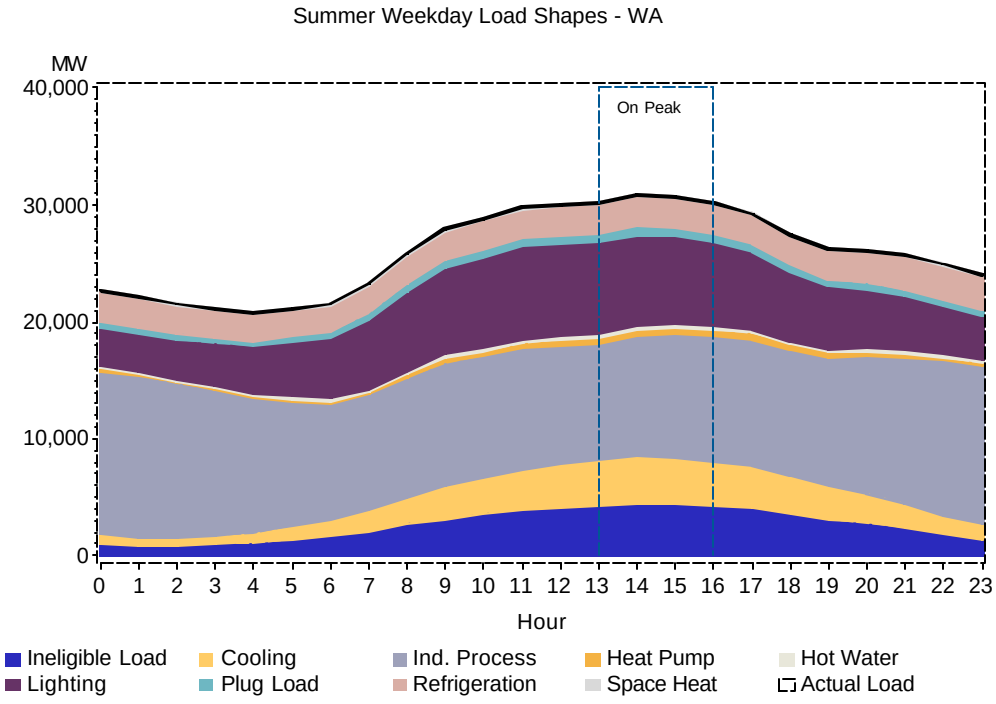
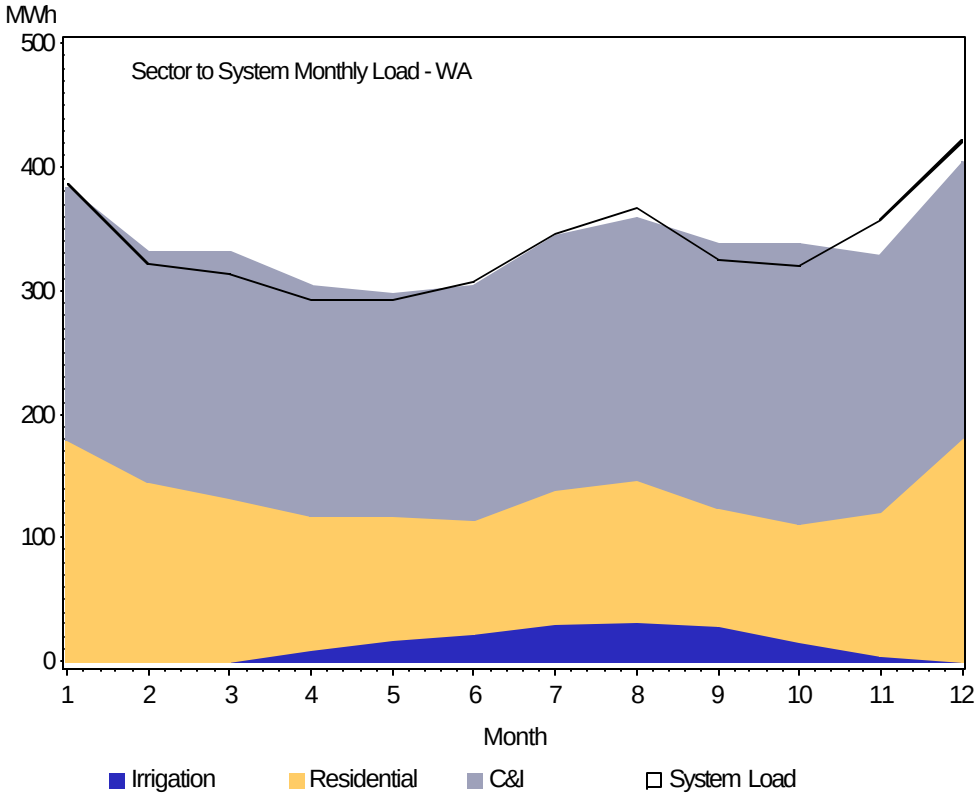


Figure B.15. Washington System Monthly Load Shape



Wyoming

Figure B.16. Wyoming Residential Load Shape

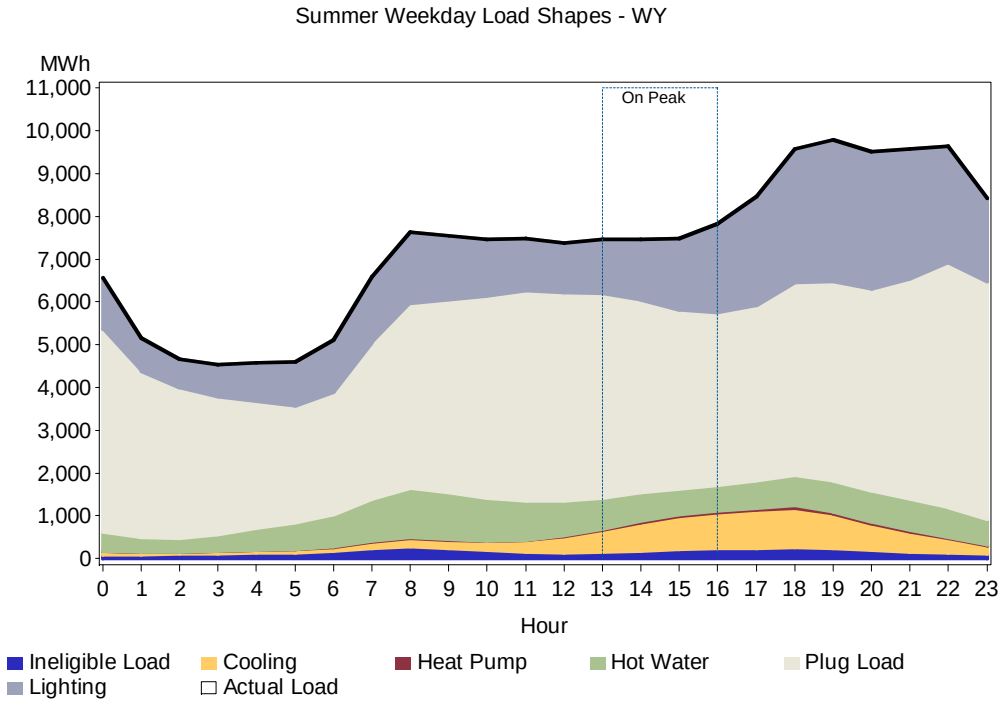


Figure B.17. Wyoming C&I Load Shape

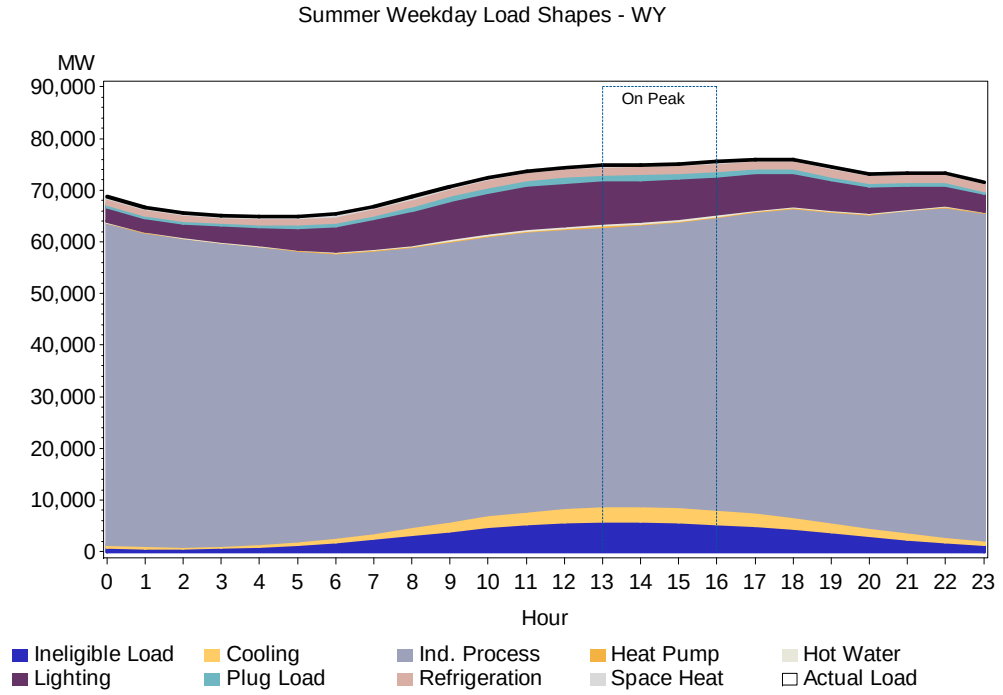
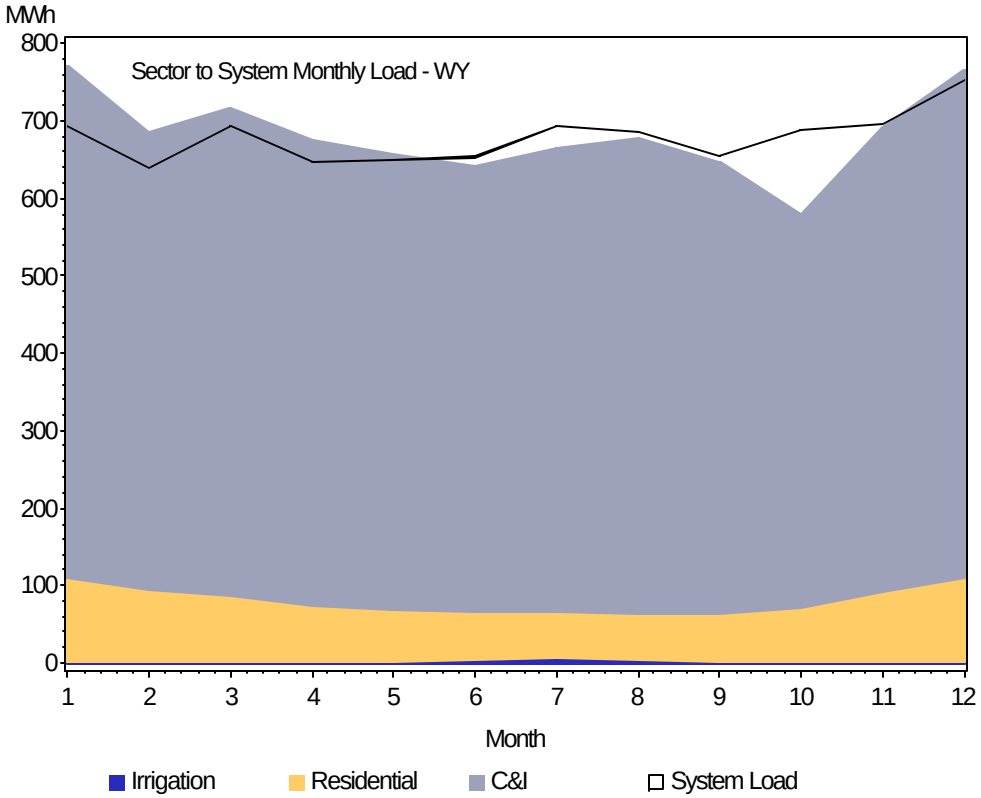


Figure B.18. Wyoming System Monthly Load Shape



All States Total

Figure B.19. All States Residential Load Shape

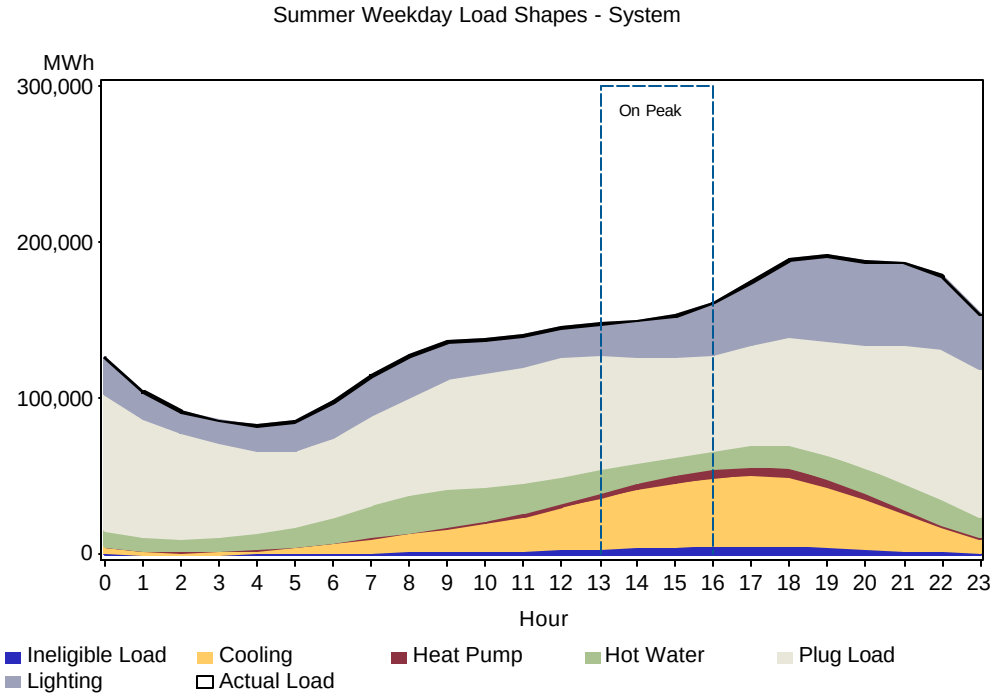


Figure B.20. All States C&I Load Shape

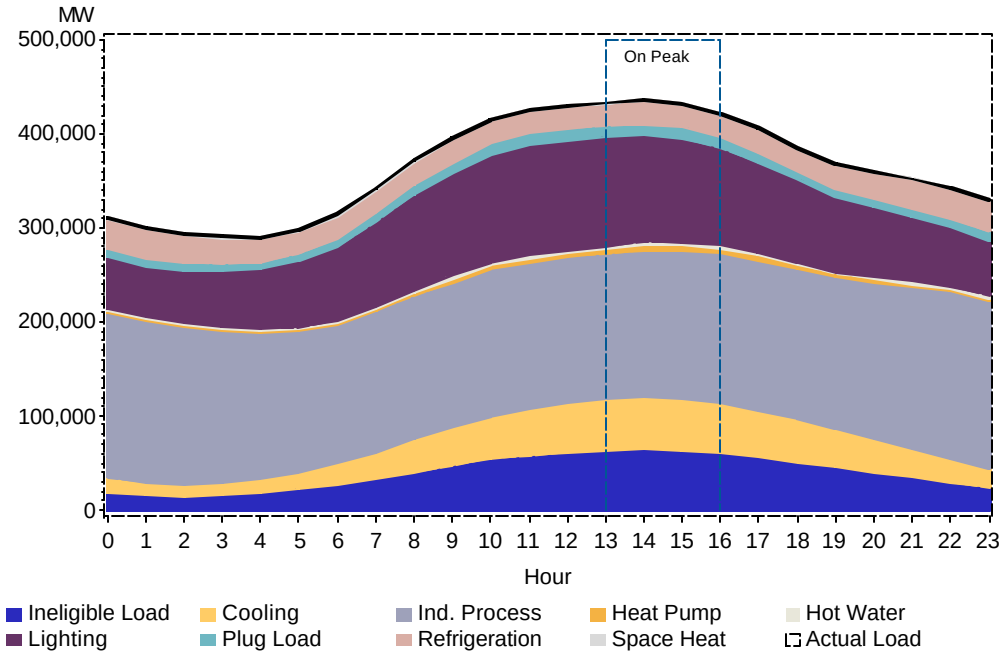
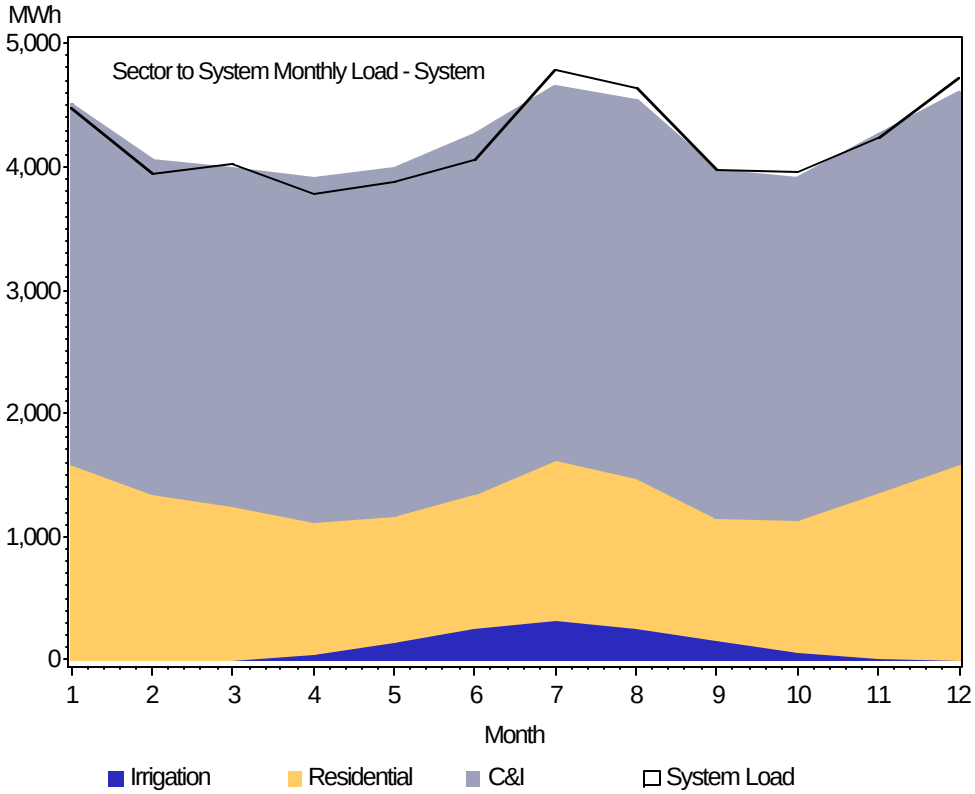


Figure B.21. All States System Monthly Load Shape



Appendix B-3. Capacity-Focused Resource Materials: Detailed Program Results – Year and Market Segment (Summer)

DLC - RES - AC and Water Heat

Table B.30. Achievable Potential (kW) by State and Year: DLC - RES - AC and Water Heat

Year	System Total	CA	ID	OR	UT	WA	WY
2008	90,071	874	605	13,350	65,467	8,385	1,389
2009	98,043	937	659	14,301	71,656	8,981	1,509
2010	106,307	1,001	715	15,269	78,102	9,587	1,632
2011	114,862	1,066	774	16,254	84,804	10,204	1,761
2012	123,709	1,132	834	17,256	91,762	10,832	1,893
2013	132,848	1,200	896	18,276	98,977	11,470	2,029
2014	142,279	1,269	960	19,312	106,449	12,119	2,170
2015	152,001	1,339	1,026	20,366	114,177	12,778	2,314
2016	162,015	1,410	1,095	21,437	122,162	13,448	2,463
2017	172,321	1,483	1,165	22,525	130,403	14,129	2,616
2018	176,071	1,498	1,191	22,745	133,701	14,266	2,669
2019	179,821	1,514	1,217	22,966	136,999	14,402	2,723
2020	183,571	1,529	1,243	23,187	140,298	14,539	2,776
2021	187,321	1,544	1,269	23,407	143,596	14,675	2,829
2022	191,071	1,560	1,295	23,628	146,894	14,812	2,882
2023	194,821	1,575	1,321	23,848	150,192	14,949	2,936
2024	198,571	1,591	1,347	24,069	153,490	15,085	2,989
2025	202,321	1,606	1,373	24,290	156,789	15,222	3,042
2026	206,071	1,621	1,399	24,510	160,087	15,358	3,096
2027	209,821	1,637	1,424	24,731	163,385	15,495	3,149

Table B.31. Achievable Potential (kW) by Market Segment (2027): DLC - RES - AC and Water Heat

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	27.6	0.2	0.2	10.9	11.7	1.9	2.7
Health	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lodging	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous	81.0	0.8	0.3	19.4	54.0	3.1	3.4
Restaurant	52.3	3.1	0.6	16.7	19.0	3.4	9.4
School	5.9	0.1	0.0	0.5	5.0	0.1	0.3
Small Office	584.5	9.9	58.1	145.1	312.9	29.0	29.4
Small Retail	182.0	17.4	5.3	74.4	59.5	12.7	12.6
Warehouse	45.2	0.1	3.2	0.9	34.7	0.0	6.4
Chemical Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Electronic Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Food Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Industrial Machinery	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Irrigation	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lumber Wood Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Paper Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Primary Metal Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Transportation Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Single Family	184,226.0	1,205.5	1,242.7	17,788.5	148,229.2	12,997.3	2,762.7
Multi Family	12,690.8	55.7	6.3	962.2	10,885.2	655.7	125.7
Manufactured	11,925.6	344.1	107.8	5,712.2	3,773.8	1,791.6	196.3

DLC - RES - AC

Table B.32 Achievable Potential (kW) by State and Year: DLC - RES - AC

Year	System Total	CA	ID	OR	UT	WA	WY
2008	78,709	534	452	7,271	62,954	6,467	1,030
2009	85,806	573	493	7,788	68,906	6,926	1,120
2010	93,173	612	536	8,316	75,104	7,394	1,212
2011	100,810	652	579	8,852	81,549	7,870	1,308
2012	108,717	693	625	9,398	88,241	8,354	1,406
2013	116,893	734	672	9,953	95,180	8,846	1,508
2014	125,339	777	720	10,518	102,365	9,346	1,613
2015	134,055	820	770	11,092	109,797	9,855	1,721
2016	143,040	864	822	11,675	117,476	10,371	1,833
2017	152,295	908	875	12,268	125,401	10,896	1,947
2018	155,762	918	895	12,388	128,573	11,002	1,987
2019	159,230	927	914	12,508	131,745	11,107	2,028
2020	162,697	937	934	12,629	134,917	11,212	2,068
2021	166,164	946	954	12,749	138,089	11,317	2,108
2022	169,631	956	974	12,869	141,261	11,423	2,148
2023	173,098	966	994	12,989	144,433	11,528	2,188
2024	176,566	975	1,014	13,110	147,605	11,633	2,229
2025	180,033	985	1,033	13,230	150,777	11,738	2,269
2026	183,500	994	1,053	13,350	153,949	11,844	2,309
2027	186,967	1,004	1,073	13,470	157,121	11,949	2,349

Table B.33. Achievable Potential (kW) by Market Segment (2027): DLC - RES – AC

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	27.6	0.2	0.2	10.9	11.7	1.9	2.7
Health	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lodging	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous	81.0	0.8	0.3	19.4	54.0	3.1	3.4
Restaurant	52.3	3.1	0.6	16.7	19.0	3.4	9.4
School	5.9	0.1	0.0	0.5	5.0	0.1	0.3
Small Office	584.5	9.9	58.1	145.1	312.9	29.0	29.4
Small Retail	182.0	17.4	5.3	74.4	59.5	12.7	12.6
Warehouse	45.2	0.1	3.2	0.9	34.7	0.0	6.4
Chemical Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Electronic Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Food Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Industrial Machinery	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Irrigation	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lumber Wood Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Paper Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Primary Metal Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Transportation Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Single Family	166,648.3	755.9	950.7	9,983.1	142,745.5	10,143.3	2,069.8
Multi Family	11,398.9	34.8	- - -	639.1	10,105.3	525.7	94.0
Manufactured	7,941.5	181.7	54.7	2,580.2	3,773.8	1,229.5	121.5

DLC - Commercial

Table B.34. Achievable Potential (kW) by State and Year: DLC - Commercial

Year	System Total	CA	ID	OR	UT	WA	WY
2008	49	0	1	14	29	2	2
2009	101	0	1	28	61	5	5
2010	156	1	2	43	96	7	8
2011	216	1	2	58	134	10	10
2012	334	1	4	89	209	15	16
2013	460	2	5	120	291	20	22
2014	652	3	8	167	416	27	31
2015	855	3	10	216	549	35	41
2016	1,068	4	12	266	692	43	50
2017	1,292	5	15	317	843	52	61
2018	1,328	5	16	321	872	52	62
2019	1,364	5	16	326	901	53	64
2020	1,400	5	17	330	929	54	65
2021	1,436	5	17	335	958	54	66
2022	1,471	5	17	339	987	55	68
2023	1,507	5	18	343	1,016	56	69
2024	1,543	5	18	348	1,045	56	71
2025	1,579	5	19	352	1,074	57	72
2026	1,615	5	19	356	1,103	58	73
2027	1,650	5	20	361	1,132	58	75

Table B.35. Achievable Potential (kW) by Market Segment (2027): DLC – Commercial

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	222.3	0.4	1.4	65.2	125.9	13.5	16.0
Health	456.6	3.9	1.0	134.9	264.6	24.8	27.4
Large Office	319.3	- - -	- - -	86.0	224.2	5.0	4.1
Large Retail	81.1	- - -	- - -	18.0	61.6	1.6	- - -
Lodging	46.6	0.3	- - -	14.2	28.1	2.7	1.4
Miscellaneous	147.9	0.6	0.4	17.1	120.1	3.5	6.2
Restaurant	1.3	- - -	- - -	0.4	0.5	0.4	- - -
School	183.2	0.1	0.5	14.8	145.0	3.1	19.7
Small Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Small Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Warehouse	192.0	0.1	16.5	10.2	161.6	3.6	- - -
Chemical Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Electronic Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Food Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Industrial Machinery	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Irrigation	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lumber Wood Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Paper Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Primary Metal Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Transportation Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Single Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Multi Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Manufactured	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Irrigation

Table B.36. Achievable Potential (kW) by State and Year: Irrigation

Year	System Total	CA	ID	OR	UT	WA	WY
2008	66,501	3,536	49,095	3,780	4,958	4,397	735
2009	73,639	3,878	54,391	4,200	5,507	4,843	819
2010	80,726	4,210	59,655	4,620	6,056	5,280	904
2011	87,763	4,532	64,888	5,040	6,605	5,709	989
2012	94,749	4,843	70,088	5,460	7,154	6,129	1,075
2013	101,686	5,145	75,257	5,880	7,702	6,541	1,161
2014	108,572	5,436	80,393	6,300	8,250	6,944	1,248
2015	115,407	5,717	85,498	6,720	8,797	7,339	1,335
2016	122,192	5,988	90,572	7,141	9,345	7,724	1,423
2017	128,927	6,249	95,613	7,561	9,892	8,102	1,512
2018	128,475	6,157	95,326	7,561	9,889	8,025	1,516
2019	128,022	6,066	95,040	7,561	9,887	7,948	1,521
2020	127,569	5,974	94,753	7,561	9,884	7,871	1,526
2021	127,116	5,882	94,467	7,561	9,881	7,794	1,531
2022	126,663	5,791	94,181	7,561	9,879	7,717	1,535
2023	126,211	5,699	93,894	7,561	9,876	7,640	1,540
2024	125,758	5,608	93,608	7,561	9,874	7,563	1,545
2025	125,305	5,516	93,321	7,561	9,871	7,486	1,550
2026	124,852	5,425	93,035	7,561	9,868	7,409	1,554
2027	124,399	5,333	92,748	7,561	9,866	7,332	1,559

Table B.37. Achievable Potential (kW) by Market Segment (2027): Irrigation

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Health	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lodging	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Restaurant	- - -	- - -	- - -	- - -	- - -	- - -	- - -
School	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Small Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Small Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Warehouse	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Chemical Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Electronic Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Food Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Industrial Machinery	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Irrigation	124,399.3	5,333.2	92,748.3	7,560.6	9,865.7	7,332.5	1,559.1
Lumber Wood Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Paper Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Primary Metal Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Transportation Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Single Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Multi Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Manufactured	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Thermal Energy Storage

Table B.38. Achievable Potential (kW) by State and Year: Thermal Energy Storage

Year	System Total	CA	ID	OR	UT	WA	WY
2008	240	1	5	52	164	14	5
2009	498	1	11	105	343	27	11
2010	773	2	17	159	538	41	17
2011	1,066	2	24	213	748	56	23
2012	1,650	3	37	322	1,168	84	35
2013	2,270	5	52	432	1,620	113	49
2014	3,216	6	74	598	2,312	157	69
2015	4,214	8	97	766	3,051	201	90
2016	5,264	10	123	936	3,837	247	112
2017	6,366	12	149	1,108	4,669	293	135
2018	6,539	13	154	1,115	4,824	295	139
2019	6,712	13	159	1,122	4,979	298	142
2020	6,886	13	164	1,128	5,134	300	146
2021	7,059	13	169	1,135	5,289	303	149
2022	7,232	13	174	1,142	5,444	305	153
2023	7,405	14	180	1,149	5,599	308	156
2024	7,578	14	185	1,156	5,754	310	160
2025	7,751	14	190	1,163	5,908	313	163
2026	7,924	14	195	1,170	6,063	315	167
2027	8,097	15	200	1,177	6,218	318	170

Table B.39. Achievable Potential (kW) by Market Segment (2027): Thermal Energy Storage

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	1,036.6	2.6	5.2	239.7	727.9	41.1	20.1
Health	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Office	1,761.2	- - -	- - -	66.2	1,634.1	29.5	31.4
Large Retail	3,309.0	- - -	87.5	743.6	2,251.2	180.9	45.7
Lodging	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Restaurant	- - -	- - -	- - -	- - -	- - -	- - -	- - -
School	453.5	0.7	0.5	14.4	424.5	2.5	10.7
Small Office	1,516.9	8.0	105.7	105.7	1,177.3	61.4	58.8
Small Retail	20.0	3.2	0.7	7.5	3.3	2.0	3.4
Warehouse	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Chemical Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Electronic Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Food Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Industrial Machinery	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Irrigation	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lumber Wood Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Paper Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Primary Metal Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Transportation Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Single Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Multi Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Manufactured	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Curtailable Load

Table B.40. Achievable Potential (kW) by State and Year: Curtailable Load

Year	System Total	CA	ID	OR	UT	WA	WY
2008	1,429	4	23	160	824	47	371
2009	2,933	8	45	326	1,708	95	751
2010	4,512	12	69	496	2,654	143	1,138
2011	6,167	16	92	672	3,660	193	1,534
2012	9,478	25	139	1,023	5,673	293	2,325
2013	12,939	33	186	1,383	7,808	396	3,133
2014	18,207	46	257	1,930	11,071	550	4,353
2015	23,702	59	329	2,491	14,517	708	5,598
2016	29,423	72	402	3,067	18,146	869	6,867
2017	35,371	86	475	3,659	21,957	1,033	8,161
2018	36,127	86	478	3,709	22,566	1,044	8,243
2019	36,882	87	480	3,759	23,176	1,055	8,325
2020	37,638	88	483	3,809	23,785	1,066	8,407
2021	38,393	89	486	3,859	24,395	1,077	8,489
2022	39,149	89	488	3,909	25,004	1,088	8,571
2023	39,905	90	491	3,959	25,613	1,099	8,653
2024	40,660	91	493	4,009	26,223	1,110	8,735
2025	41,416	91	496	4,059	26,832	1,121	8,817
2026	42,171	92	498	4,109	27,441	1,132	8,898
2027	42,927	93	501	4,159	28,051	1,143	8,980

Table B.41. Achievable Potential (kW) by Market Segment (2027): Curtailable Load

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	1,385.8	2.2	8.8	408.5	780.7	84.8	100.9
Health	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Office	8,857.3	- - -	- - -	2,413.9	6,187.5	141.1	114.7
Large Retail	1,167.6	- - -	- - -	264.7	879.2	23.7	- - -
Lodging	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous	3,994.3	19.3	11.1	490.1	3,182.4	101.4	190.0
Restaurant	88.0	- - -	- - -	28.2	32.9	26.8	- - -
School	7,902.6	4.1	20.8	481.7	6,528.9	102.4	764.7
Small Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Small Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Warehouse	1,354.1	0.4	119.2	55.7	1,159.1	19.7	- - -
Chemical Mfg	3,418.4	- - -	158.9	- - -	1,209.2	- - -	2,050.3
Electronic Equipment Mfg	421.2	- - -	- - -	- - -	421.2	- - -	- - -
Food Mfg	1,174.6	- - -	137.7	2.2	815.8	219.0	- - -
Industrial Machinery	266.6	- - -	- - -	- - -	266.6	- - -	- - -
Irrigation	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lumber Wood Products	181.1	65.6	- - -	5.9	- - -	109.5	- - -
Mining	4,767.5	- - -	- - -	- - -	1,556.1	- - -	3,211.5
Miscellaneous Mfg	4,320.8	0.9	44.7	5.3	1,406.6	315.0	2,548.3
Paper Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	1,981.2	- - -	- - -	- - -	1,981.2	- - -	- - -
Primary Metal Mfg	907.8	- - -	- - -	2.4	905.4	- - -	- - -
Transportation Equipment Mfg	738.0	- - -	- - -	- - -	738.0	- - -	- - -
Single Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Multi Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Manufactured	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Demand Bidding

Table B.42. Achievable Potential (kW) by State and Year: Demand Bidding

Year	System Total	CA	ID	OR	UT	WA	WY
2008	18,204	54	315	4,687	6,860	976	5,312
2009	19,604	58	335	5,007	7,480	1,042	5,683
2010	21,039	61	354	5,331	8,123	1,108	6,061
2011	22,508	65	373	5,660	8,791	1,175	6,444
2012	24,013	69	392	5,993	9,482	1,243	6,834
2013	25,553	73	412	6,331	10,196	1,312	7,229
2014	27,128	76	431	6,673	10,935	1,382	7,631
2015	28,738	80	450	7,020	11,697	1,452	8,039
2016	30,383	84	470	7,371	12,482	1,523	8,453
2017	32,063	88	489	7,727	13,291	1,595	8,873
2018	32,514	89	490	7,785	13,596	1,605	8,950
2019	32,965	89	490	7,842	13,900	1,616	9,028
2020	33,416	90	490	7,900	14,204	1,626	9,106
2021	33,867	90	491	7,957	14,508	1,637	9,184
2022	34,318	91	491	8,014	14,812	1,647	9,262
2023	34,768	91	492	8,072	15,117	1,657	9,339
2024	35,219	92	492	8,129	15,421	1,668	9,417
2025	35,670	93	492	8,187	15,725	1,678	9,495
2026	36,121	93	493	8,244	16,029	1,688	9,573
2027	36,572	94	493	8,302	16,333	1,699	9,651

Table B.43. Achievable Potential (kW) by Market Segment (2027): Demand Bidding

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	767.5	1.2	4.9	226.2	432.4	47.0	55.9
Health	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Grocery	5,101.7	2.9	11.7	3,802.6	1,037.7	112.7	134.2
Health	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Office	5,978.0	- - -	- - -	3,768.9	2,121.4	48.4	39.3
Large Retail	1,050.9	- - -	- - -	238.3	791.3	21.3	- - -
Lodging	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous	2,212.2	10.7	6.1	271.5	1,762.6	56.1	105.2
Restaurant	19.0	- - -	- - -	6.1	7.1	5.8	- - -
School	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Small Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Small Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Warehouse	906.2	0.2	66.0	187.1	642.0	10.9	- - -
Chemical Mfg	4,102.1	- - -	190.7	- - -	1,451.0	- - -	2,460.4
Electronic Equipment Mfg	505.4	- - -	- - -	- - -	505.4	- - -	- - -
Food Mfg	1,409.6	- - -	165.2	2.6	979.0	262.8	- - -
Industrial Machinery	320.0	- - -	- - -	- - -	320.0	- - -	- - -
Irrigation	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lumber Wood Products	217.3	78.7	- - -	7.1	- - -	131.4	- - -
Mining	5,721.0	- - -	- - -	- - -	1,867.3	- - -	3,853.8
Miscellaneous Mfg	5,184.9	1.1	53.6	6.3	1,687.9	378.0	3,057.9
Paper Mfg	679.5	- - -	- - -	8.2	- - -	671.3	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	1,188.7	- - -	- - -	- - -	1,188.7	- - -	- - -
Primary Metal Mfg	1,089.4	- - -	- - -	2.9	1,086.5	- - -	- - -
Transportation Equipment Mfg	885.6	- - -	- - -	- - -	885.6	- - -	- - -
Single Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Multi Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Manufactured	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Time Of Use Rates

Table B.44. Achievable Potential (kW) by State and Year: Time Of Use Rates

Year	System Total	CA	ID	OR	UT	WA	WY
2008	655	17	17	235	290	70	26
2009	1,338	35	34	475	599	142	53
2010	2,049	53	53	720	927	215	81
2011	2,788	71	72	970	1,274	290	111
2012	4,266	107	111	1,470	1,968	439	170
2013	5,800	145	152	1,980	2,700	592	232
2014	8,130	201	214	2,751	3,816	822	327
2015	10,543	258	278	3,536	4,990	1,056	425
2016	13,041	317	346	4,336	6,220	1,295	527
2017	15,623	377	416	5,152	7,508	1,539	633
2018	15,904	381	425	5,202	7,698	1,553	646
2019	16,184	384	434	5,252	7,887	1,568	659
2020	16,465	388	443	5,302	8,077	1,583	672
2021	16,745	392	452	5,352	8,267	1,598	685
2022	17,026	396	460	5,403	8,456	1,613	698
2023	17,306	399	469	5,453	8,646	1,628	711
2024	17,587	403	478	5,503	8,836	1,643	724
2025	17,868	407	487	5,553	9,026	1,658	736
2026	18,148	411	496	5,604	9,215	1,672	749
2027	18,429	415	505	5,654	9,405	1,687	762

Table B.45. Achievable Potential (kW) by Market Segment (2027): Time Of Use Rates

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Health	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lodging	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Restaurant	- - -	- - -	- - -	- - -	- - -	- - -	- - -
School	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Small Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Small Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Warehouse	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Chemical Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Electronic Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Food Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Industrial Machinery	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Irrigation	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lumber Wood Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Paper Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Primary Metal Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Transportation Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Single Family	15,868.2	330.3	459.9	4,362.6	8,601.4	1,423.7	690.4
Multi Family	1,202.1	22.9	19.2	420.6	584.4	114.4	40.7
Manufactured	1,358.2	61.3	26.3	870.6	219.4	149.3	31.3

Critical Peak Pricing - Residential

Table B.46. Achievable Potential (kW) by State and Year: Critical Peak Pricing – Residential

Year	System Total	CA	ID	OR	UT	WA	WY
2008	1,838	51	50	662	800	191	83
2009	3,758	104	104	1,339	1,655	385	171
2010	5,759	158	160	2,031	2,564	584	263
2011	7,842	214	219	2,736	3,527	787	359
2012	12,006	324	338	4,148	5,453	1,193	551
2013	16,334	438	462	5,588	7,488	1,607	751
2014	22,906	609	653	7,763	10,594	2,232	1,056
2015	29,722	784	852	9,982	13,862	2,869	1,373
2016	36,782	963	1,060	12,243	17,294	3,519	1,703
2017	44,086	1,145	1,277	14,548	20,888	4,181	2,046
2018	44,899	1,158	1,308	14,693	21,430	4,222	2,088
2019	45,712	1,171	1,338	14,837	21,973	4,263	2,131
2020	46,525	1,184	1,368	14,981	22,515	4,304	2,173
2021	47,338	1,197	1,398	15,126	23,057	4,345	2,215
2022	48,151	1,209	1,429	15,270	23,600	4,386	2,257
2023	48,964	1,222	1,459	15,415	24,142	4,427	2,299
2024	49,777	1,235	1,489	15,559	24,684	4,468	2,342
2025	50,590	1,248	1,519	15,703	25,226	4,509	2,384
2026	51,403	1,261	1,550	15,848	25,769	4,550	2,426
2027	52,216	1,274	1,580	15,992	26,311	4,591	2,468

Table B.47. Achievable Potential (kW) by Market Segment (2027): Critical Peak Pricing – Residential

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	71.9	0.5	0.7	33.9	22.6	6.0	8.3
Health	823.1	24.8	16.0	308.5	363.3	54.7	55.9
Large Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lodging	173.4	4.7	12.1	75.8	61.2	11.6	8.1
Miscellaneous	559.4	9.4	3.4	149.1	328.7	23.5	45.3
Restaurant	311.6	23.2	4.9	101.9	93.8	20.8	67.1
School	75.0	0.7	0.5	10.3	50.5	2.2	10.9
Small Office	1,164.9	27.8	147.2	295.8	547.3	58.9	87.9
Small Retail	1,315.8	118.8	60.3	501.8	423.8	85.3	125.8
Warehouse	451.9	0.5	38.8	13.2	295.4	0.5	103.6
Chemical Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Electronic Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Food Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Industrial Machinery	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Irrigation	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lumber Wood Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Paper Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Primary Metal Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Transportation Equipment Mfg	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Single Family	40,702.1	847.3	1,179.5	11,190.1	22,062.5	3,651.7	1,770.9
Multi Family	3,083.5	58.7	49.1	1,078.8	1,499.0	293.4	104.4
Manufactured	3,483.9	157.3	67.5	2,233.0	562.9	382.9	80.3

Critical Peak Pricing - C&I

Table B.48. Achievable Potential (kW) by State and Year: Critical Peak Pricing – C&I

Year	System Total	CA	ID	OR	UT	WA	WY
2008	2,556	15	65	202	1,273	170	831
2009	5,214	31	131	409	2,621	344	1,678
2010	7,973	48	198	620	4,044	520	2,543
2011	10,834	65	267	836	5,543	699	3,424
2012	16,556	98	406	1,267	8,541	1,057	5,187
2013	22,482	133	547	1,708	11,689	1,421	6,984
2014	31,473	186	760	2,374	16,486	1,969	9,696
2015	40,768	240	978	3,054	21,510	2,526	12,459
2016	50,369	296	1,201	3,748	26,759	3,092	15,273
2017	60,275	354	1,427	4,456	32,235	3,666	18,138
2018	61,293	359	1,442	4,502	32,988	3,695	18,307
2019	62,310	364	1,457	4,548	33,741	3,724	18,476
2020	63,327	369	1,472	4,594	34,494	3,752	18,645
2021	64,345	374	1,487	4,641	35,247	3,781	18,815
2022	65,362	379	1,502	4,687	36,000	3,809	18,984
2023	66,380	384	1,517	4,733	36,753	3,838	19,153
2024	67,397	390	1,532	4,779	37,507	3,867	19,323
2025	68,415	395	1,547	4,826	38,260	3,895	19,492
2026	69,432	400	1,562	4,872	39,013	3,924	19,661
2027	70,449	405	1,577	4,918	39,766	3,952	19,831

Table B.49. Achievable Potential (kW) by Market Segment (2027): Critical Peak Pricing – C&I

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	1,211.1	4.5	7.9	425.3	599.7	72.5	101.2
Health	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Office	5,389.1	- - -	- - -	774.9	4,425.6	82.6	106.0
Large Retail	6,391.8	- - -	181.6	1,436.3	4,145.6	348.4	279.9
Lodging	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous	3,857.3	28.8	16.7	607.4	2,913.8	107.9	182.6
Restaurant	2,787.5	141.2	26.2	827.4	1,233.7	131.8	427.1
School	5,261.5	10.5	19.1	419.4	4,194.2	71.9	546.4
Small Office	913.6	24.8	82.1	239.4	487.3	33.3	46.8
Small Retail	185.0	33.5	12.9	76.7	29.3	13.7	19.0
Warehouse	1,867.5	0.8	429.6	55.9	1,314.3	12.8	54.1
Chemical Mfg	7,855.2	- - -	357.3	- - -	2,864.6	- - -	4,633.3
Electronic Equipment Mfg	1,086.2	- - -	- - -	- - -	1,086.2	- - -	- - -
Food Mfg	2,937.3	- - -	330.0	5.5	2,003.3	598.6	- - -
Industrial Machinery	961.1	- - -	- - -	- - -	961.1	- - -	- - -
Irrigation	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lumber Wood Products	473.9	156.9	- - -	14.1	- - -	303.0	- - -
Mining	11,030.4	- - -	- - -	- - -	3,653.1	- - -	7,377.3
Miscellaneous Mfg	10,760.7	4.0	114.1	14.7	3,662.7	908.5	6,056.6
Paper Mfg	1,283.0	- - -	- - -	15.5	- - -	1,267.5	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	2,388.9	- - -	- - -	- - -	2,388.9	- - -	- - -
Primary Metal Mfg	2,048.4	- - -	- - -	5.6	2,042.8	- - -	- - -
Transportation Equipment Mfg	1,760.0	- - -	- - -	- - -	1,760.0	- - -	- - -
Single Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Multi Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Manufactured	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Real Time Pricing Com

Table B.50. Achievable Potential (kW) by State and Year: Real Time Pricing – C&I

Year	System Total	CA	ID	OR	UT	WA	WY
2008	609	3	46	21	266	44	229
2009	1,237	7	91	43	546	88	463
2010	1,882	10	136	65	838	132	701
2011	2,545	13	181	87	1,143	177	943
2012	3,870	20	271	131	1,753	267	1,428
2013	5,231	27	360	176	2,389	358	1,922
2014	7,291	37	494	243	3,356	494	2,666
2015	9,403	47	628	310	4,362	632	3,424
2016	11,569	57	760	379	5,407	772	4,195
2017	13,789	67	892	447	6,490	913	4,980
2018	13,966	67	890	449	6,619	917	5,024
2019	14,144	67	888	451	6,749	922	5,068
2020	14,321	66	886	453	6,878	926	5,112
2021	14,499	66	884	455	7,007	931	5,156
2022	14,677	66	882	457	7,136	935	5,200
2023	14,854	66	879	459	7,266	940	5,244
2024	15,032	66	877	461	7,395	944	5,287
2025	15,209	66	875	463	7,524	949	5,331
2026	15,387	66	873	465	7,654	953	5,375
2027	15,565	66	871	467	7,783	958	5,419

Table B.51. Achievable Potential (kW) by Market Segment (2027): Real Time Pricing – C&I

Building Type	System Total	CA	ID	OR	UT	WA	WY
Grocery	213.2	0.3	1.3	62.8	120.1	13.0	15.5
Health	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Large Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lodging	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Miscellaneous	614.5	3.0	1.7	75.4	489.6	15.6	29.2
Restaurant	- - -	- - -	- - -	- - -	- - -	- - -	- - -
School	1,718.0	0.9	4.5	104.7	1,419.3	22.3	166.2
Small Office	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Small Retail	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Warehouse	208.3	0.1	18.3	8.6	178.3	3.0	- - -
Chemical Mfg	2,278.9	- - -	106.0	- - -	806.1	- - -	1,366.9
Electronic Equipment Mfg	280.8	- - -	- - -	- - -	280.8	- - -	- - -
Food Mfg	783.1	- - -	91.8	1.5	543.9	146.0	- - -
Industrial Machinery	177.8	- - -	- - -	- - -	177.8	- - -	- - -
Irrigation	975.4	17.6	617.6	200.8	35.8	101.9	1.7
Lumber Wood Products	120.7	43.7	- - -	4.0	- - -	73.0	- - -
Mining	3,178.4	- - -	- - -	- - -	1,037.4	- - -	2,141.0
Miscellaneous Mfg	2,880.5	0.6	29.8	3.5	937.7	210.0	1,698.8
Paper Mfg	377.5	- - -	- - -	4.6	- - -	372.9	- - -
Petroleum Refining	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Stone Clay Glass Products	660.4	- - -	- - -	- - -	660.4	- - -	- - -
Primary Metal Mfg	605.2	- - -	- - -	1.6	603.6	- - -	- - -
Transportation Equipment Mfg	492.0	- - -	- - -	- - -	492.0	- - -	- - -
Single Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Multi Family	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Manufactured	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Appendix B-4. Capacity-Focused Resource Materials: Winter Results

Class 1 DR Programs

Table B.52. Rocky Mountain Power Cumulative (20-Year) Technical, Economic and Achievable Capacity-Focused Potentials (MW) for the Class 1 DR Programs

Sector	Technical Potential	Achievable Potential	Achievable as % of 2027 Peak
Residential	- - -	- - -	- - -
Commercial	97	1	0%
Industrial	- - -	- - -	- - -
Irrigation	- - -	- - -	- - -
Total	87	1	0%

Table B.53. Pacific Power Cumulative (20-Year) Technical, Economic and Achievable Capacity-Focused Potentials (MW) for the Class 1 DR Programs

Sector	Technical Potential	Achievable Potential	Achievable as % of 2027 Peak
Residential	- - -	- - -	- - -
Commercial	40	0	0%
Industrial	- - -	- - -	- - -
Irrigation	- - -	- - -	- - -
Total	40	0	0%

Table B.54. Cumulative (20-year) Achievable Capacity Focused Potentials (MW) by Region for the Class 1 DR Programs

Levelized Cost	DLC - RES - AC and Water Heat	DLC - Commercial	Irrigation	Thermal Energy Storage
Rocky Mountain Power	- - -	1	- - -	- - -
Pacific Power	- - -	0	- - -	- - -

Class 3 DR Programs

Table B.55. Rocky Mountain Power Cumulative (20-Year) Technical, Economic and Achievable Capacity-Focused Potentials (MW) for the Class 3 DR Programs

Sector	Technical Potential	Achievable Potential	Achievable as % of 2027 Peak
Residential	694	694	39
Commercial	676	676	40
Industrial	1,342	1,342	95
Irrigation	- - -	- - -	- - -
Total	2,712	2,712	174

Table B.56. Pacific Power Cumulative (20-Year) Technical, Economic and Achievable Capacity-Focused Potentials (MW) for the Class 3 DR Programs

Sector	Technical Potential	Economic Potential	Achievable Potential	Achievable As Percent of 2027 Peak
Residential	737	737	41	2%
Commercial	484	484	25	1%
Industrial	74	74	6	3%
Irrigation	- - -	- - -	- - -	0%
Total	1,295	1,295	72	1%

Table B.57. Cumulative (20-year) Achievable Capacity Focused Potentials (MW) by Region for the Class 3 DR Programs

	Curtailable Load	Demand Bidding	Time of Use Rates	Critical Peak Pricing - Residential	Critical Peak Pricing - C&I	Real Time Pricing Com
Rocky Mountain Power	37	25	11	30	58	14
Pacific Power	7	11	11	32	10	1

Appendix C.1. Technical Supplements: Energy Efficiency Resources, Measure Descriptions

The assessment of energy efficiency potential involved the incorporation of dozens of different data elements to characterize the different market segments, end uses, and measures. These data elements vary by state, sector, market segment, end use, construction vintage, and year of the forecast.

Residential Measure Descriptions

This section provides an overview of the analyzed energy-efficiency measures within the residential sector, and categorized by end use. Since existing and new construction vintages have many of the same measures, they have been combined for the purpose of this appendix. However, due to variation in equipment saturations, baseline consumption, and other characteristics, there can be significant differences in the total resource cost (TRC) test results by region; both Rocky Mountain Power and Pacific Power TRCs[1] are shown. Results for measures that do not represent a replacement of end use equipment (non-equipment measures) are shown below by end use, while all equipment replacement has been grouped into the End Use Equipment category. Lastly, some "emerging technology" measures that are not yet widely available, but are expected to become so over the planning horizon are described.

The results presented represent measure impacts and cost-effectiveness in 2027. Some measures may be cost-effective in 2027, but not in earlier years, duet to changes in IRP decrement values over time.

Lighting

Incandescent lighting is a highly inefficient light source; as such, significant savings can be gained by switching to fluorescent lighting. Lighting measures for typical household applications are assumed to have an average usage of 2.5 hr/day.[2]

[1] In this appendix, the numbers associate with the term "TRC" represent the benefit – cost ratio under the Total Resource Cost Test. For Washington, Idaho, and California, this includes a 10% conservation adder.

[2] Based on data available from the Northwest Power and Conservation Council.

Table C.1. Residential Lighting

Lighting	Baseline	End Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
CFL Lamps 15 W	Incandescent 60W	59%	9.4	8.5
CFL Fixtures 2-15 W	Incandescent 2-60W	12%	7.8	7.0
CFL Torchieres 2-18W	Incandescent Torchieres, 180W Halogen	4%	13.5	12.2

CFL Lamps, Torchieres and Fixtures. A 15W compact fluorescent light (CFL) can be a drop-in replacement for a 60W incandescent light, resulting in a 75% energy savings. However, since stand-alone incandescent bulbs comprise only about 79% of residential lighting consumption, this 75% reduction per bulb corresponds to only 59% of the entire lighting end use consumption. Similarly, CFL torchiere and fixture replacements were analyzed, as shown in Table C.1.

Heating, Ventilation, and Air-Conditioning (HVAC)

Measures associated with the HVAC system improve the overall heating and cooling loads in the building. For residential buildings, HVAC measures affect several end uses; central air conditioning (C-AC), central heating (C-HT), heat pump (HP), room air conditioning (R-AC), and room heating (R-HT). Table C.2 separates the measures into four categories that are related to cooling end uses, heating end uses, heating and cooling end uses, and envelope measures and provides TRC results for each measure (where a TRC result of greater than 1.0 signifies cost-effectiveness).

Table C.2. Residential HVAC

Technology	Baseline	End Use % Savings					TRC Rocky Mountain Power					TRC Pacific Power				
		C-AC	C-HT	HP	R-AC	R-HT	C-AC	C-HT	HP	R-AC	R-HT	C-AC	C-HT	HP	R-AC	R-HT
Cooling End Uses																
Attic Fan	No Attic Fan	15%		15%			0.6		0.3			0.3		0.2		
Cool Roof (ENERGY STAR)	Dark Colored Roof	12%		1%	12%		9.3		4.1	5.7		4.2		3.3	3.0	
High Efficiency Ceiling Fan	No Ceiling Fan	3%			3%		0.4			0.3		0.2			0.1	
Evaporative coolers	Standard AC Unit (13 SEER)	70%					+99					+99				
Heating End Uses																
Air-to-Air Heat Exchangers	No Heat Exchanger		10%	10%				2.3	2.3				1.8	1.5		
VFD Furnace Fan Motor, Existing	Constant speed		11%					7.1					6.2			
VFD Furnace Fan Motor, New	2-speed operation		9%					4.4					3.7			

Technology	Baseline	End Use % Savings					TRC Rocky Mountain Power					TRC Pacific Power				
		C-AC	C-HT	HP	R-AC	R-HT	C-AC	C-HT	HP	R-AC	R-HT	C-AC	C-HT	HP	R-AC	R-HT
Heating and Cooling End Uses																
"Check Me" Duct Sealing	No Duct Sealing	5%	5%	5%			0.4	2.0	2.0			0.2	1.9	1.7		
"Check Me" Tune-up/Maintenance	No Tune-Up	10%	10%				0.6		3.2			0.3		3.2		
Duct Insulation Upgrade (R-8)	R-4	3%	4%	3%			1.1	5.5	4.1			0.2	2.5	1.6		
Heat Pumps - Service Contracts	No Tune-Up			10%					3.1					2.5		
Envelope																
Insulation-Ceiling Above Code (R-49)	R-38		2%	2%		2%		0.7	0.6		0.8		0.4	0.3		0.4
Insulation-Ceiling To Code (R-38)	R-25		7%	5%		8%		1.9	1.3		2.5		1.7	1.0		1.5
Insulation-Floor (R-30)	R-15		5%	4%		5%		1.1	0.7		1.1		0.8	0.5		0.7
Insulation-Wall 2x4 (R-13)	R-11		3%	2%		4%		0.6	0.4		0.7		0.6	0.3		0.4
Insulation-Wall 2x6, Existing (R-21)	R-11		6%	6%		6%		0.7	0.6		0.6		0.7	0.5		0.4
Insulation-Wall 2x6, New (R-21)	R-19		1%	1%		1%		0.3	0.5		0.3		0.3	0.2		0.2
SIPs insulation 2x6 Wall (R-26)	R-19		16%	16%		16%		0.7	0.7		0.8		0.6	0.5		0.5
Below Grade Insulation (R-10)	R-0		4%	3%		4%		1.3	0.9		1.3		1.1	0.7		0.8
ENERGY STAR New Construction - Single Family	State Code	36%	36%	29%	36%	36%	0.2	1.0	0.8	0.2	1.2	0.1	0.9	0.6	0.1	0.8
ENERGY STAR New Construction Manufactured	State Code	36%	36%	29%	36%	36%	0.2	1.4	0.8	0.1	1.3	0.1	0.9	0.7	0.1	0.8
Whole house air sealing, Existing (0.5 ACH)	1.0 ACH		31%	23%		31%		4.0	2.4		3.7		2.9	1.7		2.2
Whole house air sealing, New (0.35 ACH)	0.5 ACH		18%	10%		18%		1.5	0.8		1.5		1.1	0.4		1.0
Windows ENERGY STAR, Existing (U=0.35)	U=0.67		18%	13%		18%		2.4	1.6		2.2		2.4	1.4		1.7
Windows ENERGY STAR, New (U=0.35) - Electric Resistance	U=0.40 (Electric Resist)		4%			4%		3.2			3.5		3.0			2.3
Windows ENERGY STAR, New (U=0.35) - Heat Pump	U=0.55 (Heat Pump)			3%					0.4					0.3		

Cooling End Use Measures. Measures specific to residences using central air conditioning, heat pump (cooling side), and/or room air conditioning.

- *Attic Fan*. A whole house fan is a simple and inexpensive method of cooling a house. The fan draws cool outdoor air inside through open windows and exhausts hot indoor air through the attic to the outside. Running a whole house fan whenever outdoor temperatures are lower than indoor temperatures will cool a house.[3]
- *Cool Roof* (ENERGY STAR). ENERGY STAR® qualified cool roofs can lower roof surface temperature by up to 100ºF, decreasing the amount of heat transferred into a building. Cool roofs can help reduce the amount of air conditioning needed in buildings, and can reduce peak cooling demand by 10%–15%.[4]
- *High Efficiency Ceiling Fan*. ENERGY STAR qualified ceiling fans use improved motors and blade designs. This measure does not include other accessories such as a light kit. All savings are associated with the improved fan design.
- *Evaporative Coolers*. Evaporative coolers, or swamp coolers, provide cooling by using the evaporation process of water in air. More effective in dryer climates, residential evaporative coolers are inexpensive and very energy efficient compared to standard AC units. There are two main types of evaporative coolers: direct and in-direct. Typical residential systems use direct evaporation by lowering the temperature of air from latent heat of evaporation, changing water to vapor.[5] The TRC is very high, above 100, since evaporative coolers cost less than a standard air conditioning systems.

Heating End Use Measures. Measures specific to residences using electricity for central heating, heat pump (heating side), or room heat.

- *Air-to-Air Heat Exchanger*. Advanced ventilation brings in fresh, outdoor air, but pre-heats the outside air with the warm exhaust air. Only for new construction.
- *VFD Furnace Fan Motor*. Variable Frequency Drive (VFD) furnace fan motors provide significant energy savings compared to constant speed motors and 2-speed motors. The measure savings over the baseline of the constant speed motor, only for existing construction, is 70%. The measure savings over the baseline of the 2-speed motor, only for new construction, is 60%.

Heating and Cooling End Use Measures. This category includes those measures that affect the centralized HVAC systems, including the central air conditioner, central heating, and/or heat pump.

- *"Check Me" Duct Sealing*. By repairing and sealing leaky ducts, significant energy savings can be attained by ensuring the conditioned air is freely traveling to the occupied spaces. Only for existing homes.

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[3] Office of Building Technology, State and Community Programs, Energy Efficiency and Renewable Energy, DOE

[4] ENERGY STAR

[5] ToolBase Services with NAHB Research Center and Wikipedia

- *"Check Me" Tune-up/Maintenance*. Doing certified maintenance will improve the overall efficiency of the heating and cooling systems. Specific to residences using an electric furnace and/or central air conditioning for their space heating and cooling needs. Only for existing homes.
- *Duct Insulation*. Adding insulation (to R-8) around the ducts in the heating system will reduce heat loss to unconditioned spaces. Only for existing homes.
- *Heat Pumps - Service Contracts.* Similar to "Check Me" tune-ups, but this measure is specifically for heat pumps as an annual or multi-year service contract. Repeated certified maintenance visits will improve the overall efficiency of the heat pump and extent the life of the system. Only for existing homes.

Building Envelope Measures. "Building envelope" measures improve the thermal performance of the building's walls, floor, ceiling or windows. The baseline technology and the energy-efficiency upgrades are discussed below. The building envelope energy-efficiency measures include insulation (ceiling, wall, and floor), windows, whole house air sealing, and ENERGY STAR envelope package options. These measures result in savings for heat pump and space heat (central and room) end uses.

- *Ceiling Insulation*. This measure represents an increase in R-value. Adding insulation in existing buildings increases the thermal performance and brings the resistance value up to and past code, depending on vintage. Existing homes are brought up to code, R-38 represents current code in the ceiling. New homes can exceed code to R-49.
- *Floor Insulation*. Similar to ceiling insulation, this measure represents an increase in R-value, bringing the resistance value up to code. Currently, R-25 represents code for typical residential homes. Only for existing homes.
- *Wall Insulation*. This measure represents an increase in R-value thereby increasing the thermal performance of the building. Depending on building construction, there are different wall insulation measures.
    - Insulation – Wall 2x4. Currently, R-13 represents code for 2x4 construction. Only for existing homes.
    - Insulation – Wall 2x6. This measure apply to both new and existing construction. The 6-inch wall cavity allows for an insulation of up to R-21.
    - SIPs insulation 2x6 Wall. Structural insulated panels (SIPs) are high-performance building panels made using expanded polystyrene (EPS), or polyisocyanurate rigid foam insulation sandwiched between two structural skins of oriented strand board (OSB). The result is a building system that is very strong, predictable, and energy efficient.[6] This measure only applies to new construction.
- *Below Grade Insulation*. Adding insulation to the basement or crawlspace walls increases the thermal performance of the concrete foundation. For existing construction the R-value is increased from 0 to 10. Only for existing homes.

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[6] Source: Structural Insulated Panel Association

- *ENERGY STAR Home.* For manufactured or single-family homes, an ENERGY STAR rating exists to improve the overall efficiency of a new home. This package option includes the following measures: whole house air sealing (leakage reduction), duct insulation, wall/ceiling/floor insulation, and ENERGY STAR windows. Only for new construction.
- *Whole House Air Sealing.* In existing buildings, air infiltration can account for 30% of a home's heating and cooling costs.[7] Windows, doors, attic, crawlspaces and outside walls contribute to air leakages. Sealing these air leaks decreases overall heating and cooling losses. For existing residences, the energy efficiency measure is a reduction from 1.0 air changes per hour (ACH) to 0.5 ACH. For new construction, however the baseline is 0.5ACH and the energy efficiency measure is 0.35 ACH (the minimum ACH value allowed by code for health and safety reasons).
- *Windows ENERGY STAR.* The efficiency of windows is rated by U-value, where a lower U-value indicates a higher efficiency window. Higher performance windows can be achieved by using double-pane glass with low-emissivity (low-e) films, and/or argon gas filling the gap between the panes. ENERGY STAR rated windows have a U-value of U=0.35 or better. For existing homes, the measure represents an increase in performance by improving the U-value from U=0.67 to U=0.35. For new homes, the code (baseline) depends on the type of heating system installed. The minimum code requirement for windows in homes employing electric resistance is U=0.40 whereas homes using heat pumps are required to have a value of U=0.55.

Water Heat

In addition to more efficient water heating systems, any measure that requires less hot water is also included in the list of water heat measures below.[8]

[7] Source: U.S. Department of Energy – Air Sealing Spec Sheet by the Office of Building Technology, State and Community Programs.

[8] Information on solar water heating is presented in Appendix E.

Table C.3. Residential Water Heat

Water Heat	Baseline	End Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Drain Water Heat Recovery (GFX)	No Heat Recovery	20%	1.8	1.4
ENERGY STAR Clothes Washer High Efficiency (MEF=1.72)	Standard Clothes Washer (MEF=1.26)	11%	1.1	1.0
ENERGY STAR Clothes Washer Premium Efficiency (MEF=2.0)	Standard Clothes Washer (MEF=1.26)	18%	1.4	1.3
ENERGY STAR Dishwasher (EF=0.65)	Standard Dishwasher (EF=0.46)	6%	8.8	7.8
Faucet Aerators (2.5 GPM)	4.0 GPM	3%	9.0	8.1
High Efficiency Water Heater (EF=0.95)	EF=0.93	2%	1.0	0.6
Hot Water Pipe Insulation R-4	R-0	1%	0.7	0.4
Low-Flow Showerheads (2.5 GPM)	4.0 GPM	13%	17.7	16.0
Water Heater Temperature Setback (115 degrees)	130 degrees	4%	3.4	1.8

Drain Water Heat Recovery (GFX). This measure recovers heat from wastewater and recycles it for use in the heating of incoming water. For example, as hot water passes down the drain from a shower, heat is exchanged with incoming cold water from the water main thereby pre-heating incoming cold water to the water heater tank. Only for new construction.

ENERGY STAR Appliances. Upgrading to an ENERGY STAR-rated appliance, such as dishwasher or clothes washer, will reduce overall water heating needs by decreasing water use. ENERGY STAR clothes washers have two efficiency levels, high and premium.

Faucet Aerators. Faucet aerators, by mixing water and air, lower the water flow from 4.0 gallons per minute (GPM) to 2.50 GPM. The faucet aerator creates a fine water spray with a screen that is inserted in the faucet head. Only for existing construction.

High Efficiency Water Heater. High efficiency water heaters are more efficient than standard electric water heaters. This measure assumes an energy factor (EF) for the high efficiency water heaters of 0.95, an increase from the code minimum of 0.93.

Hot Water Pipe Insulation. Adding R-4 insulation around the pipes will decrease heat loss. Only for existing construction.

Low-Flow Showerheads. Low-flow showerheads use the same principle as faucet aerators to achieve a flow reduction of nearly 50%, lowering the flow rate to 2.5 GPM from 4.0 GPM. Only for existing construction.

Water Heater Temperature Setback. This measure is designed to set back the water heater temperature to 115° from 130°. This saves electricity by eliminating energy consumption needed to heat the water the unnecessary 15°.

Refrigeration

Table C.4. Residential Refrigeration

Refrigeration	Baseline	End Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Refrigerator, ENERGY STAR (1.16 kWh/day)	1.36 kWh per day	15%	1.3	1.3
Removal of Secondary Refrigerator	Base Secondary Refrigerator	100%	8.6	5.3
Removal of Secondary Freezer	Base Secondary Freezer	100%	9.7	6.0

Refrigerator ENERGY STAR. High efficiency refrigerators having an ENERGY STAR rating and that use 1.16 kWh/day or less. Comparably, the 2004 Federal standard or baseline is 1.36 kWh/day.

Removal of Secondary Refrigerator or Freezer. This refers to the environmentally-friendly disposal of unneeded appliances such as secondary refrigerators or stand-alone freezers.

Plug Load

Plug-in loads that are purchased with an ENERGY STAR rating reduce the overall electric load of the household compared to standard equipment. The following list includes both typical household entertainment equipment and home-office equipment. Office equipment such as computers, monitors, and printers can all be ENERGY STAR-classified, indicating lower energy consumption than conventional equipment. This is, in part, achieved by allowing the machine to go into standby mode.

Table C.5. Residential Plug Load

Plug Load	Baseline	End Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Digital Set Top Receivers (1 watt standby mode)	Standard Receiver (4 watts standby mode)	0.2%	0.1	0.1
Efficient DVD systems (1 watt standby mode)	Standard DVD System (4.5 watts standby mode)	0.2%	428	423
Efficient high definition televisions LCD (1 Watt on standby mode)	Standard HDTV (Not Flat Panel)	1%	0.1	0.1
Power Supply Transformer/Converter - 80 plus (80%)	50% efficient power supply (non-ENERGY STAR)	0.5%	1501	1444
Power-strip with Occupancy Sensor	No Occupancy Sensor	1.4%	0.4	0.4

ENERGY STAR Plug-In Equipment

- Digital set top receivers
- Efficient DVD systems
- Efficient high-definition televisions

Power Supply Transformer/Converter. External power adapters, also known as power supplies or battery chargers, convert high voltage AC electricity from the wall outlet to low-voltage DC power. Typical electronic products such as MP3 players, digital cameras, laptops, and cordless and mobile phones use power adapters, and would be ideal candidates for this measure. This measure is ENERGY STAR compliant and on average, 30% more efficient than conventional models.

Power Strip with Occupancy Sensor. Energy saving products such as power strips with an occupancy sensor are found in workstations where power strips are commonly used. The sensor will turn on and off the power to all devices such as computers, desk lights, and audio equipment that are plugged into the power strip based on occupancy within the work area.

End Use Equipment

In either existing or new construction, when new equipment needs to be purchased, savings can be gained by purchasing high-efficiency models.

Table C.6. Residential Lost Opportunity – Equipment

Technology	Baseline	End Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
HVAC				
High Efficiency Heat Pump (15 SEER, 8.2 HSPF)	Standard Efficiency (13 SEER, 7.7 HSPF)	8%	2.4	1.7
Premium Efficiency (16 SEER, 8.6 HSPF)	Standard Efficiency (13 SEER, 7.7 HSPF)	13%	1.2	0.8
Advanced Efficiency (18 SEER, 9.0 HSPF)	Standard Efficiency (13 SEER, 7.7 HSPF)	18%	0.4	0.3
High Efficiency Central AC (15 SEER)	Standard Efficiency (13 SEER)	15%	1.0	0.7
Premium Efficiency Central AC (16 SEER)	Standard Efficiency (13 SEER)	21%	1.0	0.7
Advanced Efficiency Central AC (18 SEER)	Standard Efficiency (13 SEER)	31%	0.2	0.2
ENERGY STAR Room AC (10.7 EER)	9.7 EER	9%	0.5	0.3
Appliances				
ENERGY STAR Freezer	Standard Freezer	10%	1.7	1.4
High Efficiency Dryer w/ Moisture Sensor (EF=3.49)	Standard Dryer EF = 3.01	14%	1.7	1.5

High/Premium/Advanced-Efficiency Air-Source Heat Pump. Electric air-source heat pumps use the difference between outdoor air temperatures and indoor air temperatures to cool and heat the home. A standard air-source heat pump has a SEER=13 and HSPF=7.7. Though heat pumps are available at numerous levels of SEER and HSPF, for this study, three typical efficiencies were analyzed: A high-efficiency unit with SEER=15 and HSPF=8.2, a premium-efficiency unit with SEER=16 and HSPF=8.6, and an advanced-efficiency unit with SEER=18 and HSPF=9.0, with energy savings of 8%, 13%, and 18%, respectively, over the standard.

High/Premium/Advanced-Efficiency Central AC. A central air conditioner consists of an evaporator or cooling coil, compressor, and condenser. Central air conditioners provide the function of air-cooling for the home. A standard central air conditioning unit has a SEER=13. As with heat pumps above, this study analyzed three typical efficiency levels above code: A high-efficiency unit with SEER=15, a premium-efficiency unit with SEER=16 and an advanced-efficiency unit with SEER=18, with energy savings of 15%, 21% and 31%, respectively, over the standard.

ENERGY STAR Room AC. ENERGY STAR qualified room air conditioners use less energy than conventional models through improved energy performance as well as timers for better temperature control. ENERGY STAR qualified room air conditioners have a 10.7 EER value compared to a standard model that has 9.7 EER.

ENERGY STAR Freezer. ENERGY STAR qualified freezer models use at least 10% less energy than required by current federal standards from the National Appliance Energy Conservation Act (NAECA).

High Efficiency Dryer w/ Moisture Sensor. High efficiency dryers with moisture sensor are more energy efficient by integrating a type of moisture sensor, the most common being conductivity strips, to assist in identifying when to terminate a cycle. These strips serve to detect whether the load is wet or not. This saves energy by reducing the dryer's operation time and prevents over-drying.

Residential Emerging Technology

These emerging technology (ET) measures are energy-efficiency measures that are not readily available in the current market, but are expected to be so within the 20-year planning horizon. The different ET measures are in varying stages of "market readiness," and the potential study included the ET measures only after they are expected to become market-ready.

ET Lighting

Table C.7. Residential Emerging Technology – Lighting

Lighting	Baseline	End Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
LED Lighting 4 W	Incandescent 60 W	74%	3.1	2.8

LED Interior Lighting (White). Light emitting diodes (LEDs) are solid-state devices that convert electricity to light, potentially with very high efficiency and long life. Recently, lighting manufacturers have been able to produce "cool" white LED lighting indirectly, using ultraviolet LEDs to excite phosphors that emit a white-appearing light. These lights are viewed as a replacement for incandescent lamps, beginning to gain market acceptance in 2011.

ET Plug Load

Table C.8. Residential Emerging Technology – Plug Load

Plug Load	Baseline	End Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
One-Watt Standby Power	Four devices per home	4%	5.9	5.7

One-Watt Standby Power. Standby power is the electricity used by electrical equipment when it is switched off, or not performing its main function. Minimizing this loss to 1 Watt or less can reduce this standby energy consumption by more than 50%. Introduced in 2011.

ET Refrigeration

Table C.9. Residential Emerging Technology – Refrigeration

Refrigeration	Baseline	End Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
One kWh/day Refrigerator	Standard refrigerator	30%	1.8	1.8

One kWh/day Refrigerator. Reducing the energy use of a refrigerator to less than 1 kWh/day will result in 30% reduction in energy use from a baseline refrigerator. Introduced in 2011.

ET Heating, Ventilation, and Air-Conditioning (HVAC)

Table C.10. Residential Emerging Technology – HVAC

Technology	Baseline	End-Use % Savings					TRC Rocky Mtn. Power					TRC Pacific Power				
		C-AC	C-HT	HP	R-AC	R-HT	C-AC	C-HT	HP	R-AC	R-HT	C-AC	C-HT	HP	R-AC	R-HT
Heating End Uses																
Advanced Cold-Climate Heat Pump (SEER 16, HSPF 9.6)	13 SEER, 7.7 HSPF			24%					1.1					1.0		
ECPM Furnace Fan Motor	Standard Motor		8%					5.3					4.9			
Heating / Cooling End Uses																
Green Roof	Standard Dark Colored Roof	8%	9%	8%	2%	2%	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0

Advanced Cold-Climate Heat Pump. Cold-climate heat pumps are air-to-air heat pumps that have been optimized for colder climates. The performance of these heat pumps is expected to be approximately the same as ground-source heat pumps. Introduced in 2011.

ECPM Furnace Fan Motor. Electronically Commutated Permanent Magnet (ECPM) motors in residential furnace (electric) applications are more energy efficient than premium HVAC motors. An ECPM is about 80% efficient compared to a standard motor that is 50% efficient. Introduced in 2008.

Green Roof. A green roof is a living roof that supports soil and plant growth. A series of carefully engineered layers are applied to the roof deck. These layers are watertight, lightweight and long-lasting. Green roofs can be incorporated into new buildings as long as load requirements are met. They are suited for roofs that have slopes ranging up to 20° and are most successful when sufficient attention has been paid to selecting plants that will thrive in the local climate and conditions. One of the most significant advantages is that a green roof can last up to three times longer than a standard roof. The added benefit of a green roof's ability to buffer temperature extremes improves a building's energy performance by dropping the temperatures on the roof 3° – 7° degrees, resulting in approximately an 8% to 10% reduction in cooling loads. Introduced in 2011.

ET Water Heat

Table C.11. Residential Emerging Technology – Water Heat

Water Heat	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Heat Pump Water Heater (EF=2.9)	EF = 0.93	34%	0.8	0.8
Heat Trap	No Heat Trap	10%	5.8	3.8

Heat Pump Water Heater. Heat pump water heaters are more efficient than standard electric water heaters. This measure assumes an energy factor (EF) for heat pump water heaters of 2.9, an increase from the code minimum of 0.93. Introduced in 2008.

Heat Trap. Heat traps are valves or loops of pipe that allow water to flow into the water heater tank but prevent unwanted hot-water flow out of the tank. The valves have balls inside that either float or sink into a seat, which stops convection. These specially designed valves come in pairs. The valves are designed differently for use in either the hot or cold water line.[9] Introduced in 2008.

Commercial Measure Descriptions

This section provides an overview of the selected energy-efficiency measure within the commercial sector, categorized by end use. Since existing and new construction vintages have many of the same measures, they have been combined for the purpose of this appendix. However, due to variation in equipment saturations, baseline consumption, and other characteristics, there can be significant differences in the total resource cost (TRC) test results by region; both Rocky Mountain Power and Pacific Power TRCs are shown. Results for measures that do not represent a replacement of end use equipment (non-equipment measures) are shown below by end use, while all equipment replacement has been grouped into the End Use Equipment category. Lastly, some "emerging technology" measures that are not yet widely available, but are expected to become so over the planning horizon are described.

Lighting

Commercial lighting is an area which has seen large gains in efficiency recently. Significant amounts of electricity can be saved through using newer technologies to reduce lighting power density, decreasing the hours of operation through occupancy sensors, and using appropriate dimming when appropriate. These and other lighting upgrades are described below.

[9] Source: DOE's Office of Energy Efficiency and Renewable Energy

Table C.12. Commercial Lighting

Lighting	Baseline	End Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Continuous Dimming, Fluorescent Fixtures	No Dimming Controls	13%	1.8	1.2
Stepped Dimming Fluorescent Fixtures	No Dimming Controls	8%	0.7	0.5
Integrated Lighting, Classrooms	1.2 W/sq. ft.	16%	1.3	1.0
LED Exit Signs (2W)	CFL Exit Sign (9W)	1%	909	656
LED Refrigeration Case Lights (10W)	Fluorescent Case Lights (34W)	9%	3.9	3.0
Lighting Package, High Efficiency (15% reduction in W/sqft)	Baseline Lighting Power density (W/sqft)	15%	26.4	25.0
Lighting Package, Premium Efficiency (25% reduction in W/ sqft)	Baseline Lighting Power density (W/sqft)	25%	21.1	20.2
Lighting Package, Premium High Bay (35% reduction in W/sqft)	Baseline Lighting Power density (W/sqft)	35%	16.7	10.1
Occupancy Sensor Control, Fluorescent	No Occupancy Sensor	6%	13.5	7.2

Stepped/Continuously Dimming. Rather than a light operating at full power, a dimming switch will allow light levels to vary from 0% - 100% brightness. A stepped dimming switch has several discrete levels of brightness, while a continuously dimming switch will allow variation throughout the range, increasing electricity savings.

Integrated Lighting, Classrooms. Integrated lighting includes daylighting control, super T8 lights, reflective lighting fixtures, and occupancy sensors.

LED. Light-emitting diodes (LEDs) are highly efficient bulbs that can be used for refrigeration case lights and exit signs, over 70% energy savings compared to a fluorescent bulb. Currently, LEDs are not cost-effective to be used in general lighting applications.

Occupancy Sensors. If a space is unoccupied for a designated amount of time, an occupancy sensor will turn off the lights. The lights will turn on again once the sensor detects a person has entered the space.

Reduced Interior Lighting Power Density Packages. This measure is a generic way to indicate improved lighting efficiency. The baseline lighting technology is representative of all available technologies that make up the total Watts per square foot for that particular building type. This includes all overhead lighting such as T12, T8, T5 tubes, canned CFLs, etc. The lighting reduction package measures reduce the lighting power density (W/sqft) by installing higher efficiency technologies such as high performance T8 or T5 tubes, high-efficiency ballasts, reflective lighting fixtures, etc. A low reduction package results in a 15% decrease in power density and high reduction results in a 25% decrease in lighting power density. Lighting reduction packages such as T5HO (High Output) for high bay applications, in warehouse and grocery, can reduce the power density by 35%.

Heating, Ventilation, and Air-Conditioning (HVAC)

Measures associated with the HVAC system improve the overall heating and cooling loads on the building. These measures can impact heating or cooling solely, or a combination of both. Therefore, HVAC measures have been split into five sections:, chiller measures, cooling DX measures, heat pump measures, space heating measures, and all HVAC measures.

Chiller-Specific Measures

The two primary components of a chiller are the chiller itself (screw, centrifugal, or reciprocating) and the cooling tower. Chiller-specific measures can apply to the system itself, or to any of the sub-components.

Table C.13. Commercial HVAC – Chiller Measures

Chiller End Use	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Chilled Water / Condenser Water Settings-Optimization	EMS already installed - No Optimization	5%	1.7	1.0
Chilled Water Piping Loop w/ VSD Control	Primary loop only w/ constant speed pump	8%	0.2	0.1
Chiller Tune-Up / Diagnostics	No Chiller Tune-Up / Diagnostics	5%	0.4	0.1
Chiller-Water Side Economizer	No Economizer	19%	0.3	0.1
Cooling Tower-Decrease Approach Temp. (6 Deg F)	10 Deg F	8%	5.1	2.9
Cooling Tower-Two-Speed Fan Motor	Cooling Tower-One-Speed Fan Motor	14%	86	48
Cooling Tower-VSD Fan Control	Cooling Tower-Two-Speed Fan Motor	4%	2.0	1.3
Direct Digital Control System-Optimization	High Efficiency EMS System	10%	1.6	0.7
Pipe Insulation (R-4)	R-0	1%	5.5	2.4

Chilled Water/Condenser Water Settings – Optimization. As part of the entire direct digital control system, this measure optimizes the control of the chilled water temperature and/or flow settings.

Chilled Water Piping Loop with VSD Control. A VSD, or variable-speed drive, replaces a constant speed pump with three-way valves. Varying the speed of the drive allows the pump to run at its optimal load; thus, minimizing its energy requirements.

Chiller Tune-Up / Diagnostics. This measure increases the overall efficiency of the chiller equipment by doing any required maintenance or tune-up. The baseline building will have no tune-up performed. This measure has specific savings depending on what type of equipment is installed. Only for existing construction.

Chiller Water-Side Economizer. This measure reflects the addition of a water-side economizer that consists of a coil attached to a condenser-water loop. The coil operates whenever a cooling load exists, and the outdoor conditions can produce condenser water colder than the mixed-air temperature. A water-side economizer is used if an outdoor-air economizer is not practical. Only for new buildings.

Cooling Tower – Decrease Approach Temperature. The approach temperature is the difference between the tower water leaving and the wet-bulb temperatures. As a result, the cooling tower will be oversized but the chiller can be smaller. On a total energy usage basis, over-sizing a cooling tower requires less energy than a larger chiller. Only for existing construction.

Cooling Tower – Two-Speed Fan Motor. Using a fan that can operate at two speeds, rather than one, allows for better optimization. A one-speed fan will cycle on and off to maintain tower set point, while a two-speed fan will cycle between off, low, and high speed to maintain the set point. Adding in the low-speed option uses less energy than a single, high speed fan.

Cooling Tower – VSD Fan Control. One step more sophisticated than the two-speed fan motor is the variable speed drive (VSD). A VSD drive is able to modulate the air flow so that the heat rejection exactly matches the load at the desired set point.

Direct Digital Control System – Optimization. The optimization of the control system is upgrading a high-efficiency energy management system to a premium efficiency system.

Pipe Insulation. The chilled water is carried through pipes between the cooling tower and chillers. Insulating these pipes minimizes heat loss. Only for existing construction.

Cooling DX Package Specific Measures

A DX system, or direct-expansion air conditioning system is what is generally referred to as a "Central AC" unit in the residential sector.

Table C.14. Commercial HVAC – Cooling DX Measures

Cooling DX End Use	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Direct / Indirect Evaporative Cooling, Pre-Cooling	Standard DX cooling	38%	0.9	0.6
DX Package-Air Side Economizer	No Economizer	19%	5.4	3.4
DX Tune-Up / Diagnostics	No DX Tune-Up / Diagnostics	10%	2.7	1.1

Direct/Indirect Evaporative Cooling, Pre-Cooling. Including an evaporative cooler before the DX system will reduce the overall cooling load. A direct evaporative cooler is a low-energy system that evaporates water into the air stream, thus reducing the temperature of the air, but increasing the humidity. An indirect evaporative cooler uses a secondary air stream that is cooled by water and goes through a heat exchanger with the primary air stream, cooling it but not

affecting the humidity. A direct/indirect system will cool the air stream first through an indirect cooler, then cool it further through a direct cooler.

DX Package Air-Side Economizer. An air-side economizer varies the proportion of outside air to return air to maintain the mixed air temperature set point.

DX Tune-Up / Diagnostics. This measure increases the overall efficiency of the HVAC equipment by doing any required maintenance or tune-up. The baseline building will have no tune-up performed. This measure has specific savings depending on what type of equipment is installed. Only for existing construction.

Heat Pump Measures

Heat pump systems all have the same basic components. These components consist of a pump, a condenser, an evaporator, and an expansion valve. A heat pump can satisfy both heating and cooling needs for a building.

Table C.15. Commercial HVAC – Heat Pump Specific Measures

Heat Pump End Use	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Ground Source Heat Pump (20 EER and 4.0 COP)	10.1 EER, 3.2 COP Air Source HP	58%	0.4	0.4

Ground Source Heat Pump. Geothermal or ground source heat pumps (GSHP) use the constant temperature of the earth as the exchange medium instead of the outside air temperature. This allows the system to reach fairly high efficiencies on the coldest of winter nights, compared to air-source heat pumps on cool days.[10] Typically, GSHP Energy Efficiency Ratios (EER) values of around 20.0 are significantly higher than a standard air source heat pump with an EER of 10.1. The Coefficient Of Performance (COP) for a GSHP is 4.0, while a standard heat pump has a COP of 3.2. GSHPs will save 58% of the energy use over a standard model air source heat pump.

Space Heat Measures

Measures applicable to any electric space heating system.

Table C.16. Commercial HVAC – Space Heat Specific Measures

Space Heat End Use	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Exhaust Air to Ventilation Air Heat Recovery	No Heat Recovery	15%	0.7	0.4

[10] Description source: EERE

Exhaust Air to Ventilation Air Heat Recovery. The air that is exhausted out of a building during the heating season will be warmer than the air outside. Capturing some of this heat and transferring it to the incoming air lowers the overall heating load.

All HVAC Measures

Measures specific to buildings that may apply to the centralized HVAC systems that use chiller cooling, DX cooling packages, heat pumps, and/or space heating. For commercial buildings, HVAC measures affect different end uses; chiller cooling (CH), cooling DX (DX), heat pump (HP), and space heating (SH). Table C.17 separates the measures into three sub-categories that are related to cooling end uses, heating and cooling end uses, and envelope measures.

Table C.17. Commercial HVAC – HVAC Measures

Technology	Baseline	End-Use % Savings				TRC Rocky Mtn. Power				TRC Pacific Power			
		CH	DX	HP	SH	CH	DX	HP	SH	CH	DX	HP	SH
Cooling End Uses													
Cool Roof - Light color reflective paint coating	Standard Dark Colored Roof - No Change	10%	10%	5%		1.3	1.7	1.7		0.7	1.4	1.4	
Cool Roof - Light color single ply	Standard Dark Colored Roof	10%	10%	5%		0.7	1.1	1.1		0.4	0.8	0.8	
Natural Ventilation	None - Standard Ventilation	10%	10%	4%		0.3	0.4	0.3		0.1	0.2	0.2	
Heating and Cooling End Uses													
Convert Constant Volume Air System to VAV	Constant Volume Air System	12%	12%		12%	0.4	0.9		1.3	0.2	0.6		0.7
Duct Insulation (R-8) – Existing	R-0	5%	5%	5%	5%	3.0	3.7	7.8	13.8	1.4	2.2	4.0	4.0
Duct Insulation (R-8) – New	R-4	2%	2%	2%	2%	2.4	3.0	6.8	12.1	1.2	1.7	3.2	4.0
Duct Repair and Sealing	No Repair or Sealing 15% duct losses	3%	3%	3%	3%	2.2	3.0	6.0	5.8	1.0	1.7	3.2	2.7
Programmable Thermostat	No Programmable Thermostat		5%	9%	14%		12.3	62.2	128		7.0	37.7	68.2
Retro-Commissioning	None	15%	15%	15%	15%	0.6	0.7	2.1	1.2	0.3	0.3	0.9	0.6
Terminal HVAC units-Occupancy Sensor Control	No Occupancy Sensor		25%		25%		1.6		2.7		1.2		3.0
Building Envelope													
Infiltration Reduction 20% reduction (0.40 ACH)	0.50 ACH	3%	35	33%	33%	1.1	0.7	20.3	25.4	0.5	0.5	13.5	15.1
Insulation - 2*4 Walls 16" O.C. (R-13)	R-3			10%	22%			1.3	3.1			1.2	2.4
Insulation - Ceiling Fiberglass Batt 24" O.C. (R-21)	R-8			6%	12%			1.0	1.5			0.6	0.8
Insulation - Floor (R-19)	R-10			6%	15%			1.2	1.9			0.7	1.4
New Construction Integrated Bldg. Design	Standard 90 Design	14%	14%	14%		0.1	0.2	0.6		0.1	0.1	0.3	
Windows-High Efficiency (U=0.35) – Existing	U=0.65			3%	9%			0.0	0.1			0.0	0.0
Windows-High Efficiency (U=0.35) – New	U=0.55			5%	13%			0.6	1.3			0.5	1.0

Cooling End Use Measures

Measures specific to commercial building that use chillers, cooling DX, and/or heat pump (cooling side).

Cool Roof. ENERGY STAR qualified cool roofs can lower roof surface temperature by up to 100F, decreasing the amount of heat transferred into a building. Cool roof can help reduce the amount of air conditioning needed in buildings, and can reduce peak cooling demand by 10% – 15%.[11] For commercial flat roofed buildings, the main two options are coatings (reflective paint) and reflective membranes. For existing buildings, the reflective coatings were analyzed and for new construction, single-ply reflective membranes were examined.

Natural Ventilation. Natural ventilation systems rely on pressure differences to move fresh air through buildings. Natural ventilation, unlike fan-forced ventilation, uses the natural forces of wind and buoyancy to deliver fresh air into buildings. The specific approach and design of natural ventilation systems will vary based on building type and local climate. However, the amount of ventilation depends critically on the careful design of internal spaces and the size and placement of openings in the building.[12] Natural ventilation offsets the energy required to run forced air ventilation systems.

Heating and Cooling End Use Measures

Measures specific to commercial building that use chillers, cooling DX, heat pump, and/or electric space heat.

Convert Constant Volume Air System to Variable Volume. Similar to using VSD control, converting to a variable air volume (VAV) system will allow for the drives to operate at an optimal load level and thus, minimize energy consumption. The baseline building only runs at a single volume flow. Only for existing construction.

Duct Insulation. Packaged DX and heat-pump equipment are generally coupled with a ducting system inside the building. Insulating the ducts will reduce energy loss in the unoccupied plenum space. The baseline value for this insulation is R-0 for existing buildings and for new construction the insulation is R-4. The measure increases the insulation to R-8.

Duct Repair and Sealing. Similar to duct insulation, this measure is applicable to building using packaged DX equipment or heat pumps. Basically, by repairing and sealing leaky ducts, significant energy savings could be attained by ensuring the conditioned air is traveling to the occupied spaces. Only for existing construction.

Programmable Thermostat. A programmable thermostat simply controls the set point temperatures automatically. This allows for lower energy use by ensuring the HVAC system is not running during low-occupancy hours. Only for existing construction.

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[11] Description source: ENERGY STAR

[12] Description source: National Renewable Energy Laboratory

Retro-Commissioning. "Retro-commissioning" is the process of optimizing the operation of an existing building through simple, low- or no-cost repairs and operational changes. For example, temperature controls will be set to operate only during occupied periods, ensuring that the ideal static pressure is being met for the fans. Only for existing construction.

Terminal HVAC units-Occupancy Sensor Control. Specially used in the hospitality industry, having energy management features to control the HVAC system can provide a significant energy savings. Such systems include hotel key card controls, for example. The occupancy sensor will ensure that the HVAC system only operates when the room is occupied. This measure is specific to hotel/motel buildings.

Building Envelope Measures

"Building envelope" measures improve the thermal performance of the building's floor and ceiling insulation, reduce infiltration, integrate building design, and improve window efficiency. Insulation improvements are simply an increase in the "R-value" of the building envelope. The greater the R-value, the better the thermal performance. The efficiency of windows is rated by its "U-value," which is effectively 1/R-value. In other words, the smaller the U-value, the better the thermal performance. A U-value=1 indicates a single-pane, ¼", clear glass window. Higher performance windows can be achieved by using double-pane glass with low-emissivity (low-e) films, and/or argon gas filling the gap between the panes.

Wall Insulation. This measure represents an increase in R-value to current code values of R-13. This measure is based on 2 X 4 wall construction with 16" on-center construction. The baseline is an average of existing insulation values across all building types. Only for existing construction.

Ceiling Insulation. This measure represents an increase in R-value to current code values of R-21 in the ceiling. This measure is based on 2 X 6 ceilings with 24" on-center construction using fiberglass batts. The baseline is an average of existing insulation values across all building types. Only for existing construction.

Floor Insulation. The measure represents an increase in R-value to current code levels of R-19 for the floor space (non-slab). The baseline is an average of existing insulation values across all building types. Only for existing construction.

Infiltration Reduction. In existing buildings, reducing air infiltration can save 3% to 36% of a building's heating and cooling costs.[13] Windows, doors, roof, crawlspaces and outside walls contribute to air leakages. Sealing the air leaks improves overall heating and cooling losses. This measure reduces the infiltration by 20%, from 0.50 ACH to 0.40 ACH. Only for existing buildings.

New Construction Integrated Building Design. This measure refers to growing field of high performance integrated building design. Leadership in Energy and Environmental Design

[13] Source: National Institute of Standards and Technology 2005

(LEED) has developed guidelines for designs and clients to build energy efficient buildings. According to ASHRAE, integrated buildings can achieve envelope performance levels 14% beyond code. Only for new construction.

Windows – High-efficiency. This measure represents an increase in performance by changing the U-value from 0.67 to 0.35 for existing construction. For new buildings, the baseline (code) U-value is 0.55 and measure represents an increase in performance to 0.35.

HVAC Auxiliary Measures

Measures specific to the HVAC ventilation or exhaust system, including motors.

Table C.18. Commercial HVAC Aux. Measures

HVAC Aux.	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Automated Ventilation VFD Control	Constant Ventilation	10%	0.2	0.2
Optimized Variable Volume Lab Hood Design	Constant Volume Lab Hood Design	2%	0.6	0.5
Premium Efficiency HVAC motors	Standard Efficiency motors	1%	1.7	1.4
VAV Box High Efficiency Motors	Standard Efficiency - induction motors	11%	0.9	0.8

Automatic Ventilation VFD Control. This measure allows the ventilation to run only when CO_2 levels are above a specified level. Without it, the ventilation system would run constantly.

Optimized Variable Volume Lab Hood Design. For buildings such as universities, schools, and hospitals that use lab hoods, a small savings can be obtained by using a variable, rather than constant, volume lab hood. By allowing the volumetric flow rate to vary will allow a constant speed through the duct, regardless of sash opening.

Premium Efficiency HVAC motors. Premium efficiency motors are more efficient than standard efficiency motors. According to CEE, premium efficiency motors are typically cost effective in applications when they operate more then 4,000 hours a year. Payback within two years is estimated. Currently, CEE and NEMA have premium efficiency standards for manufacturers to adhere by. This measure specifically relates to HVAC motors, ranging from 1 HP to 200 HP, depending on the building size.

VAV Box High Efficiency Motors. High efficiency fan-powered boxes prevent hot and cold spots by maintaining room air circulation while supply-air temperature is modulated to match load. Energy is saved by re-circulating warm air from zones that have less heating requirements to zones with greater heating requirements. An Electronically commutated motor (ECM) powers the fan in each VAV box. An ECM is a brushless DC motor with all of its speed and torque

controls built in electronically. This allows the motor to adjust its speed to ensure the optimal airflow at all times.[14]

Water Heat

In addition to a more efficient water heating system, any equipment measures that require less hot water fall under the auspices of water heat measures.

Table C.19. Commercial Water Heat

Water Heat	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Chemical Dishwashing System	High Temp Commercial Dishwasher	5%	2.3	2.2
Commercial High Efficiency Clothes Washer and Dryer	Commercial Standard Clothes Washer and Dryer	24%	1.5	1.1
Demand Controlled Circulating Systems	Constant Circulation	5%	0.2	0.1
Faucet Aerators (2.5 GPM)	4.5 GPM	2%	5.4	3.8
Hot Water Pipe Insulation (R-4)	No Insulation	5%	5.5	3.7
Low-Flow Showerheads (2.5 GPM)	5.0 GPM	3%	5.7	4.9
Low-Flow Spray Heads (1.6 GPM)	3.0 GPM	1%	5.8	5.3
Water Cooled Refrigeration with Heat Recovery	No Heat Recovery	11%	0.3	0.3
Water Heater Temperature Setback (115 F)	135 F	24%	194	90

Chemical Dishwashing System. Instead of sanitizing the dishes with hot water, chemical sanitizers are used instead. This allows for a lower water temperatures with the same cleaning result.

Commercial High-Efficiency Clothes Washers and Dryers. This measure applies to laundromat type facilities where commercial grade clothes washers and dryers are used. Energy can be saved by using ENERGY STAR clothes washers and dryers with moisture sensor controls.

Demand-Controlled Circulating Systems. In order to ensure hot water demands are met, some buildings will have continuously circulating hot water systems resulting in energy loss through pipes. To reduce this loss, a demand-controlled circulating system can be installed to only circulate hot water when required.

Faucet Aerators. Faucet aerators, by mixing water and air, lower the water flow from 4.5 GPM to 2.5 GPM. The faucet aerator creates a fine water spray with a screen that is inserted in the faucet head.

[14] LEED qualified Justice Center reported by DCJ.com and Minnesota Power Incentive Program

Hot Water Pipe Insulation. Adding R-4 insulation around the pipes will decrease heat loss. Only for existing construction.

Low-Flow Showerheads. Low-flow showerheads use the same principle as faucet aerators to achieve a flow reduction of 50%, lowering the flow rate to 2.5 GPM from 5.0 GPM.

Low-Flow Spray Heads. Low-flow spray heads use the same principle as faucet aerators to achieve a flow reduction of nearly 50%, lowering the flow rate to 1.6 GPM from 3.0 GPM.

Water-Cooled Refrigeration with Heat Recovery. The heat that is extracted from a refrigeration unit can be recaptured for hot water requirements rather than dumped into the ambient.

Water Heater Temperature Setback. Often, the set point temperature on a hot water system is set higher than generally required. This measure reflects the savings obtained by reducing the set point temperature from 135° to 115°. Only for existing construction.

Refrigeration

Measures that improve refrigeration and/or freezer energy requirements are listed here.

Table C.20. Commercial Refrigeration

Refrigeration	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Anti-Sweat (Humidistat) Controls	No Anti-Sweat Controls	5%	2.0	1.5
Compressor VSD Retrofit	Constant Speed Compressor	6%	3.7	2.9
Demand Control Defrost - Hot Gas	Defrost - Electric	3%	2.5	2.0
High Efficiency Case Fans	Standard Efficiency Case Fans	2%	10.6	7.6
High Efficiency Compressors (60%)	Standard Compressors (40%)	9%	11.7	10.0
High Efficiency Ice Maker	Standard Ice Maker	2%	2.3	1.9
Installation of Floating Condenser Head Pressure Controls	No Floating Condenser Head Pressure Controls	3%	4.1	2.6
Reduced Speed or Cycling of Evaporator (VFD) Fans	Constant speed evaporator fans	6%	1.2	0.8
Refrigeration Commissioning or Re-commissioning	No Commissioning / Re-commissioning	5%	0.9	0.5
Solid Door ES Refrigerators/Freezers	Standard Solid Door	24%	27.3	22.7
Strip Curtains for Walk-Ins	No Strip Curtains	4%	7.7	6.2

Anti-Sweat (Humidistat) Controls. A humidistat control allows the user to turn refrigeration display case anti-sweat heaters off when ambient relative humidity is low enough that sweating will not occur. The baseline scenario without the control generally runs these heaters continuously.

Compressor VSD Retrofit. This measure upgrades from a constant speed compressor to a variable speed drive (VSD) compressor. A variable speed compressor modulates the motor speed in response to changes in load. When low-load conditions exist, the current to the compressor motor is decreased, decreasing the compressor work done on the refrigerant.

Demand Control Defrost – Hot Gas. Frost collects on the evaporator, reducing coil capacity by acting as a layer of insulation and reducing the airflow between the fins. In hot gas defrost, refrigerant vapor from either the compressor discharge or the high pressure receiver is used to warm the evaporator coil and melt the frost that has collected there.[15]

High Efficiency Case Fans. The fans used for circulating cool air in a refrigerated space can be upgraded to a higher efficiency.

High Efficiency Compressors. In the refrigeration cycle, high efficiency compressors can operate 20% more efficiently than standard efficiency compressors.

High Efficiency Ice Makers. According to CEE, nationally, the commercial ice-maker market estimates 1.2 million automatic commercial ice-makers are in service, consuming roughly 9.4 billion kWh annually. High efficiency ice makers are 15% more efficient than standard ice makers. The saving can be realized through the use of high-efficiency compressors and fan motors, thicker insulation, and other measures.[16]

Installation of Floating Condenser Head Pressure Controls. This technology allows more heat to be rejected through the condenser at low outside air temperatures, thereby increasing the compressor efficiency.

Reduced Speed or Cycling of Evaporator Fans. By allowing the evaporator fans to run less frequently or at a lower speed, the evaporator is run to fit the system need, rather than having the fans run continuously at high speed. Only for new construction.

Refrigeration Commissioning or Re-commissioning. Refrigeration commissioning is the process of optimizing the operation of an existing refrigeration system. For example, optimizing temperature controls, compressor and evaporator fan operation. Only for existing construction.

Solid Door ENERGY STAR Refrigerators/Freezers. ENERGY STAR labeled commercial solid door refrigerators and freezers are designed with high efficiency components such as ECM evaporator and condenser fan motors, hot gas anti-sweat heaters, or high-efficiency compressors. Compared to standard models, ENERGY STAR labeled commercial solid door refrigerators and freezers can lead to energy savings.[17]

Strip Curtains for Walk-Ins. Strip curtains on walk-in refrigerators reduce the infiltration of warm air into the refrigerated space. Savings come from the reduction of heat loss from a walk-in unit by improving the barrier between the cold space and ambient air.

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[15] Parker Refrigeration Specialists

[16] Consortium for Energy Efficiency (CEE)

[17] ENERGY STAR

Controlled Atmosphere Warehouse

Controlled atmosphere (CA) storage is commonly used to slow down the ripening process in fruit and vegetables. CA storage consume large amount of energy to cool. CA storage is found primarily in Washington state.

Table C.21. Commercial Controlled Atmosphere Warehouse

Refrigeration	Baseline	End-Use % Savings	TRC Pacific Power
Refrigeration System Upgrade	Standard Refrigeration System	40%	3.5

Refrigeration System Upgrade. This measure for CA storage is designed as a combined package of other refrigeration measures. The system upgrade includes a premium efficiency EMS system, VSD compressor, VSD condenser, VSD evaporator fan, and floating condenser head pressure controls

Plug Load

Mostly applicable to office space, plug loads include any devices that do not have a secondary energy conversion use, like refrigeration or heating.

Table C.22. Commercial Plug Load

Plug Load	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Power Supply Transformer/Converter	50% efficient power supply	0.5%	41.9	27.4
Power Strip with Occupancy Sensor	Power Strip w/o Occupancy Sensor	1%	0.2	0.1
Vending Machines- High Efficiency	Standard Vending Machine	4%	3.9	2.9

Power Supply Transformer/Converter. This measure applies to the 80 PLUS performance specification requirements for power supplies in computers and servers. 80 PLUS specifies 80% or greater efficiency at 20%, 50% and 100% of rated load with a true power factor of 0.9 or greater.[18]

Power Strip with Occupancy Sensor. Similar to lighting occupancy sensors, this measure is used to control plug loads. All electrical devices that are plugged into electrical outlets such as computers, task lights, and fans can be controlled by a power strip with an occupancy sensor. A typical power strip with occupancy sensor has several plugs that can be switched on and off by the sensor and several plugs that are not.

[18] www.80PLUS.org

Vending Machines - High Efficiency. High efficiency ENERGY STAR qualified new and rebuilt refrigerated beverage vending machines can be 40% more energy efficient than the standard model. ENERGY STAR vending machines incorporate more efficient compressors, fan motors, lighting systems, and low-power mode options during non-use periods.[19]

Cooking

Table C.23. Commercial Cooking

Cooking	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
High Efficiency Convection Oven	Standard Oven	9%	5.6	5.6
High Efficiency Electric Deep Fat Fryers	Standard Electric Deep Fat Fryers	1%	0.9	0.8

High Efficiency Convection Oven. High efficiency convection ovens use fans to circulate heat evenly throughout the oven by moving hot air past the food. This allows the convection oven to operate at lower temperatures and quicker cook times than a standard oven.

High Efficiency Electric Deep Fat Fryers. This measure follows the 2006 CEE qualified electric deep fat fryers requirements. Under heavy load, the fryer operates at 80% or better efficiency and less than 1,000 Watts in idle.

End Use Equipment

In both existing and new construction, when new equipment needs to be purchased, savings can be gained by purchasing high-efficiency models.

[19] ENERGY STAR

Table C.24. Commercial Lost Opportunity – Equipment

Technology	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Cooling Chiller				
High Efficiency (0.574 kW/ton)	Standard Efficiency (0.634 kW/ton)	9%	2.5	2.4
Premium Efficiency (0.407 kW/ton)	Standard Efficiency (0.634 kW/ton)	19%	1.6	1.5
Advanced Technology (0.461 kW/ton)	Standard Efficiency (0.634 kW/ton)	23%	0.8	0.7
Cooling DX				
High Efficiency (EER=11.0)	Standard Efficiency (EER=10.3)	7%	2.7	2.6
Premium Efficiency (EER=12.2)	Standard Efficiency (EER=10.3)	18%	1.6	1.6
Air Source Heat Pump				
High Efficiency ASHP (11.0 EER, 3.5 COP)	Standard Efficiency (10.1 EER, 3.2 COP)	8%	2.1	1.5

High/Premium/Advanced-Efficiency Centrifugal Chiller. The efficiency of a standard chiller is around 0.634 kW/ton, but high-efficiency chillers with a rated efficiency of 0.507 kW/ton, premium-efficiency at 0.475 kW/ton, and advanced technology with 0.461 kW/ton are available, resulting in a 9%, 19%, and 23% energy savings, respectively.

High/Premium-Efficiency DX Package. Increasing the Energy Efficiency Ratio (EER) of DX package chillers from 10.3 to 11.0 or 12.2 will save 7% and 18% of the energy use, respectively.

High-Efficiency Air Source Heat Pump. Increasing the Energy Efficiency Ratio (EER) of the cooling package from 10.1 to 11.0 and increasing the Coefficient Of Performance (COP) of the heating package from 3.2 to 3.5 will save 8% of the energy use. Heat pump systems all have the same basic components. These components consist of a pump, a condenser, an evaporator, and an expansion valve. A heat pump can provide both heating and cooling needs for a building.

Commercial Emerging Technologies

These ET measures are energy-efficiency measures that are not readily available in the current market, but are expected to be so within the 20-year planning horizon. The different ET measures are in varying stages of "market readiness," and the potential study includes the ET measures only after they become market ready.

ET Lighting

Table C.25. Commercial Emerging Technologies – Lighting

Lighting	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Cold Cathode Lighting (5 W)	30 W Incandescent Bulb	1%	28.4	23.9
Induction Lighting (55 W QL)	150 W Metal Halide	1%	0.3	0.2
Low Wattage Ceramic Metal Halide Lamps (39 W)	100W Halogen-IR PAR lamps	2%	2.8	2.1
Solid State LED White Lighting	50W 10hrs/day, 365 day/yr	7%	1.8	1.5

Cold Cathode Lighting. A cold cathode light is a tubular light or bulb that works by passing an electrical current through a gas or vapor, much like neon lighting. A cold cathode light is up to five times brighter than neon lighting, and it has one of the longest lives of any lighting fixture at about 50,000 hours.[20] Introduced in 2008.

Induction Lighting. A 100 W incandescent lamp can be replaced by a 55 W induction lamp, a 45% energy savings per bulb. An induction lamp has an induction coil at its center powered by an electronic unit that produces a magnetic field that energizes a mercury electron-ion plasma material in the glass assembly surrounding the coil. Introduced in 2008.

Low-Wattage Ceramic Metal Halide Lamps. Advances in metal halide lamp technology have led to the production of ceramic metal halide (CMH) lamps that use ceramic rather than typical quartz arc tubes. Ceramic arc tubes can tolerate a higher temperature than quartz, resulting in improved quality of light color as desired in retail and other color-sensitive applications. CMH lamps represent an attractive alternative to halogen lamps commonly used in these applications due to longer lamp life and 50% less energy required. Introduced in 2011.

Solid State LED White Lighting. Light emitting diodes (LEDs) are solid-state devices that convert electricity to light, potentially with very high efficiency and long life. Recently, lighting manufacturers have been able to produce "cool" white LED lighting indirectly, using ultraviolet LEDs to excite phosphors that emit a white-appearing light. These lights are viewed as a replacement for incandescent lamps, beginning to gain market acceptance in 2011.

[20] Conjecture Corporation of wisegeek.com

ET Heating, Ventilation, and Air-Conditioning (HVAC)

Table C.26. Commercial Emerging Technologies – HVAC

Heating and Cooling End Uses	Baseline	End-Use % Savings				TRC Rocky Mtn. Power				TRC Pacific Power			
		CH	DX	HP	SH	CH	DX	HP	SH	CH	DX	HP	SH
Green Roof	Standard Conventional Roof	12%	12%	15%	3%	0.1	0.1	0.2	0.0	0.0	0.0	0.1	0.0
Leak Proof Duct Fittings	Standard Duct Workmanship	20%	20%	20%	20%	4.5	6.4	12.3	12.1	2.5	4.3	8.1	7.3

Green Roof. A green roof is a living roof that supports soil and plant growth. A series of carefully engineered layers are applied to the roof deck. These layers are watertight, lightweight and long-lasting. Green roofs can be incorporated into new and existing buildings as long as load requirements are met. They are suited for roofs that have slopes ranging up to 20° and are most successful when sufficient attention has been paid to selecting plants that will thrive in the local climate and conditions. One of the most significant advantages is that a green roof can last up to three times longer than a standard roof. The added benefit of a green roof's ability to buffer temperature extremes improves a building's energy performance by dropping the temperatures on the roof 3° – 7° degrees, resulting in approximately a 10% reduction in cooling loads. Introduced in 2011.

Leak-proof Duct Fittings. The majority of duct leakage in commercial HVAC systems is due to improperly sealed connections between ductwork and fittings. Even when duct connections are initially well-sealed, leakage may increase over time. Although the use of mastics and mechanical fasteners is becoming more widespread, a low cost, leak-proof system will help to transform the market. Introduced in 2011.

ET Refrigeration

Table C.27. Commercial Emerging Technologies – Refrigeration

Refrigeration	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Special Glass Doors for Refrigerated Reach-in Cases	Standard Glass Doors	3%	8.3	7.2

Special Glass Doors for Refrigerated Reach-in Cases. Refrigerated reach-in cases with "low-E," double pane thermal glass doors to reduce cooling loses.

ET Water Heat

Table C.27. Commercial Emerging Technologies – Water Heat

Water Heat	Baseline	End-Use % Savings	TRC	
			Rocky Mtn. Power	Pacific Power
Heat Pump Water Heater (EF = 2.9)	EF = 0.93	30%	0.4	0.3

Heat Pump Water Heater. A heat pump water heater is an effective and efficient way to provide hot water for commercial buildings. The system uses a water heating heat pump to move heat from a cool reservoir such as air and transfer this heat into water. The system employs an evaporator, compressor, condenser, expansion valve, hot water circulating pump and controls to accomplish this function[21]. The energy factor (EF) of a commercial heat pump water heater is 2.9 compared to a standard water heater with an energy factor of 0.93. The energy savings is 30%.

Industrial Measure Descriptions

In Table C.28, the End-Use Percent savings and TRC are averaged over all applicable building types for 2027 and the TRC is given for the base-case scenario.

Table C.28. Industrial Measures

Measure	End Use % Savings	TRC	
		Rocky Mtn. Power	Pacific Power
Process			
Cooling Improvements	20%	29	20
Heating Improvements	29%	65	66
Fan System Improvements	13%	17	13
Pump System Improvements	15%	10	7
Other Motor Improvements	5%	12	18
Other Motor O&M	6%	15	8
Air Compressor Improvements	18%	24	26
Air Compressor O&M	18%	16	10
Refrigeration	10%	19	17
Other Process Improvements/O&M	42%	39	23
Building			
Lighting	9%	14	13
HVAC Improvements	15%	18	12
HVAC O&M	17%	20	7
Other Building Improvements	34%	34	42

[21] Description source: U.S. Department of Energy

Process-Related Measures. Any measures to improve the industrial process, not specific to the building itself.

- *Process Cooling Improvements.* Improvements that will decrease the energy required for process-related cooling. Examples would include avoid frost formation on evaporators, shutting of cooling water when not required, using economic thickness of insulation for low temperatures.
- *Process Heating Improvements.* Improvements that will decrease the energy required for process-related heating. Examples would include optimizing schedule for drying oven, reducing temperature of process equipment when on standby, and modifying equipment to improve drying process.
- *Fan System Improvements.* Savings from variable-speed drives (VSD) and/or improvements to the design of the fan system, such as better fans, ducting and flow design.
- *Pump System Improvements.* Similar to fan system improvements, with savings from a VSD and/or improvements to the overall pump system, such as better pumps, more efficient piping and eliminating unnecessary flows. In irrigation, this would include nozzle improvements and scientific irrigation systems.
- *Other Motor Improvements.* Improvements to motors not specific to fans or pumps. This would include using higher efficiency motors, improved rewind practices and correct motor sizing. In the mining industry, this would also include milling technique improvements.
- *Other Motor O&M*. Changing operation and maintenance (O&M) procedures of motors can improve overall energy efficiency of a plant. Some O&M examples include develop and repair/replace policy, avoid emergency rewind of motors, and avoid rewinding motors more than twice.
- *Air Compressor Improvements.* Air compressor energy efficiency, used in the industrial process, can be improved by installing compressor air intakes in coolest locations, or using optimum-sized compressors, amongst others.
- *Air Compressor O&M.* Changing operation and maintenance (O&M) procedures of an air compressor can improve the overall energy efficiency of a plant. Some O&M examples include reducing the pressure of compressed air to the minimum required, cooling compressor air intake with a heat exchanger or eliminating leaks.
- *Refrigeration Improvements.* Refrigeration improvements can include isolating hot equipment from refrigerated area, using highest allowable temperature for refrigerated space or modify refrigeration system to operate at a lower pressure.
- *Other Process Improvements/O&M*. Some generic process improvements/O&M include upgrading obsolete equipment, replace hydraulic/pneumatic equipment with electrical equipment and use optimum size and capacity equipment.

Building-Related Measures. Any measures to improve the building itself, not specific to the industrial process.

- *Lighting Improvements.* Any changes to overall illumination levels, use of natural lighting, or technology improvements to use more efficient bulbs or ballasts that will decrease the overall lighting energy consumption.
- *HVAC Improvements.* There are many changes that can be made to reduce the energy consumption in HVAC control of a plant. Many are measures found in the commercial and residential lists. A sample of improvements include: conditioning only space in use, installing timers and/or thermostats, lowering ceiling to reduce conditioned space, and installing or upgrading insulation on distribution systems.
- *HVAC O&M.* Some operation and maintenance (O&M) improvements to the HVAC control system include size air handling grills/ducts/coils to minimize air resistance, adjust vents to minimize energy use and maintain air filters by cleaning or replacement.
- *Other Building Improvements.* Some generic improvements to the building include de-energizing excess transformer capacity, increase electrical conductor size to reduce distribution losses, and optimize plant power factor.

Appendix C.2. Technical Supplements
Energy Efficiency Resources, Market Segmentation

Table C.30 and Table C.31 show the states in which the different market segment and end uses were assessed. The mapping of segments to states was driven by the database of commercial and industrial customers that PacifiCorp provided for this study. Although most commercial market segments and end uses were included in all five states, there are some exceptions, such as California, which consisted of only rural areas and excluded large offices. In the case of the industrial assessment, the specific facility types were much more state specific, with some market segments included in only one state. No table is provided for the residential sector because the three home types were included in every state. Note that irrigation is included in the industrial sector's table.

Table C.30. Actual Commercial Market Segments and End Uses by State

Market Segment	Space Heat	Cooling Chillers	Cooling DX	Heat Pump	HVAC Aux	Lighting	Water Heat	Refrigeration	Cooking	Plug Load	Other
Grocery	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY
Health	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY
Large Office	ID, UT, WA, WY	ID, UT, WA, WY		ID, UT, WA, WY	ID, UT, WA, WY	ID, UT, WA, WY	ID, UT, WA, WY			ID, UT, WA, WY	ID, UT, WA, WY
Large Retail	ID, UT, WA, WY		ID, UT, WA, WY	ID, UT, WA, WY	ID, UT, WA, WY	ID, UT, WA, WY	ID, UT, WA, WY			ID, UT, WA, WY	ID, UT, WA, WY
Lodging	CA, ID, UT, WA, WY		CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY		CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY
Miscellaneous	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY			CA, ID, UT, WA, WY	CA, ID, UT, WA, WY
Restaurant	CA, ID, UT, WA, WY		CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY
School	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY
Small Office	CA, ID, UT, WA, WY		CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY			CA, ID, UT, WA, WY	CA, ID, UT, WA, WY
Small Retail	CA, ID, UT, WA, WY		CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY			CA, ID, UT, WA, WY	CA, ID, UT, WA, WY
Warehouse	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY		CA, ID, UT, WA, WY	CA, ID, UT, WA, WY
Warehouse CA	WA	WA	WA	WA	WA	WA	WA	WA		WA	WA

Table C.31. Actual Industrial Market Segments and End Uses by State

Market Segment	HVAC	Indirect Boiler	Lighting	Process Electro Chemical	Process Heat	Process Other	Process Cool	Fans	Pumps
Chemical Mfg	ID, UT, WY	ID, UT, WY	ID, UT, WY	ID, UT, WY	ID, UT, WY	ID, UT, WY	ID, UT, WY	ID, UT, WY	ID, UT, WY
Electronic Equipment Mfg	UT	UT	UT	UT	UT	UT	UT	UT	UT
Food Mfg	ID, UT, WA	ID, UT, WA	ID, UT, WA	ID, UT, WA	ID, UT, WA	ID, UT, WA	ID, UT, WA	ID, UT, WA	ID, UT, WA
Industrial Machinery	UT	UT	UT	UT	UT	UT	UT	UT	UT
Irrigation									CA, ID, UT, WA, WY
Lumber Wood Products	CA, WA	CA, WA	CA, WA	CA, WA	CA, WA	CA, WA	CA, WA	CA, WA	CA, WA
Mining	UT, WY	UT, WY	UT, WY	UT, WY	UT, WY	UT, WY	UT, WY	UT, WY	UT, WY
Miscellaneous Mfg	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY	CA, ID, UT, WA, WY
Paper Mfg	WA	WA	WA	WA	WA	WA	WA	WA	WA
Petroleum Refining	UT, WY	UT, WY	UT, WY	UT, WY	UT, WY	UT, WY	UT, WY	UT, WY	UT, WY
Primary Metal Mfg	UT	UT	UT	UT	UT	UT	UT	UT	UT
Stone Clay Glass Products	UT	UT	UT	UT	UT	UT	UT	UT	UT
Transportation Equipment Mfg	UT	UT	UT	UT	UT	UT	UT	UT	UT
Wastewater			CA, ID, UT, WA, WY						CA, ID, UT, WA, WY
Water			CA, ID, UT, WA, WY					CA, ID, UT, WA, WY	CA, ID, UT, WA, WY

Baseline Forecasts

Each state and market segment had its own baseline forecast. These are presented below for each sector by the overall system and the two service territories.

Figure C.1. Baseline Residential Forecast 2006 – 2027, Overall

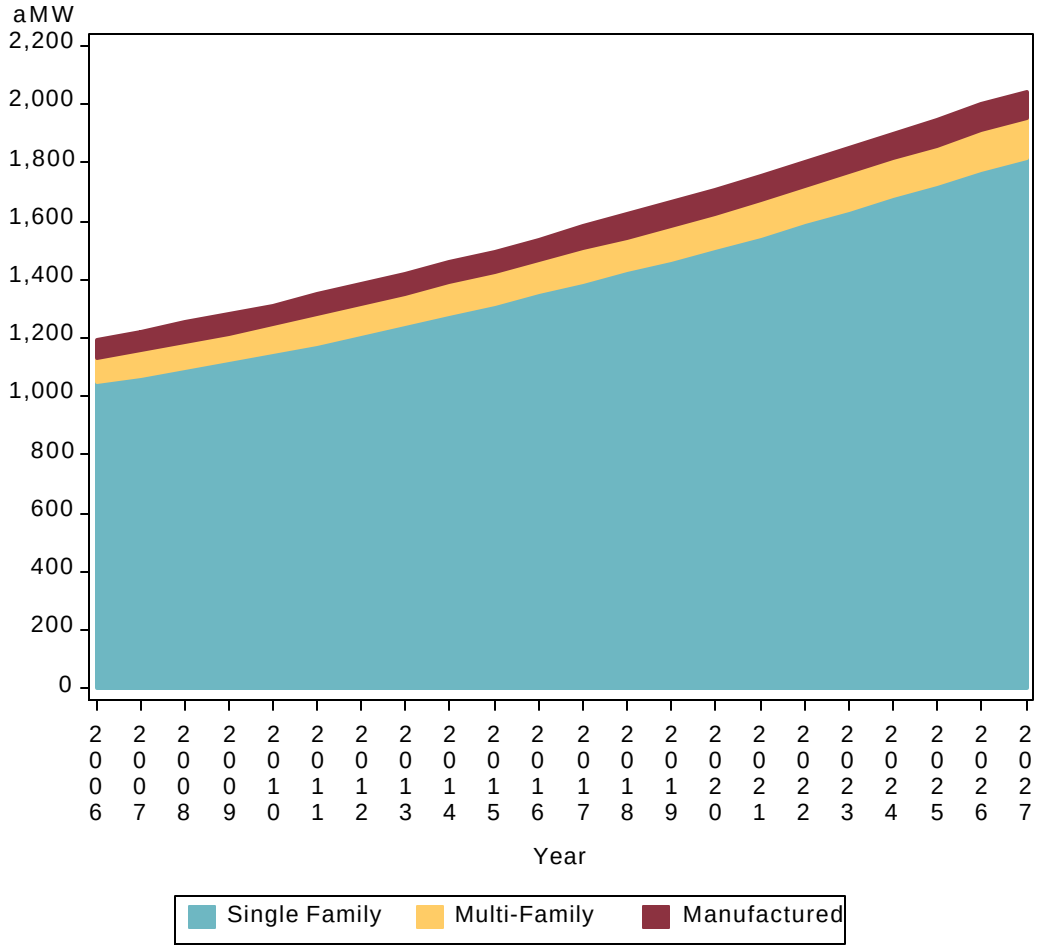


Figure C.2. Baseline Residential Forecast 2006 - 2027, Pacific Power

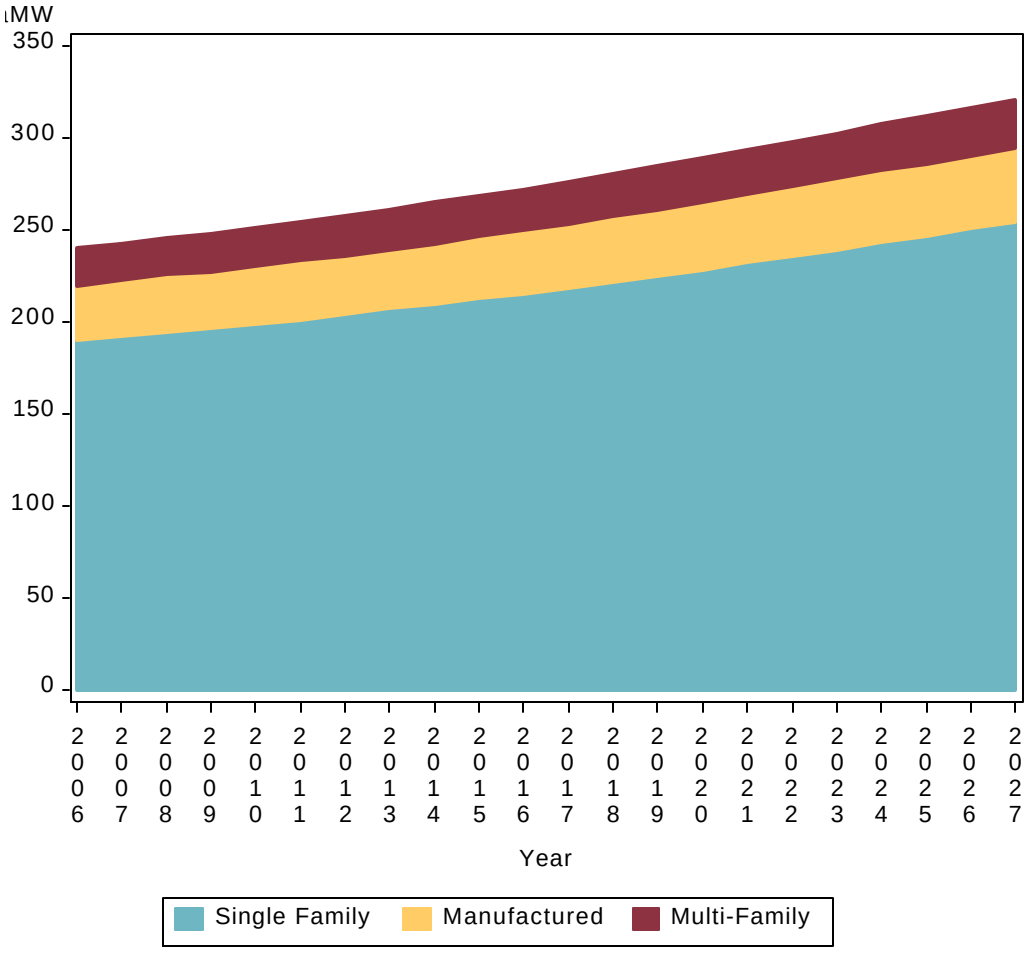


Figure C.3. Baseline Residential Forecast 2006 - 2027, Rocky Mountain Power

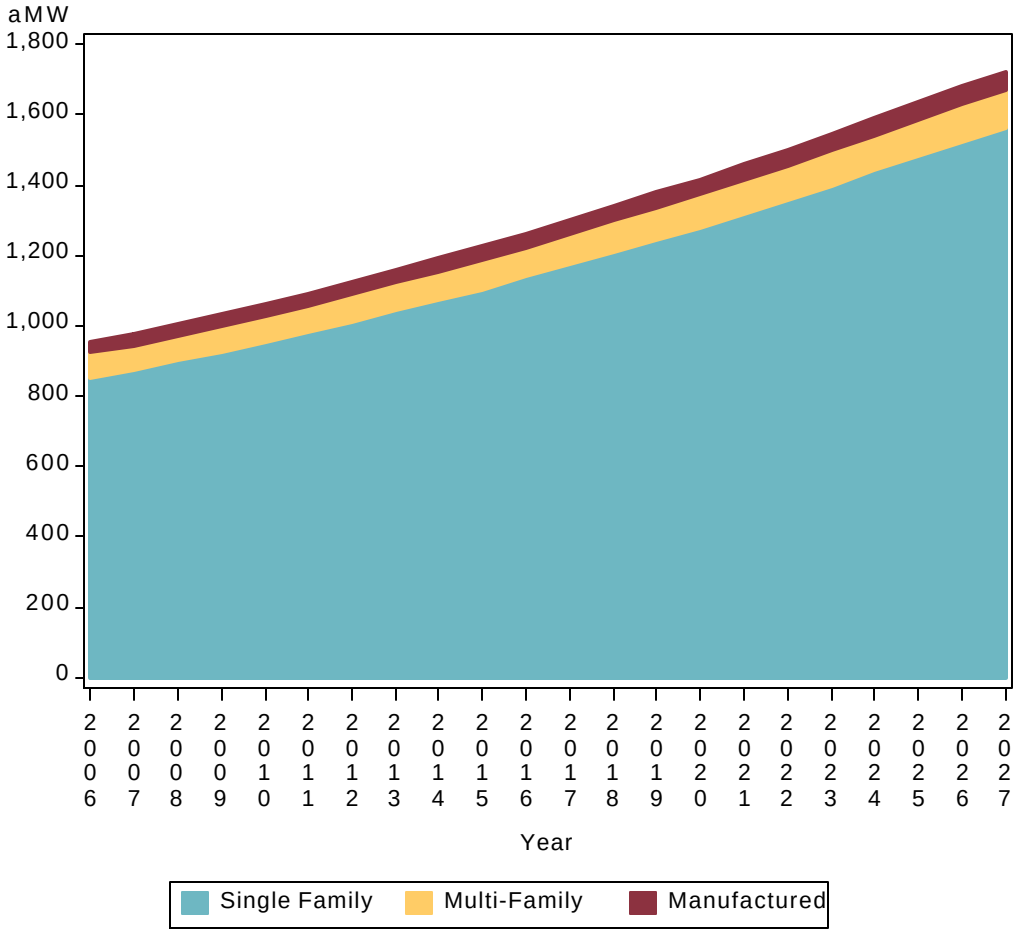


Figure C.4. Baseline Commercial Forecast 2006 – 2027, Overall

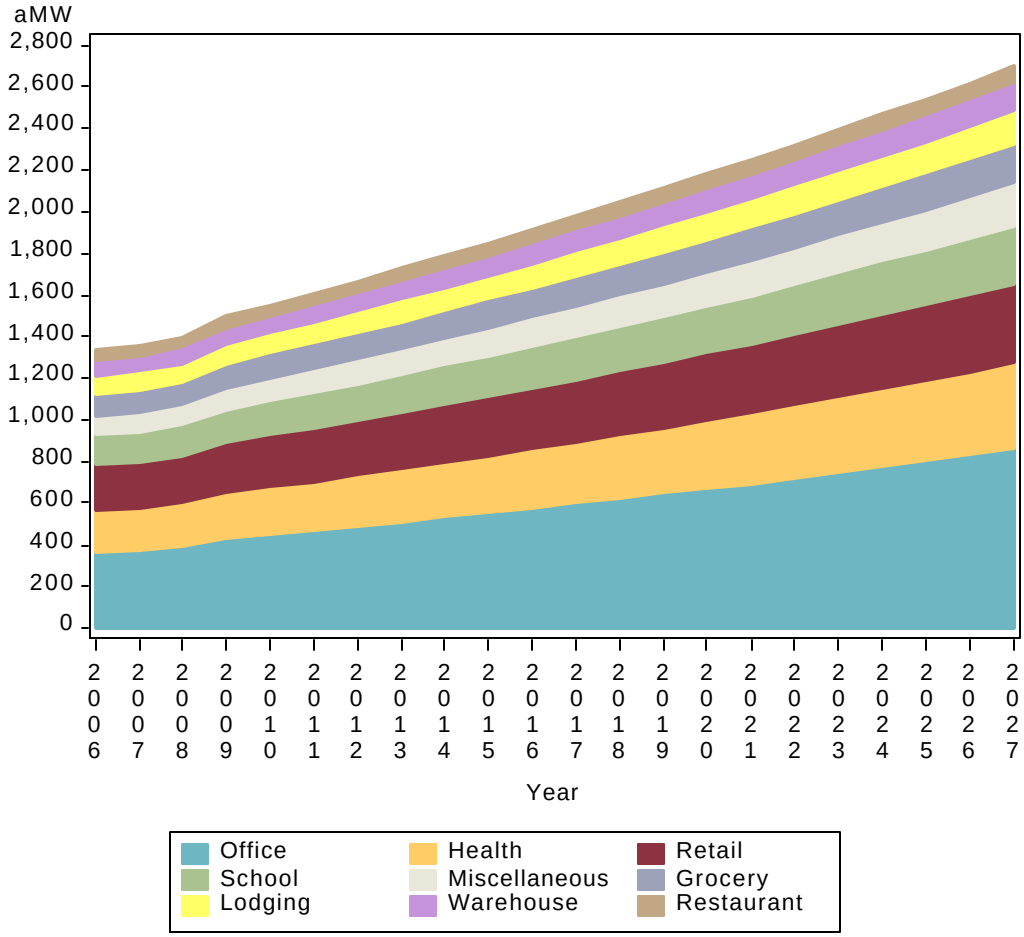


Figure C.5. Baseline Commercial Forecast 2006 - 2027, Pacific Power

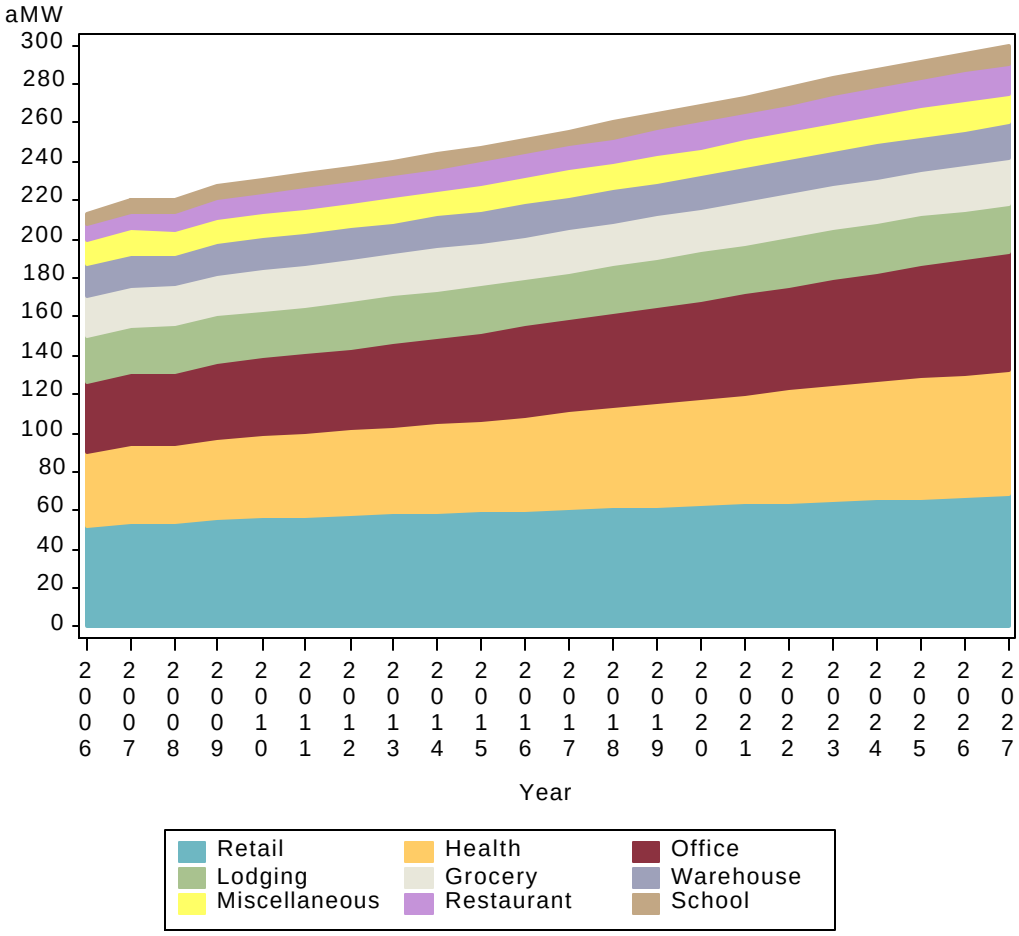


Figure C.6. Baseline Commercial Forecast 2006 - 2027, Rocky Mountain Power

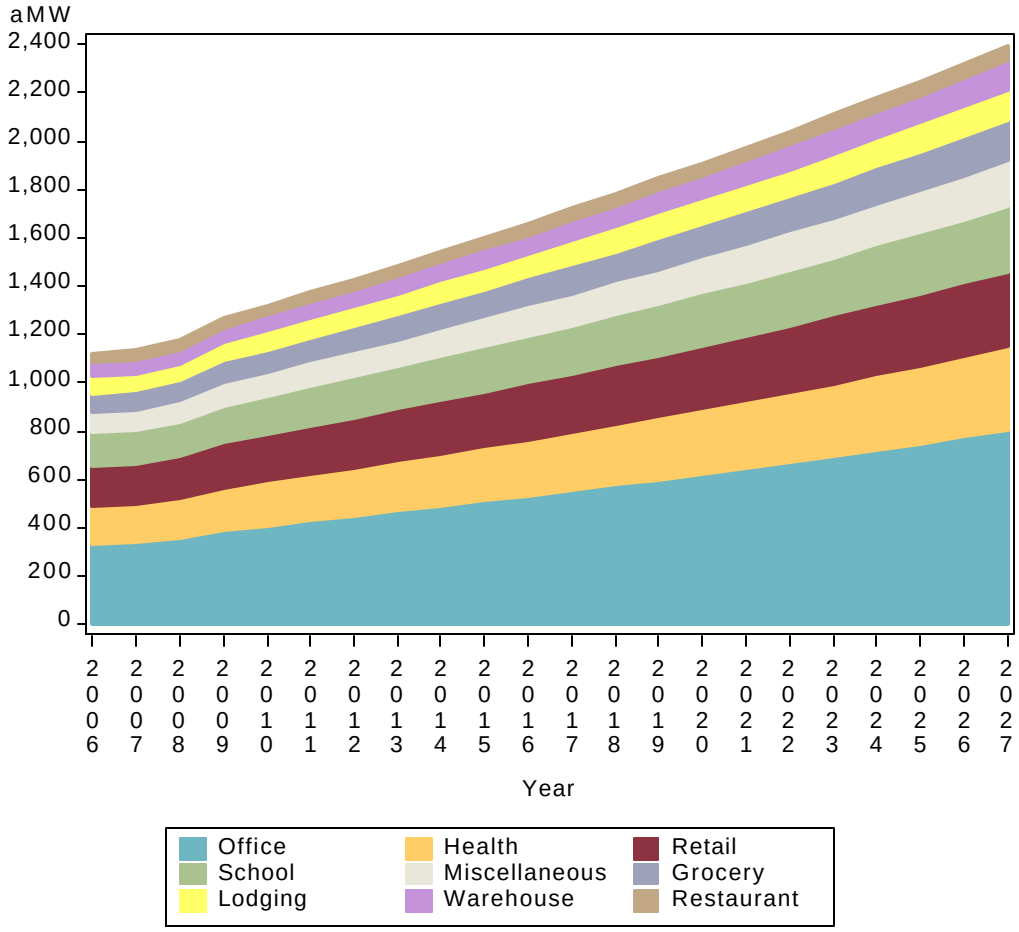


Figure C.7. Baseline Industrial Forecast 2006 - 2027, Overall

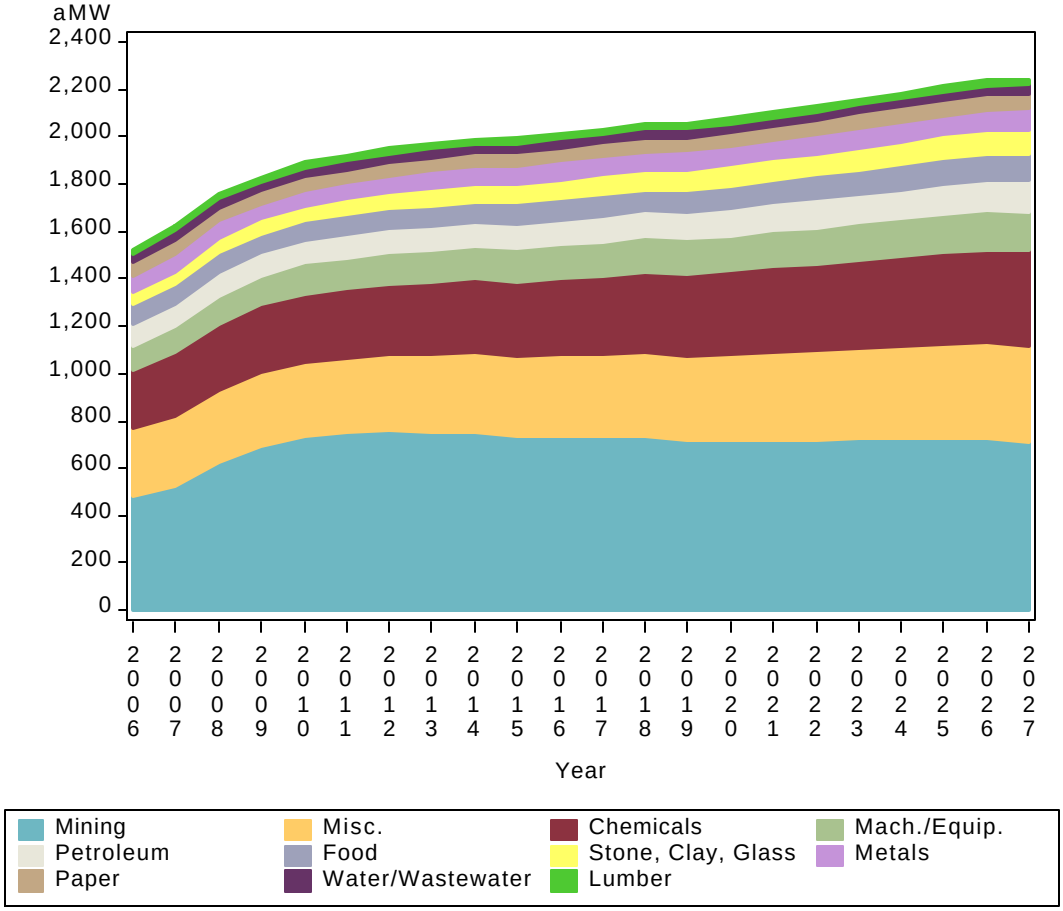


Figure C.8. Baseline Industrial Forecast 2006 - 2027, Pacific Power

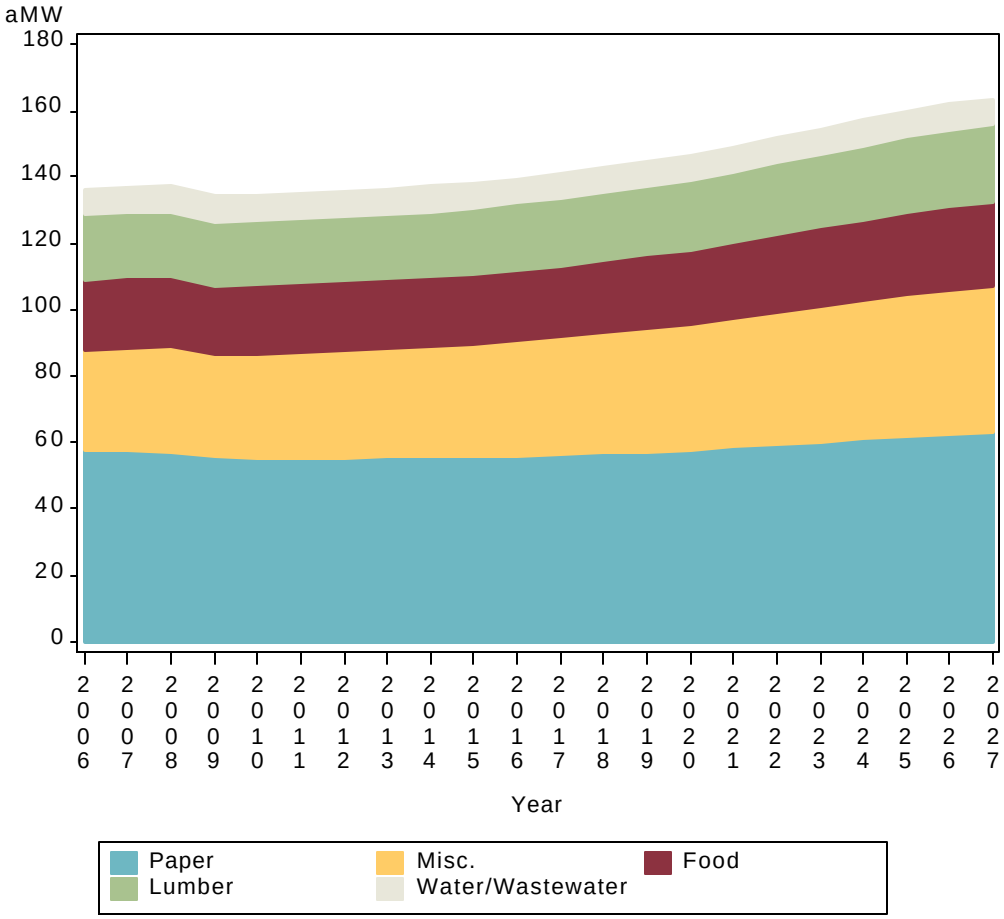


Figure C.9. Baseline Industrial Forecast 2006 - 2027, Rocky Mountain Power

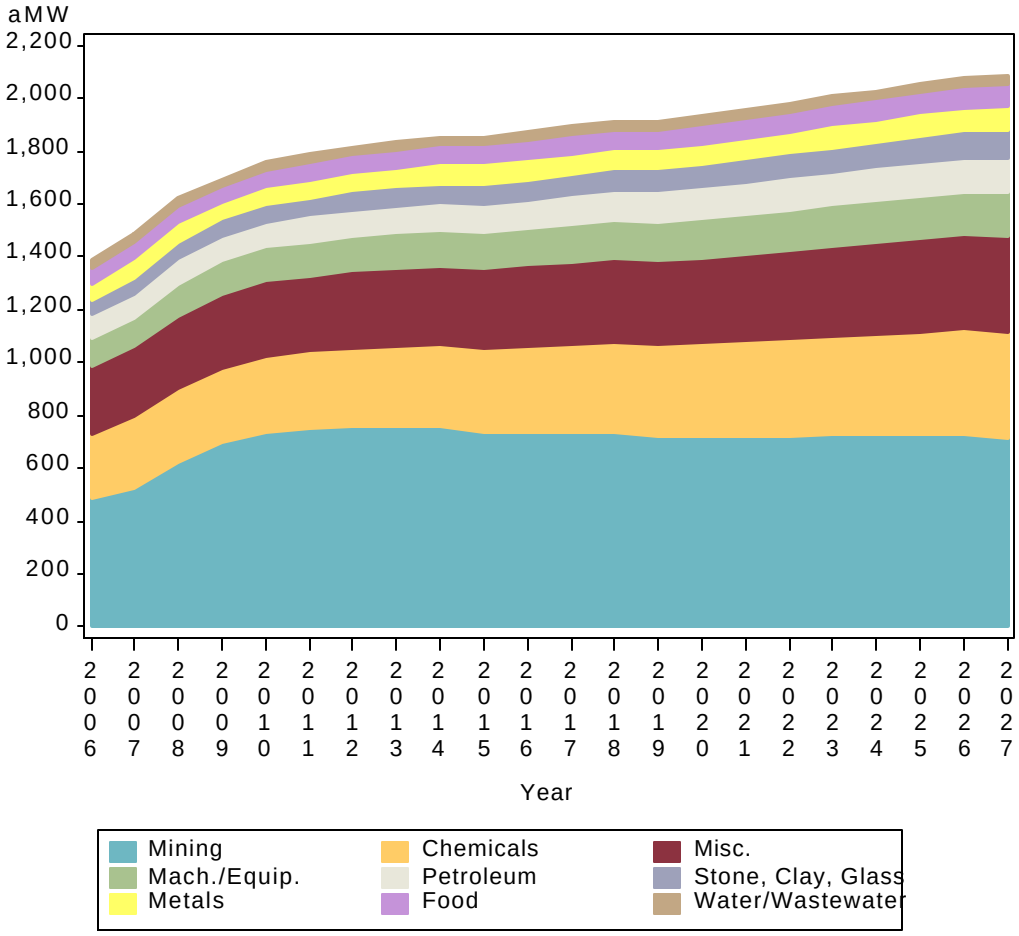


Figure C.10. Baseline Irrigation Forecast 2006 - 2027, Overall

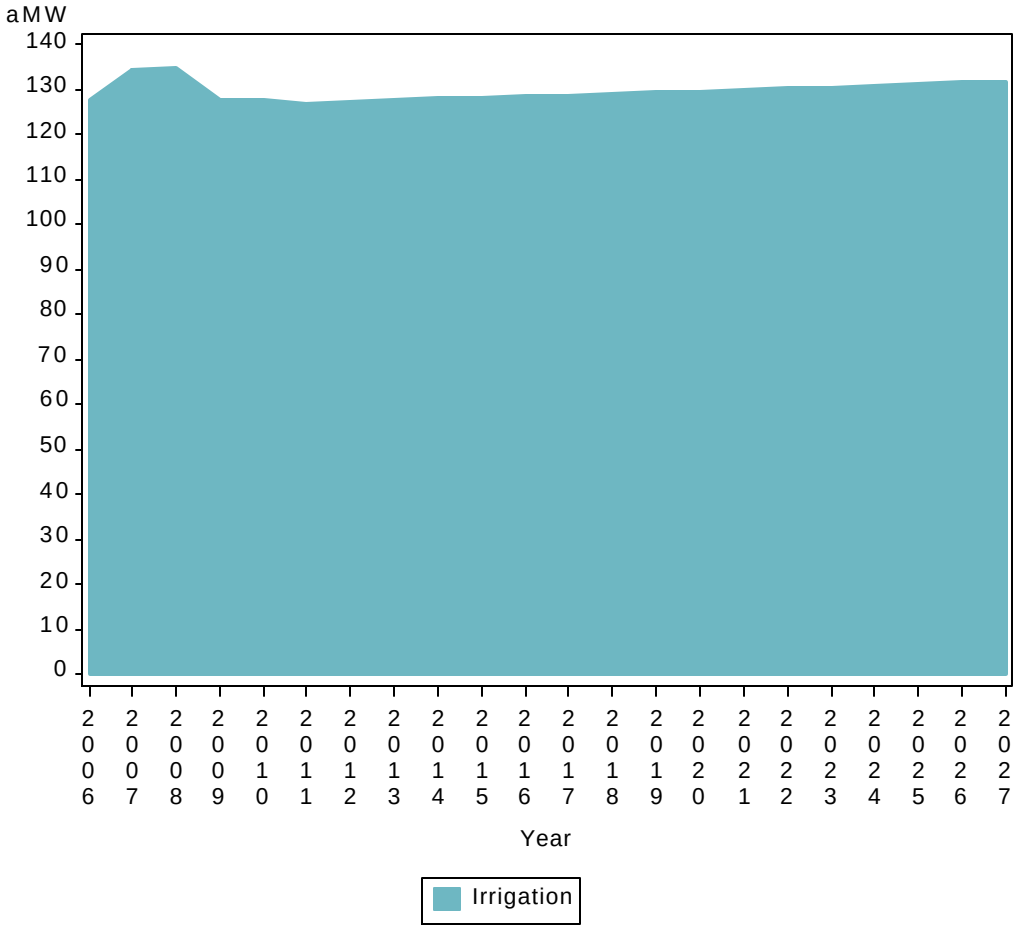


Figure C.11. Baseline Irrigation Forecast 2006 - 2027, Pacific Power

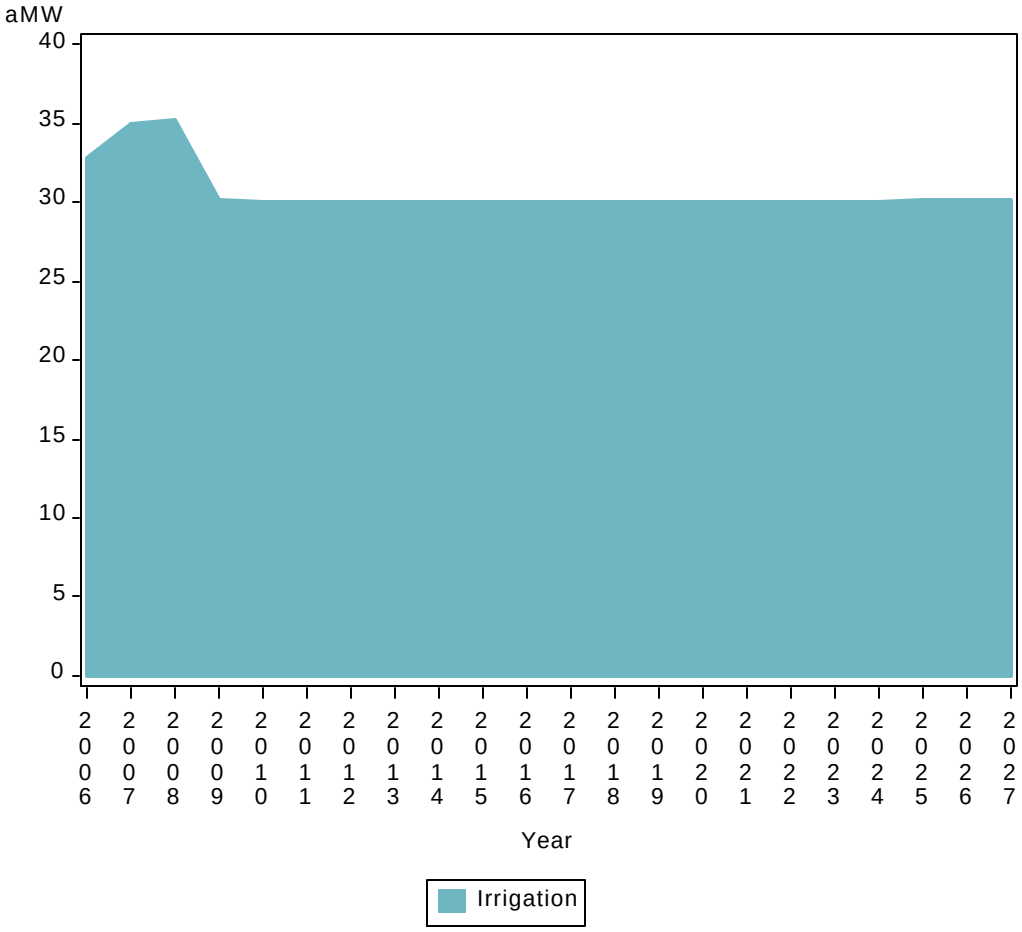
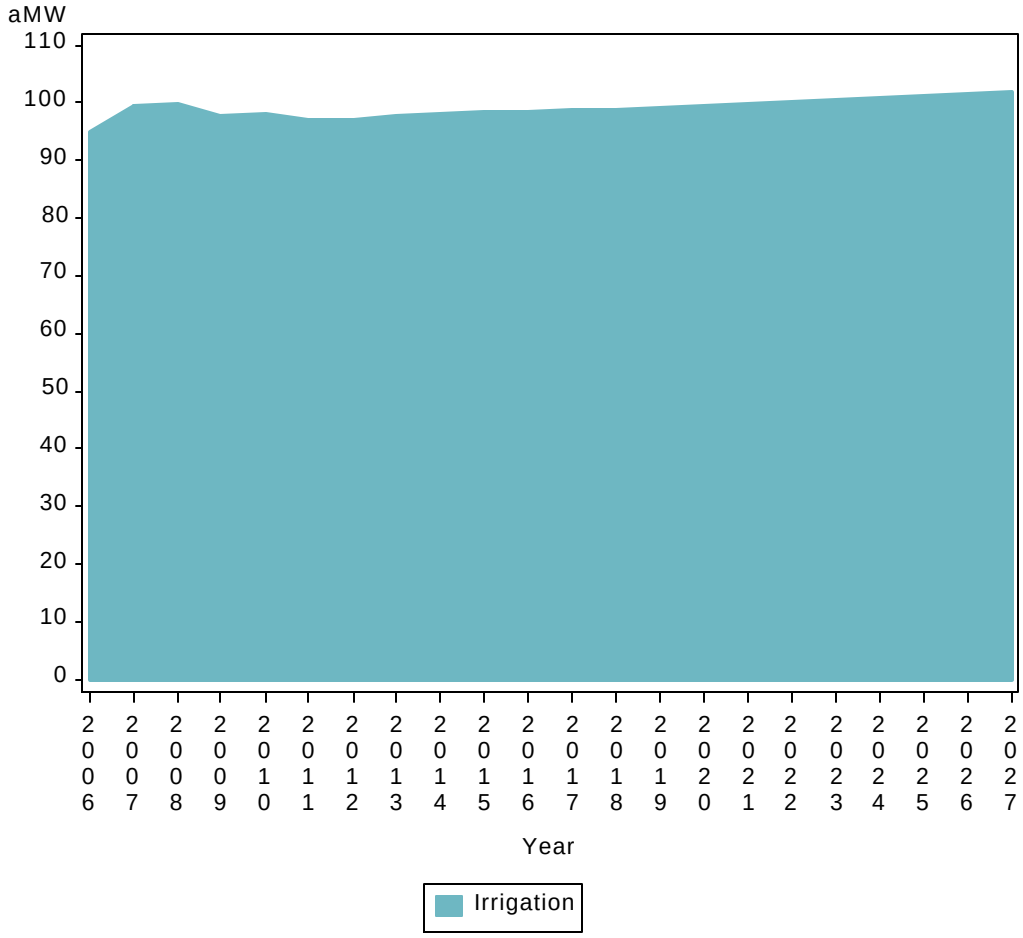


Figure C.12. Baseline Irrigation Forecast 2006 - 2027, Rocky Mountain Power



End Use Saturations and Electric Shares

The saturation of end uses – defined as the percentage of buildings or homes that have the end use, irrespective of fuel – and then that associated share for electricity are key inputs into the development of the baseline forecasts. Table C.32 through Table C.35 present these data inputs by state, building type, and end use.

Table C.32. Residential End Use Saturations

State/Home Type	Enduse	Percent of Sites with End Use
California		
Manufactured	Central AC	9.9%
Manufactured	Central Heat	51.3%
Manufactured	Dryer	55.5%
Manufactured	Evaporative AC	19.8%
Manufactured	Freezer	46.5%
Manufactured	Heat Pump	3.4%
Manufactured	Room AC	4.9%
Manufactured	Room Heat	10.9%
Multi Family	Central AC	7.4%
Multi Family	Central Heat	20.0%
Multi Family	Dryer	36.0%
Multi Family	Evaporative AC	0.0%
Multi Family	Freezer	8.2%
Multi Family	Heat Pump	4.0%
Multi Family	Room AC	18.5%
Multi Family	Room Heat	54.0%
Single Family	Central AC	4.1%
Single Family	Central Heat	36.3%
Single Family	Dryer	64.9%
Single Family	Evaporative AC	8.3%
Single Family	Freezer	56.8%
Single Family	Heat Pump	8.8%
Single Family	Room AC	10.0%
Single Family	Room Heat	8.6%
Idaho		
Manufactured	Central AC	0.0%
Manufactured	Central Heat	66.3%
Manufactured	Dryer	65.3%
Manufactured	Evaporative AC	29.3%
Manufactured	Freezer	54.1%
Manufactured	Heat Pump	0.0%
Manufactured	Room AC	10.3%
Manufactured	Room Heat	40.0%
Multi Family	Central AC	0.0%
Multi Family	Central Heat	40.6%
Multi Family	Dryer	43.8%
Multi Family	Evaporative AC	0.0%
Multi Family	Freezer	10.3%
Multi Family	Heat Pump	0.0%
Multi Family	Room AC	20.0%
Multi Family	Room Heat	40.0%
Single Family	Central AC	5.8%
Single Family	Central Heat	52.8%
Single Family	Dryer	72.3%
Single Family	Evaporative AC	3.9%

State/Home Type	Enduse	Percent of Sites with End Use
Single Family	Freezer	95.1%
Single Family	Heat Pump	1.5%
Single Family	Room AC	10.6%
Single Family	Room Heat	40.0%
Utah		
Manufactured	Central AC	45.4%
Manufactured	Central Heat	87.6%
Manufactured	Dryer	73.2%
Manufactured	Evaporative AC	25.0%
Manufactured	Freezer	56.3%
Manufactured	Heat Pump	0.5%
Manufactured	Room AC	2.6%
Manufactured	Room Heat	3.5%
Multi Family	Central AC	54.1%
Multi Family	Central Heat	72.1%
Multi Family	Dryer	50.8%
Multi Family	Evaporative AC	21.6%
Multi Family	Freezer	10.7%
Multi Family	Heat Pump	0.0%
Multi Family	Room AC	5.4%
Multi Family	Room Heat	11.5%
Single Family	Central AC	45.4%
Single Family	Central Heat	87.6%
Single Family	Dryer	73.2%
Single Family	Evaporative AC	25.0%
Single Family	Freezer	56.3%
Single Family	Heat Pump	0.5%
Single Family	Room AC	2.6%
Single Family	Room Heat	3.5%
Washington		
Manufactured	Central AC	42.9%
Manufactured	Central Heat	68.1%
Manufactured	Dryer	56.0%
Manufactured	Evaporative AC	7.1%
Manufactured	Freezer	57.4%
Manufactured	Heat Pump	12.1%
Manufactured	Room AC	16.1%
Manufactured	Room Heat	5.5%
Multi Family	Central AC	26.9%
Multi Family	Central Heat	48.1%
Multi Family	Dryer	55.6%
Multi Family	Evaporative AC	0.0%
Multi Family	Freezer	32.0%
Multi Family	Heat Pump	3.7%
Multi Family	Room AC	38.5%
Multi Family	Room Heat	40.7%

State/Home Type	Enduse	Percent of Sites with End Use
Single Family	Central AC	37.3%
Single Family	Central Heat	55.8%
Single Family	Dryer	65.6%
Single Family	Evaporative AC	2.8%
Single Family	Freezer	64.6%
Single Family	Heat Pump	10.6%
Single Family	Room AC	25.4%
Single Family	Room Heat	16.4%
Wyoming		
Manufactured	Central AC	12.0%
Manufactured	Central Heat	82.6%
Manufactured	Dryer	66.3%
Manufactured	Evaporative AC	42.0%
Manufactured	Freezer	52.1%
Manufactured	Heat Pump	0.0%
Manufactured	Room AC	4.0%
Manufactured	Room Heat	7.0%
Multi Family	Central AC	14.8%
Multi Family	Central Heat	46.7%
Multi Family	Dryer	51.1%
Multi Family	Evaporative AC	3.7%
Multi Family	Freezer	26.2%
Multi Family	Heat Pump	2.2%
Multi Family	Room AC	14.8%
Multi Family	Room Heat	40.0%
Single Family	Central AC	15.1%
Single Family	Central Heat	66.0%
Single Family	Dryer	67.6%
Single Family	Evaporative AC	21.9%
Single Family	Freezer	69.8%
Single Family	Heat Pump	0.9%
Single Family	Room AC	9.0%
Single Family	Room Heat	12.4%

Table C.33 Commercial End Use Saturations

State/Building Type	Enduse	Percent of Sites with End Use
California		
Small Office	Space Heat	78.1%
Small Office	Cooling DX	15.6%
Small Office	Heat Pump	21.9%
Small Office	Water Heat	87.5%
Restaurant	Space Heat	86.7%
Restaurant	Cooling DX	20.0%
Restaurant	Heat Pump	13.3%
Restaurant	Water Heat	73.3%
Restaurant	Refrigeration	40.0%
Restaurant	Cooking	86.7%
Small Retail	Space Heat	93.8%
Small Retail	Cooling DX	22.9%
Small Retail	Heat Pump	6.3%
Small Retail	Water Heat	64.6%
Grocery	Cooling Chillers	10.0%
Grocery	Cooling DX	10.0%
Grocery	Heat Pump	0.0%
Grocery	Water Heat	80.0%
Grocery	Refrigeration	60.0%
Grocery	Cooking	50.0%
Warehouse	Space Heat	66.7%
Warehouse	Cooling Chillers	0.0%
Warehouse	Cooling DX	16.7%
Warehouse	Heat Pump	33.3%
Warehouse	Refrigeration	0.0%
School	Space Heat	60.0%
School	Cooling Chillers	0.0%
School	Cooling DX	10.0%
School	Heat Pump	40.0%
School	Refrigeration	40.0%
School	Cooking	60.0%
Health	Space Heat	66.7%
Health	Cooling Chillers	0.0%
Health	Cooling DX	50.0%
Health	Heat Pump	33.3%
Health	Water Heat	83.3%
Health	Refrigeration	0.0%
Health	Cooking	16.7%
Lodging	Space Heat	83.3%
Lodging	Cooling DX	0.0%
Lodging	Heat Pump	16.7%
Lodging	Water Heat	91.7%
Lodging	Cooking	75.0%

State/Building Type	Enduse	Percent of Sites with End Use
Miscellaneous	Space Heat	92.3%
Miscellaneous	Cooling Chillers	1.5%
Miscellaneous	Cooling DX	7.7%
Miscellaneous	Heat Pump	7.7%
Miscellaneous	Water Heat	49.2%
Idaho		
Small Office	Space Heat	96.7%
Small Office	Cooling DX	56.7%
Small Office	Heat Pump	3.3%
Small Office	Water Heat	86.7%
Large Office	Cooling Chillers	0.0%
Large Office	Heat Pump	0.0%
Restaurant	Cooling DX	55.0%
Restaurant	Heat Pump	0.0%
Restaurant	Water Heat	85.0%
Restaurant	Refrigeration	50.0%
Restaurant	Cooking	80.0%
Small Retail	Cooling DX	21.1%
Small Retail	Heat Pump	0.0%
Small Retail	Water Heat	57.9%
Large Retail	Heat Pump	0.0%
Grocery	Space Heat	90.0%
Grocery	Cooling Chillers	0.0%
Grocery	Cooling DX	30.0%
Grocery	Heat Pump	10.0%
Grocery	Refrigeration	40.0%
Grocery	Cooking	70.0%
Warehouse	Cooling Chillers	0.0%
Warehouse	Cooling DX	66.7%
Warehouse	Heat Pump	0.0%
Warehouse	Water Heat	33.3%
Warehouse	Refrigeration	33.3%
School	Cooling Chillers	0.0%
School	Cooling DX	45.5%
School	Heat Pump	0.0%
School	Refrigeration	45.5%
School	Cooking	45.5%
Health	Space Heat	81.8%
Health	Cooling Chillers	0.0%
Health	Cooling DX	54.5%
Health	Heat Pump	18.2%
Health	Refrigeration	27.3%
Health	Cooking	27.3%

State/Building Type	Enduse	Percent of Sites with End Use
Lodging	Cooling DX	20.0%
Lodging	Heat Pump	0.0%
Lodging	Water Heat	80.0%
Lodging	Cooking	20.0%
Miscellaneous	Space Heat	98.9%
Miscellaneous	Cooling Chillers	0.0%
Miscellaneous	Cooling DX	19.1%
Miscellaneous	Heat Pump	1.1%
Miscellaneous	Water Heat	49.4%
Utah		
Small Office	Cooling DX	73.3%
Small Office	Heat Pump	0.0%
Small Office	Water Heat	86.7%
Large Office	Cooling Chillers	50.0%
Large Office	Heat Pump	0.0%
Restaurant	Cooling DX	65.4%
Restaurant	Heat Pump	0.0%
Restaurant	Water Heat	88.5%
Restaurant	Refrigeration	61.5%
Restaurant	Cooking	80.8%
Small Retail	Cooling DX	27.6%
Small Retail	Heat Pump	0.0%
Small Retail	Water Heat	58.6%
Large Retail	Heat Pump	0.0%
Grocery	Space Heat	94.4%
Grocery	Cooling Chillers	0.0%
Grocery	Cooling DX	61.1%
Grocery	Heat Pump	5.6%
Grocery	Water Heat	88.9%
Grocery	Refrigeration	66.7%
Grocery	Cooking	55.6%
Warehouse	Cooling Chillers	8.3%
Warehouse	Cooling DX	66.7%
Warehouse	Heat Pump	0.0%
Warehouse	Refrigeration	33.3%
School	Cooling Chillers	25.0%
School	Cooling DX	40.0%
School	Heat Pump	0.0%
School	Water Heat	90.0%
School	Refrigeration	20.0%
School	Cooking	60.0%

State/Building Type	Enduse	Percent of Sites with End Use
Health	Space Heat	95.7%
Health	Cooling Chillers	13.0%
Health	Cooling DX	78.3%
Health	Heat Pump	4.3%
Health	Water Heat	82.6%
Health	Refrigeration	30.4%
Health	Cooking	26.1%
Lodging	Space Heat	85.0%
Lodging	Cooling DX	15.0%
Lodging	Heat Pump	15.0%
Lodging	Water Heat	90.0%
Lodging	Cooking	60.0%
Miscellaneous	Space Heat	97.0%
Miscellaneous	Cooling Chillers	1.0%
Miscellaneous	Cooling DX	36.0%
Miscellaneous	Heat Pump	3.0%
Miscellaneous	Water Heat	58.0%
Washington		
Small Office	Space Heat	87.5%
Small Office	Cooling DX	65.0%
Small Office	Heat Pump	12.5%
Small Office	Water Heat	90.0%
Large Office	Cooling Chillers	50.0%
Large Office	Heat Pump	0.0%
Restaurant	Space Heat	96.6%
Restaurant	Cooling DX	72.4%
Restaurant	Heat Pump	3.4%
Restaurant	Water Heat	86.2%
Restaurant	Refrigeration	62.1%
Restaurant	Cooking	72.4%
Small Retail	Space Heat	98.1%
Small Retail	Cooling DX	33.3%
Small Retail	Heat Pump	1.9%
Small Retail	Water Heat	72.2%
Large Retail	Cooling DX	0.0%
Large Retail	Heat Pump	0.0%
Grocery	Cooling Chillers	0.0%
Grocery	Cooling DX	63.6%
Grocery	Heat Pump	0.0%
Grocery	Water Heat	63.6%
Grocery	Refrigeration	45.5%
Grocery	Cooking	54.5%

State/Building Type	Enduse	Percent of Sites with End Use
Warehouse	Cooling Chillers	0.0%
Warehouse	Cooling DX	33.3%
Warehouse	Heat Pump	0.0%
Warehouse	Water Heat	33.3%
Warehouse	Refrigeration	0.0%
Warehouse CA	Cooling Chillers	0.0%
Warehouse CA	Cooling DX	33.3%
Warehouse CA	Heat Pump	0.0%
Warehouse CA	Water Heat	33.3%
Warehouse CA	Refrigeration	0.0%
School	Space Heat	92.3%
School	Cooling Chillers	7.7%
School	Cooling DX	46.2%
School	Heat Pump	7.7%
School	Water Heat	92.3%
School	Refrigeration	53.8%
School	Cooking	69.2%
Health	Space Heat	94.1%
Health	Cooling Chillers	5.9%
Health	Cooling DX	76.5%
Health	Heat Pump	5.9%
Health	Water Heat	82.4%
Health	Refrigeration	29.4%
Health	Cooking	29.4%
Lodging	Space Heat	69.2%
Lodging	Cooling DX	38.5%
Lodging	Heat Pump	30.8%
Lodging	Cooking	38.5%
Miscellaneous	Space Heat	95.5%
Miscellaneous	Cooling Chillers	1.8%
Miscellaneous	Cooling DX	27.0%
Miscellaneous	Heat Pump	4.5%
Miscellaneous	Water Heat	49.5%
Wyoming		
Small Office	Space Heat	98.1%
Small Office	Cooling DX	61.5%
Small Office	Heat Pump	1.9%
Small Office	Water Heat	76.9%
Large Office	Cooling Chillers	0.0%
Large Office	Heat Pump	0.0%
Restaurant	Cooling DX	76.0%
Restaurant	Heat Pump	0.0%
Restaurant	Water Heat	92.0%
Restaurant	Refrigeration	56.0%
Restaurant	Cooking	88.0%

State/Building Type	Enduse	Percent of Sites with End Use
Small Retail	Cooling DX	31.8%
Small Retail	Heat Pump	0.0%
Small Retail	Water Heat	72.7%
Large Retail	Space Heat	80.0%
Large Retail	Cooling DX	60.0%
Large Retail	Heat Pump	20.0%
Large Retail	Water Heat	80.0%
Grocery	Space Heat	83.3%
Grocery	Cooling Chillers	0.0%
Grocery	Cooling DX	50.0%
Grocery	Heat Pump	16.7%
Grocery	Refrigeration	83.3%
Grocery	Cooking	66.7%
Warehouse	Cooling Chillers	33.3%
Warehouse	Cooling DX	0.0%
Warehouse	Heat Pump	0.0%
Warehouse	Refrigeration	33.3%
School	Cooling Chillers	0.0%
School	Cooling DX	22.2%
School	Heat Pump	0.0%
School	Water Heat	66.7%
School	Refrigeration	33.3%
School	Cooking	44.4%
Health	Space Heat	90.0%
Health	Cooling Chillers	6.7%
Health	Cooling DX	56.7%
Health	Heat Pump	10.0%
Health	Water Heat	93.3%
Health	Refrigeration	30.0%
Health	Cooking	10.0%
Lodging	Space Heat	97.1%
Lodging	Cooling DX	17.1%
Lodging	Heat Pump	2.9%
Lodging	Water Heat	88.6%
Lodging	Cooking	74.3%
Miscellaneous	Cooling Chillers	1.4%
Miscellaneous	Cooling DX	24.3%
Miscellaneous	Heat Pump	0.0%
Miscellaneous	Water Heat	50.0%

Table C.34. Residential Electric Shares

State/Home Type	Enduse	Percent of Sites Using Electricity for End Use
California		
Single Family	Central Heat	17.2%
Single Family	Room Heat	90.0%
Single Family	Water Heat	77.8%
Single Family	Cooking Oven	71.6%
Single Family	Cooking Range	56.8%
Single Family	Dryer	62.2%
Multi Family	Central Heat	50.0%
Multi Family	Room Heat	92.6%
Multi Family	Water Heat	84.0%
Multi Family	Cooking Oven	64.0%
Multi Family	Cooking Range	44.0%
Multi Family	Dryer	32.0%
Manufactured	Central Heat	67.2%
Manufactured	Water Heat	89.1%
Manufactured	Cooking Oven	65.5%
Manufactured	Cooking Range	48.7%
Manufactured	Dryer	55.5%
Idaho		
Single Family	Central Heat	14.1%
Single Family	Room Heat	76.7%
Single Family	Water Heat	54.3%
Single Family	Cooking Oven	70.3%
Single Family	Cooking Range	57.2%
Single Family	Dryer	61.9%
Multi Family	Central Heat	25.0%
Multi Family	Room Heat	93.8%
Multi Family	Water Heat	56.3%
Multi Family	Cooking Oven	65.6%
Multi Family	Cooking Range	43.8%
Multi Family	Dryer	28.1%
Manufactured	Central Heat	53.8%
Manufactured	Room Heat	61.5%
Manufactured	Water Heat	57.1%
Manufactured	Cooking Oven	50.0%
Manufactured	Cooking Range	45.9%
Manufactured	Dryer	59.2%
Utah		
Single Family	Central Heat	6.1%
Single Family	Room Heat	50.0%
Single Family	Water Heat	12.1%
Single Family	Cooking Oven	62.9%
Single Family	Cooking Range	52.8%
Single Family	Dryer	51.3%
Multi Family	Central Heat	9.1%
Multi Family	Room Heat	85.7%
Multi Family	Water Heat	32.8%

State/Home Type	Enduse	Percent of Sites Using Electricity for End Use
Multi Family	Cooking Oven	65.6%
Multi Family	Cooking Range	52.5%
Multi Family	Dryer	42.6%
Manufactured	Central Heat	6.1%
Manufactured	Room Heat	50.0%
Manufactured	Water Heat	12.1%
Manufactured	Cooking Oven	62.9%
Manufactured	Cooking Range	52.8%
Manufactured	Dryer	51.3%
Washington		
Single Family	Central Heat	25.4%
Single Family	Room Heat	81.4%
Single Family	Water Heat	70.6%
Single Family	Cooking Oven	68.1%
Single Family	Cooking Range	50.8%
Single Family	Dryer	61.7%
Multi Family	Central Heat	46.2%
Multi Family	Room Heat	95.5%
Multi Family	Water Heat	70.4%
Multi Family	Cooking Oven	66.7%
Multi Family	Cooking Range	53.7%
Multi Family	Dryer	51.9%
Manufactured	Central Heat	90.3%
Manufactured	Room Heat	80.0%
Manufactured	Water Heat	87.9%
Manufactured	Cooking Oven	65.9%
Manufactured	Cooking Range	51.6%
Manufactured	Dryer	53.8%
Wyoming		
Single Family	Central Heat	6.0%
Single Family	Room Heat	79.2%
Single Family	Water Heat	28.2%
Single Family	Cooking Oven	66.0%
Single Family	Cooking Range	50.0%
Single Family	Dryer	62.0%
Multi Family	Central Heat	4.8%
Multi Family	Water Heat	55.6%
Multi Family	Cooking Oven	66.7%
Multi Family	Cooking Range	55.6%
Multi Family	Dryer	44.4%
Manufactured	Central Heat	9.9%
Manufactured	Water Heat	38.4%
Manufactured	Cooking Oven	37.2%
Manufactured	Cooking Range	26.7%
Manufactured	Dryer	61.6%

Table C.35. Commercial Electric Shares

State/Building Type	Enduse	Percent of Sites Using Electricity for End Use
California		
Small Office	Space Heat	30.8%
Small Office	Water Heat	45.8%
Restaurant	Space Heat	29.9%
Restaurant	Water Heat	26.6%
Restaurant	Cooking	18.6%
Small Retail	Space Heat	22.0%
Small Retail	Water Heat	45.6%
Grocery	Space Heat	26.0%
Grocery	Heat Pump	100.0%
Grocery	Water Heat	51.8%
Grocery	Cooking	22.1%
Warehouse	Space Heat	12.9%
Warehouse	Water Heat	44.1%
School	Space Heat	17.4%
School	Water Heat	34.1%
School	Cooking	27.7%
Health	Space Heat	27.7%
Health	Water Heat	30.7%
Health	Cooking	4.5%
Lodging	Space Heat	46.1%
Lodging	Water Heat	30.8%
Lodging	Cooking	1.4%
Miscellaneous	Space Heat	18.3%
Miscellaneous	Water Heat	26.3%
Idaho		
Small Office	Space Heat	30.8%
Small Office	Water Heat	45.8%
Large Office	Space Heat	18.2%
Large Office	Heat Pump	100.0%
Large Office	Water Heat	25.0%
Restaurant	Space Heat	29.9%
Restaurant	Heat Pump	100.0%
Restaurant	Water Heat	26.6%
Restaurant	Cooking	18.6%
Small Retail	Space Heat	22.0%
Small Retail	Heat Pump	100.0%
Small Retail	Water Heat	45.6%
Large Retail	Space Heat	14.3%
Large Retail	Heat Pump	100.0%
Large Retail	Water Heat	33.3%

State/Building Type	Enduse	Percent of Sites Using Electricity for End Use
Grocery	Space Heat	26.0%
Grocery	Water Heat	51.8%
Grocery	Cooking	22.1%
Warehouse	Space Heat	12.9%
Warehouse	Heat Pump	100.0%
Warehouse	Water Heat	44.1%
School	Space Heat	17.4%
School	Heat Pump	100.0%
School	Water Heat	34.1%
School	Cooking	27.7%
Health	Space Heat	27.7%
Health	Water Heat	30.7%
Health	Cooking	4.5%
Lodging	Space Heat	46.1%
Lodging	Heat Pump	100.0%
Lodging	Water Heat	30.8%
Lodging	Cooking	1.4%
Miscellaneous	Space Heat	18.3%
Miscellaneous	Water Heat	26.3%
Utah		
Small Office	Space Heat	30.8%
Small Office	Heat Pump	100.0%
Small Office	Water Heat	45.8%
Large Office	Space Heat	18.2%
Large Office	Heat Pump	100.0%
Large Office	Water Heat	25.0%
Restaurant	Space Heat	29.9%
Restaurant	Heat Pump	100.0%
Restaurant	Water Heat	26.6%
Restaurant	Cooking	18.6%
Small Retail	Space Heat	22.0%
Small Retail	Heat Pump	100.0%
Small Retail	Water Heat	45.6%
Large Retail	Space Heat	14.3%
Large Retail	Heat Pump	100.0%
Large Retail	Water Heat	33.3%
Grocery	Space Heat	26.0%
Grocery	Water Heat	51.8%
Grocery	Cooking	22.1%
Warehouse	Space Heat	12.9%
Warehouse	Heat Pump	100.0%
Warehouse	Water Heat	44.1%

State/Building Type	Enduse	Percent of Sites Using Electricity for End Use
School	Space Heat	17.4%
School	Heat Pump	100.0%
School	Water Heat	34.1%
School	Cooking	27.7%
Health	Space Heat	27.7%
Health	Water Heat	30.7%
Health	Cooking	4.5%
Lodging	Space Heat	46.1%
Lodging	Water Heat	30.8%
Lodging	Cooking	1.4%
Miscellaneous	Space Heat	18.3%
Miscellaneous	Water Heat	26.3%
Washington		
Small Office	Space Heat	30.8%
Small Office	Water Heat	45.8%
Large Office	Heat Pump	100.0%
Restaurant	Space Heat	29.9%
Restaurant	Water Heat	26.6%
Restaurant	Cooking	18.6%
Small Retail	Space Heat	22.0%
Small Retail	Water Heat	45.6%
Large Retail	Space Heat	14.3%
Large Retail	Heat Pump	100.0%
Grocery	Space Heat	26.0%
Grocery	Heat Pump	100.0%
Grocery	Water Heat	51.8%
Grocery	Cooking	22.1%
Warehouse	Space Heat	12.9%
Warehouse	Heat Pump	100.0%
Warehouse	Water Heat	44.1%
Warehouse CA	Space Heat	12.9%
Warehouse CA	Heat Pump	100.0%
Warehouse CA	Water Heat	44.1%
School	Space Heat	17.4%
School	Water Heat	34.1%
School	Cooking	27.7%
Health	Space Heat	27.7%
Health	Water Heat	30.7%
Health	Cooking	4.5%
Lodging	Space Heat	46.1%
Lodging	Water Heat	30.8%
Lodging	Cooking	1.4%

State/Building Type	Enduse	Percent of Sites Using Electricity for End Use
Miscellaneous	Space Heat	18.3%
Miscellaneous	Water Heat	26.3%
Wyoming		
Small Office	Space Heat	30.8%
Small Office	Water Heat	45.8%
Large Office	Space Heat	18.2%
Large Office	Heat Pump	100.0%
Large Office	Water Heat	25.0%
Restaurant	Space Heat	29.9%
Restaurant	Heat Pump	100.0%
Restaurant	Water Heat	26.6%
Restaurant	Cooking	18.6%
Small Retail	Space Heat	22.0%
Small Retail	Heat Pump	100.0%
Small Retail	Water Heat	45.6%
Large Retail	Space Heat	14.3%
Large Retail	Water Heat	33.3%
Grocery	Space Heat	26.0%
Grocery	Water Heat	51.8%
Grocery	Cooking	22.1%
Warehouse	Space Heat	12.9%
Warehouse	Heat Pump	100.0%
Warehouse	Water Heat	44.1%
School	Space Heat	17.4%
School	Heat Pump	100.0%
School	Water Heat	34.1%
School	Cooking	27.7%
Health	Space Heat	27.7%
Health	Water Heat	30.7%
Health	Cooking	4.5%
Lodging	Space Heat	46.1%
Lodging	Water Heat	30.8%
Lodging	Cooking	1.4%
Miscellaneous	Space Heat	18.3%
Miscellaneous	Heat Pump	100.0%
Miscellaneous	Water Heat	26.3%

End-Use Consumption Estimates

See Appendix F.

Appendix C-3. Technical Resources: Energy Efficiency Resources, Measure Inputs

The following tables show the key inputs and achievable potential savings in 2027 for measures in single-family homes and large office buildings, the largest contributors to the total potential in the residential and commercial sectors, respectively. The *Measure Cost* column provides the cost associated with all assumed measure installations. For the purpose of cost-effectiveness analysis, measures with zero or negative incremental cost have been assigned a cost of $0.01,so that a beneift-cost ratio could be calculated. A comprehensive set of the same tables for customer segments are provided on the accompanying CD-ROM.

Residential Measure Details

Table C.36. Commercial Measure Details: Idaho, Urban

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Large Office	HVAC Aux	Premium Efficiency HVAC motors	40,928	1.4%	80.8%	85.0%	10	$1,132	0.00
New	Large Office	HVAC Aux	Premium Efficiency HVAC motors	35,240	1.4%	80.8%	85.0%	10	$2,136	0.00
New	Large Office	Heat Pump	High Efficiency ASHP	63,407	8.4%	NA	NA	20	$0	0.00
Existing	Large Office	Heat Pump	High Efficiency ASHP	122,269	8.4%	NA	NA	20	$4,325	0.00
Existing	Large Office	Lighting	Dimming-Continuous, Fluor.	106,311	15.8%	72.2%	95.0%	10	$40435	0.04
Existing	Large Office	Lighting	LED Exit Signs	106,311	3.9%	63.8%	95.0%	25	$11	0.02
Existing	Large Office	Lighting	Cold Cathode Lighting	106,311	0.8%	94.1%	70.0%	15	$41	0.00
New	Large Office	Lighting	Lighting Package, Premium Eff.	65,509	25.0%	72.2%	70.0%	12	$2,661	0.04
New	Large Office	Lighting	Lighting Package, High Eff.	65,509	15.0%	63.8%	90.0%	12	$2,302	0.04
New	Large Office	Lighting	Solid State LED White Lighting	65,509	2.9%	98.0%	20.0%	10	$888	0.00
New	Large Office	Lighting	Cold Cathode Lighting	65,509	0.8%	94.1%	70.0%	15	$85	0.00
Existing	Large Office	Lighting	Lighting Package, Premium Eff.	106,311	25.0%	72.2%	70.0%	12	$1,446	0.04
Existing	Large Office	Lighting	Low Wattage Ceramic Metal Hali	106,311	3.4%	94.1%	50.0%	7	$1,366	0.00
Existing	Large Office	Lighting	Solid State LED White Lighting	106,311	2.9%	98.0%	20.0%	10	$583	0.00
New	Large Office	Lighting	Dimming-Continuous, Fluor.	65,509	15.8%	72.2%	95.0%	10	$35181	0.05
Existing	Large Office	Lighting	Lighting Package, High Eff.	106,311	15.0%	63.8%	90.0%	12	$1,251	0.05
Existing	Large Office	Lighting	Occupancy Sensor Control, Fluor.	106,311	8.4%	47.8%	90.0%	10	$3,065	0.03
Existing	Large Office	Plug Load	Power Supply Transformer/Conver	28,686	1.5%	85.5%	95.0%	7	$45	0.00
Existing	Large Office	Plug Load	Vending Machines - High Eff.	28,686	1.1%	80.8%	95.0%	14	$313	0.00
New	Large Office	Plug Load	Power Supply Transformer/Conver	28,686	1.5%	85.5%	95.0%	7	$79	0.00
New	Large Office	Plug Load	Vending Machines - High Eff.	28,686	1.1%	80.8%	95.0%	14	$580	0.00
New	Large Office	Space Heat	Duct Insulation	62,273	2.4%	63.8%	75.0%	20	$194	0.00
New	Large Office	Space Heat	Leak Proof Duct Fittings	62,273	20.0%	98.0%	80.0%	30	$1,453	0.01
New	Large Office	Space Heat	Windows-High Efficiency	62,273	18.0%	74.0%	90.0%	30	$9,609	0.01
Existing	Large Office	Space Heat	Insulation - Floor (non-slab)	136,808	19.0%	71.3%	60.0%	20	$1,965	0.01
Existing	Large Office	Space Heat	Insulation - 2*4 Walls 16" O.C	136,808	27.0%	70.1%	40.0%	20	$1,154	0.01
Existing	Large Office	Space Heat	Duct Repair and Sealing	136,808	2.5%	85.5%	65.0%	18	$390	0.00
Existing	Large Office	Space Heat	Insulation - Ceiling Fiberglas	136,808	12.0%	60.2%	70.0%	20	$1,909	0.01
Existing	Large Office	Space Heat	Infiltration Reduction	136,808	33.0%	67.5%	45.0%	20	$243	0.01
Existing	Large Office	Space Heat	Convert Constant Volume Air System	136,808	12.0%	67.5%	85.0%	10	$2,296	0.00
Existing	Large Office	Space Heat	Duct Insulation	136,808	4.8%	63.8%	75.0%	20	$282	0.00
Existing	Large Office	Space Heat	Programmable Thermostat	136,808	13.8%	39.0%	95.0%	15	$79	0.01
Existing	Large Office	Space Heat	Retro-Commissioning	136,808	15.0%	90.3%	90.0%	3	$4,941	0.01
Existing	Large Office	Water Heat	Water Heater Temperature Setback	8,962	24.0%	42.5%	75.0%	10	$7	0.00

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Large Office	Water Heat	Water Heater Temperature Setback	9,148	24.0%	42.5%	75.0%	10	$15	0.00
Existing	Large Office	Water Heat	Faucet Aerators	8,962	1.3%	63.8%	95.0%	10	$19	0.00
Existing	Large Office	Water Heat	Hot Water (SHW) Pipe Insul.	8,962	5.0%	89.1%	75.0%	15	$178	0.00

Table C.37. Commercial Measure Details: Utah, Urban

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Large Office	Cooling Chillers	Cooling Tower-Decrease Approach	61,143	7.5%	94.1%	70.0%	15	$90815	0.31
Existing	Large Office	Cooling Chillers	Cooling Tower-VSD Fan Control	61,143	4.0%	80.8%	95.0%	15	$71875	0.14
Existing	Large Office	Cooling Chillers	Cooling Tower-Two-Speed Fan Mo	61,143	14.0%	42.5%	95.0%	15	$1,567	0.09
Existing	Large Office	Cooling Chillers	Direct Digital Control System-	61,143	10.0%	76.5%	75.0%	5	198484	0.19
Existing	Large Office	Cooling Chillers	Duct Repair and Sealing	61,143	2.5%	85.5%	65.0%	18	$62213	0.08
Existing	Large Office	Cooling Chillers	Cool Roof	61,143	12.0%	98.0%	95.0%	20	297765	0.13
Existing	Large Office	Cooling Chillers	Duct Insulation	61,143	4.8%	63.8%	75.0%	20	$41532	0.14
Existing	Large Office	Cooling Chillers	Pipe Insulation	61,143	1.0%	76.5%	65.0%	15	$8,680	0.03
Existing	Large Office	Cooling Chillers	Chilled Water/Condenser Water	61,143	5.0%	80.8%	95.0%	10	112076	0.22
New	Large Office	Cooling Chillers	Leak Proof Duct Fittings	36,886	20.0%	98.0%	80.0%	30	261471	0.51
New	Large Office	Cooling Chillers	Chilled Water/Condenser Water	36,886	5.0%	80.8%	95.0%	10	$92786	0.01
New	Large Office	Cooling Chillers	Direct Digital Control System-	36,886	10.0%	76.5%	75.0%	5	166684	0.17
New	Large Office	Cooling Chillers	Duct Insulation	36,886	2.4%	63.8%	75.0%	20	$25410	0.05
New	Large Office	Cooling Chillers	Cooling Tower-VSD Fan Control	36,886	4.0%	80.8%	95.0%	15	$82357	0.09
New	Large Office	Cooling Chillers	Chiller - Advanced Technology	36,886	4.7%	NA	NA	20	$0	0.98
Existing	Large Office	Cooling Chillers	Chiller - Advanced Technology	54,825	4.7%	NA	NA	20	238465	1.14
New	Large Office	HVAC Aux	Premium Efficiency HVAC motors	49,677	1.4%	80.8%	85.0%	10	193069	0.20
Existing	Large Office	HVAC Aux	Premium Efficiency HVAC motors	55,447	1.4%	80.8%	85.0%	10	148058	0.22
Existing	Large Office	Lighting	Solid State LED White Lighting	147,178	2.9%	98.0%	20.0%	10	$59459	0.10
Existing	Large Office	Lighting	Lighting Package, Premium Eff.	147,178	25.0%	71.7%	70.0%	12	160627	4.43
Existing	Large Office	Lighting	Occupancy Sensor Control, Fluor.	147,178	8.4%	47.8%	90.0%	10	297773	3.18
Existing	Large Office	Lighting	LED Exit Signs	147,178	3.9%	63.7%	95.0%	25	$1,288	2.44
Existing	Large Office	Lighting	Lighting Package, High Eff.	147,178	15.0%	63.3%	90.0%	12	138984	4.91
Existing	Large Office	Lighting	Cold Cathode Lighting	147,178	0.8%	94.1%	70.0%	15	$4,680	0.06
Existing	Large Office	Lighting	Dimming-Continuous, Fluor.	147,178	15.8%	72.2%	95.0%	10	2.05E6	3.32
New	Large Office	Lighting	Cold Cathode Lighting	90,726	0.8%	94.1%	70.0%	15	$7,020	0.05

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Large Office	Lighting	Lighting Package, Premium Eff.	90,726	25.0%	71.7%	70.0%	12	237913	3.81
New	Large Office	Lighting	Dimming-Continuous, Fluor.	90,726	15.8%	72.2%	95.0%	10	2.92E6	4.61
New	Large Office	Lighting	Lighting Package, High Eff.	90,726	15.0%	63.3%	90.0%	12	205857	4.22
New	Large Office	Lighting	Solid State LED White Lighting	90,726	2.9%	98.0%	20.0%	10	$66251	0.02
New	Large Office	Plug Load	Vending Machines- High Eff.	39,744	1.1%	80.8%	95.0%	14	$52974	0.24
Existing	Large Office	Plug Load	Vending Machines- High Eff.	39,744	1.1%	80.8%	95.0%	14	$34389	0.17
Existing	Large Office	Plug Load	Power Supply Transformer/Conver	39,744	1.5%	85.5%	95.0%	7	$4,856	0.24
New	Large Office	Plug Load	Power Supply Transformer/Conver	39,744	1.5%	85.5%	95.0%	7	$7,291	0.36
New	Large Office	Space Heat	Leak Proof Duct Fittings	20,583	20.0%	98.0%	80.0%	30	121184	0.18
Existing	Large Office	Space Heat	Infiltration Reduction	65,890	33.0%	67.5%	45.0%	20	$23903	0.51
Existing	Large Office	Space Heat	Insulation - 2*4 Walls 16" O.C	65,890	27.0%	70.1%	40.0%	20	114493	0.32
Existing	Large Office	Space Heat	Programmable Thermostat	65,890	13.8%	39.0%	95.0%	15	$8,135	0.27
Existing	Large Office	Space Heat	Duct Repair and Sealing	65,890	2.5%	85.5%	65.0%	18	$39571	0.06
Existing	Large Office	Space Heat	Duct Insulation	65,890	4.8%	63.8%	75.0%	20	$27169	0.11
Existing	Large Office	Water Heat	Hot Water (SHW) Pipe Insul.	10,626	5.0%	89.1%	75.0%	15	$19060	0.03
Existing	Large Office	Water Heat	Faucet Aerators	10,626	1.3%	63.8%	95.0%	10	$2,174	0.01
New	Large Office	Water Heat	Water Heater Temperature Setback	10,897	24.0%	42.5%	75.0%	10	$1,164	0.12
Existing	Large Office	Water Heat	Water Heater Temperature Setback	10,626	24.0%	42.5%	75.0%	10	$736	0.08

Table C.38. Commercial Measure Details: Washington, Urban

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Large Office	Cooling Chillers	Leak Proof Duct Fittings	16,687	20.0%	98.0%	80.0%	30	$5,384	0.01
Existing	Large Office	Cooling Chillers	Pipe Insulation	27,142	1.0%	76.5%	65.0%	15	$649	0.00
Existing	Large Office	Cooling Chillers	Cooling Tower-Decrease Approach	27,142	7.5%	94.1%	70.0%	15	$5,299	0.01
Existing	Large Office	Cooling Chillers	Cooling Tower-Two-Speed Fan Mo	27,142	14.0%	42.5%	95.0%	15	$91	0.00
Existing	Large Office	Cooling Chillers	Duct Insulation	27,142	4.8%	63.8%	75.0%	20	$2,842	0.00
Existing	Large Office	Cooling Chillers	Cooling Tower-VSD Fan Control	27,142	4.0%	80.8%	95.0%	15	$1,950	0.00
Existing	Large Office	Cooling Chillers	Chiller - Advanced Technology	24,336	4.7%	NA	NA	20	$10804	0.03
New	Large Office	Cooling Chillers	Chiller - High Efficiency	16,687	8.6%	NA	NA	20	$0	0.01
Existing	Large Office	HVAC Aux	Premium Efficiency HVAC motors	33,874	1.4%	80.8%	85.0%	10	$5,471	0.01
Existing	Large Office	Heat Pump	High Efficiency ASHP	80,367	8.4%	NA	NA	20	$20927	0.02

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Large Office	Lighting	Cold Cathode Lighting	95,024	0.8%	94.1%	70.0%	15	$265	0.00
Existing	Large Office	Lighting	Lighting Package, Premium Eff.	95,024	25.0%	71.1%	70.0%	12	$9,190	0.25
Existing	Large Office	Lighting	Lighting Package, High Eff.	95,024	15.0%	62.7%	90.0%	12	$7,952	0.28
Existing	Large Office	Lighting	LED Exit Signs	95,024	3.9%	63.8%	95.0%	25	$71	0.14
Existing	Large Office	Lighting	Solid State LED White Lighting	95,024	2.9%	98.0%	20.0%	10	$3,843	0.00
Existing	Large Office	Lighting	Occupancy Sensor Control, Fluor.	95,024	8.4%	47.8%	90.0%	10	$19572	0.18
New	Large Office	Lighting	Dimming-Continuous, Fluor.	58,559	15.8%	72.2%	95.0%	10	$40724	0.07
New	Large Office	Lighting	Lighting Package, Premium Eff.	58,559	25.0%	71.1%	70.0%	12	$5,547	0.09
New	Large Office	Lighting	Cold Cathode Lighting	58,559	0.8%	94.1%	70.0%	15	$156	0.00
New	Large Office	Lighting	Lighting Package, High Eff.	58,559	15.0%	62.7%	90.0%	12	$4,799	0.10
New	Large Office	Plug Load	Vending Machines - High Eff.	25,667	1.1%	80.8%	95.0%	14	$1,269	0.01
Existing	Large Office	Plug Load	Vending Machines - High Eff.	25,667	1.1%	80.8%	95.0%	14	$2,077	0.01
New	Large Office	Plug Load	Power Supply Transformer/Conver	25,667	1.5%	85.5%	95.0%	7	$179	0.01
Existing	Large Office	Plug Load	Power Supply Transformer/Conver	25,667	1.5%	85.5%	95.0%	7	$293	0.01
Existing	Large Office	Space Heat	Insulation - 2*4 Walls 16" O.C	82,801	27.0%	70.1%	40.0%	20	$7,770	0.04
Existing	Large Office	Space Heat	Programmable Thermostat	82,801	13.8%	39.0%	95.0%	15	$558	0.03
Existing	Large Office	Space Heat	Infiltration Reduction	82,801	33.0%	67.5%	45.0%	20	$1,663	0.06
Existing	Large Office	Space Heat	Insulation - Floor (non-slab)	82,801	19.0%	71.3%	60.0%	20	$13261	0.03
Existing	Large Office	Space Heat	Duct Repair and Sealing	82,801	2.5%	85.5%	65.0%	18	$3,056	0.01
Existing	Large Office	Space Heat	Duct Insulation	82,801	4.8%	63.8%	75.0%	20	$2,045	0.01
New	Large Office	Space Heat	Leak Proof Duct Fittings	39,596	20.0%	98.0%	80.0%	30	$2,773	0.01
New	Large Office	Space Heat	Duct Insulation	39,596	2.4%	63.8%	75.0%	20	$406	0.00
New	Large Office	Water Heat	Water Heater Temperature Setback	7,279	24.0%	42.5%	75.0%	10	$38	0.00
Existing	Large Office	Water Heat	Water Heater Temperature Setback	7,522	24.0%	42.5%	75.0%	10	$73	0.01
Existing	Large Office	Water Heat	Hot Water (SHW) Pipe Insul.	7,522	5.0%	89.1%	75.0%	15	$751	0.00
Existing	Large Office	Water Heat	Faucet Aerators	7,522	1.3%	63.8%	95.0%	10	$149	0.00

Table C.39. Commercial Measure Details: Wyoming, Urban

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Large Office	Cooling Chillers	Duct Insulation	10,878	2.4%	63.8%	75.0%	20	$702	0.00
New	Large Office	Cooling Chillers	Leak Proof Duct Fittings	10,878	20.0%	98.0%	80.0%	30	$7,359	0.01
Existing	Large Office	Cooling Chillers	Cooling Tower-Decrease Approach	18,051	7.5%	94.1%	70.0%	15	$3,962	0.01
Existing	Large Office	Cooling Chillers	Duct Insulation	18,051	4.8%	63.8%	75.0%	20	$1,875	0.00
Existing	Large Office	Cooling Chillers	Cooling Tower-Two-Speed Fan Mo	18,051	14.0%	42.5%	95.0%	15	$68	0.00
Existing	Large Office	Cooling Chillers	Cooling Tower-VSD Fan Control	18,051	4.0%	80.8%	95.0%	15	$1,630	0.00
Existing	Large Office	Cooling Chillers	Chilled Water/Condenser Water	18,051	5.0%	80.8%	95.0%	10	$2,396	0.00
Existing	Large Office	Cooling Chillers	Pipe Insulation	18,051	1.0%	76.5%	65.0%	15	$364	0.00
New	Large Office	Cooling Chillers	Chiller - High Efficiency	10,878	8.6%	NA	NA	20	$0	0.00
Existing	Large Office	Cooling Chillers	Chiller - Premium Efficiency	16,185	9.9%	NA	NA	20	$18268	0.01
Existing	Large Office	HVAC Aux	Premium Efficiency HVAC motors	32,631	1.4%	80.8%	85.0%	10	$6,225	0.01
New	Large Office	HVAC Aux	Premium Efficiency HVAC motors	27,823	1.4%	80.8%	85.0%	10	$6,805	0.01
Existing	Large Office	Heat Pump	High Efficiency ASHP	111,885	8.4%	NA	NA	20	$21342	0.02
New	Large Office	Heat Pump	High Efficiency ASHP	53,754	8.4%	NA	NA	20	$0	0.01
New	Large Office	Lighting	Cold Cathode Lighting	53,354	0.8%	94.1%	70.0%	15	$232	0.00
Existing	Large Office	Lighting	Solid State LED White Lighting	86,550	2.9%	98.0%	20.0%	10	$2,486	0.00
New	Large Office	Lighting	Dimming-Continuous, Fluor.	53,354	15.8%	72.2%	95.0%	10	$94950	0.16
New	Large Office	Lighting	Lighting Package, High Eff.	53,354	15.0%	63.6%	90.0%	12	$7,051	0.16
New	Large Office	Lighting	Solid State LED White Lighting	53,354	2.9%	98.0%	20.0%	10	$1,977	0.00
New	Large Office	Lighting	Lighting Package, Premium Eff.	53,354	25.0%	72.1%	70.0%	12	$8,149	0.14
Existing	Large Office	Lighting	LED Exit Signs	86,550	3.9%	63.8%	95.0%	25	$55	0.10
Existing	Large Office	Lighting	Lighting Package, High Eff.	86,550	15.0%	63.6%	90.0%	12	$5,936	0.21
Existing	Large Office	Lighting	Occupancy Sensor Control, Fluor	86,550	8.4%	47.8%	90.0%	10	$12394	0.13
Existing	Large Office	Lighting	Low Wattage Ceramic Metal Hali	86,550	3.4%	94.1%	50.0%	7	$6,412	0.00
Existing	Large Office	Lighting	Lighting Package, Premium Eff.	86,550	25.0%	72.1%	70.0%	12	$6,860	0.19
Existing	Large Office	Lighting	Cold Cathode Lighting	86,550	0.8%	94.1%	70.0%	15	$200	0.00
Existing	Large Office	Lighting	Dimming-Continuous, Fluor.	86,550	15.8%	72.2%	95.0%	10	$86549	0.14
New	Large Office	Plug Load	Power Supply Transformer/Conve	23,362	1.5%	85.5%	95.0%	7	$249	0.01
New	Large Office	Plug Load	Vending Machines - High Eff.	23,362	1.1%	80.8%	95.0%	14	$1,835	0.01
Existing	Large Office	Plug Load	Vending Machines - High Eff.	23,362	1.1%	80.8%	95.0%	14	$1,451	0.01
Existing	Large Office	Plug Load	Power Supply Transformer/Conver	23,362	1.5%	85.5%	95.0%	7	$205	0.01
Existing	Large Office	Space Heat	Insulation - 2*4 Walls 16" O.C	133,219	27.0%	70.1%	40.0%	20	$4,989	0.05
Existing	Large Office	Space Heat	Insulation - Floor (non-slab)	133,219	19.0%	71.3%	60.0%	20	$8,479	0.05
Existing	Large Office	Space Heat	Infiltration Reduction	133,219	33.0%	67.5%	45.0%	20	$1,038	0.08
Existing	Large Office	Space Heat	Insulation - Ceiling Fiberglas	133,219	12.0%	60.2%	70.0%	20	$8,297	0.02
New	Large Office	Space Heat	Windows-High Efficiency	58,723	18.0%	74.0%	90.0%	30	$25657	0.03

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Large Office	Space Heat	Duct Repair and Sealing	133,219	2.5%	85.5%	65.0%	18	$1,564	0.01
Existing	Large Office	Space Heat	Convert Constant Volume Air System	133,219	12.0%	67.4%	85.0%	10	$9,795	0.01
Existing	Large Office	Space Heat	Duct Insulation	133,219	4.8%	63.8%	75.0%	20	$1,164	0.02
New	Large Office	Space Heat	Leak Proof Duct Fittings	58,723	20.0%	98.0%	80.0%	30	$3,879	0.03
Existing	Large Office	Space Heat	Retro-Commissioning	133,219	15.0%	90.3%	90.0%	3	$28206	0.06
Existing	Large Office	Space Heat	Programmable Thermostat	133,219	13.8%	39.0%	95.0%	15	$333	0.04
New	Large Office	Space Heat	Duct Insulation	58,723	2.4%	63.8%	75.0%	20	$494	0.00
Existing	Large Office	Water Heat	Water Heater Temperature Setback	7,505	24.0%	42.5%	75.0%	10	$29	0.00
Existing	Large Office	Water Heat	Hot Water (SHW) Pipe Insul.	7,505	5.0%	89.1%	75.0%	15	$751	0.00
Existing	Large Office	Water Heat	Faucet Aerators	7,505	1.3%	63.8%	95.0%	10	$90	0.00
New	Large Office	Water Heat	Water Heater Temperature Setback	7,248	24.0%	42.5%	75.0%	10	$35	0.01

Residential Measure Details

Table C.40. Residential Measure Details: California, Rural

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Central AC	Cool Roof	1,370	12.0%	85.5%	80.0%	20	$381	0.00
Existing	Single Family	Central AC	Cool Roof	1,366	12.0%	85.5%	80.0%	20	$864	0.01
New	Single Family	Central AC	Evaporative coolers	1,370	70.0%	90.0%	100.0%	18	$0	0.01
Existing	Single Family	Central AC	Evaporative coolers	1,366	70.0%	90.0%	100.0%	18	$0	0.01
New	Single Family	Central Heat	Air-to-Air Heat Exchangers	6,685	10.0%	85.5%	65.0%	18	$2,591	0.00
Existing	Single Family	Central Heat	Check Me Tune-up/Maintenance	9,670	10.0%	63.7%	90.0%	5	$23979	0.05
Existing	Single Family	Central Heat	ECPM Furnace Fan Motor	9,670	7.5%	85.5%	70.0%	20	$8,178	0.05
New	Single Family	Central Heat	Windows, ENERGY STAR or better	6,685	5.0%	55.6%	95.0%	20	$834	0.00
Existing	Single Family	Central Heat	Whole house air sealing	9,670	28.0%	51.0%	80.0%	10	$47392	0.09
New	Single Family	Central Heat	ECPM Furnace Fan Motor	6,685	7.5%	85.5%	70.0%	20	$1,152	0.00
Existing	Single Family	Central Heat	Windows, ENERGY STAR or better	9,670	21.0%	55.6%	75.0%	20	$29915	0.05
New	Single Family	Central Heat	VFD Furnace Fan Motor	6,685	9.0%	80.8%	75.0%	20	$1,388	0.00
Existing	Single Family	Central Heat	Check Me Duct Sealing	9,670	5.0%	72.2%	45.0%	20	$5,956	0.00
New	Single Family	Central Heat	Duct Insulation Upgrade	6,685	3.6%	59.1%	50.0%	20	$108	0.00

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Single Family	Central Heat	VFD Furnace Fan Motor	9,670	10.5%	63.7%	75.0%	20	$7,780	0.06
New	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	886	13.8%	NA	NA	18	$2,249	0.00
Existing	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	886	13.8%	NA	NA	18	$15663	0.02
Existing	Single Family	Freezer	Removal of Secondary Freezer	558	100.0%	90.3%	54.0%	10	$40689	0.25
Existing	Single Family	Freezer	Freezer - ENERGY STAR or better	571	10.0%	NA	NA	11	$23510	0.02
New	Single Family	Freezer	Freezer - ENERGY STAR or better	571	10.0%	NA	NA	11	$1,977	0.00
Existing	Single Family	Heat Pump	Heat Pumps - Service Contracts	8,331	10.0%	72.2%	90.0%	5	$44768	0.08
New	Single Family	Heat Pump	Duct Insulation Upgrade	6,282	3.0%	59.1%	50.0%	20	$131	0.00
Existing	Single Family	Heat Pump	Whole house air sealing	8,331	21.0%	51.0%	80.0%	10	$34116	0.04
New	Single Family	Heat Pump	Air-to-Air Heat Exchangers	6,282	10.0%	85.5%	65.0%	18	$3,142	0.00
Existing	Single Family	Heat Pump	Check Me Duct Sealing	8,331	5.0%	72.2%	45.0%	20	$9,164	0.02
New	Single Family	Heat Pump	Cool Roof	6,282	1.1%	85.5%	80.0%	20	$176	0.00
Existing	Single Family	Heat Pump	Cool Roof	8,331	1.1%	85.5%	80.0%	20	$1,588	0.01
Existing	Single Family	Heat Pump	ASHP - High Efficiency	8,775	8.0%	NA	NA	15	$37409	0.06
New	Single Family	Heat Pump	ASHP - High Efficiency	6,602	8.0%	NA	NA	15	$4,417	0.00
New	Single Family	Lighting	CFL Lamps	2,081	63.6%	68.4%	80.0%	6	$14383	0.12
New	Single Family	Lighting	CFL Fixtures	2,081	7.5%	84.1%	80.0%	16	$2,377	0.02
New	Single Family	Lighting	LED Interior Lighting	2,081	79.1%	88.8%	65.0%	12	$12503	0.03
New	Single Family	Lighting	CFL Torchieries	2,081	4.2%	84.1%	50.0%	5	$602	0.01
Existing	Single Family	Lighting	CFL Torchieries	1,919	4.2%	84.1%	50.0%	5	$4,412	0.06
Existing	Single Family	Lighting	CFL Lamps	1,919	63.6%	68.4%	80.0%	6	123852	0.95
Existing	Single Family	Lighting	CFL Fixtures	1,919	7.5%	84.1%	80.0%	16	$26471	0.16
Existing	Single Family	Lighting	LED Interior Lighting	1,919	79.1%	88.8%	65.0%	12	$77320	0.16
Existing	Single Family	Plug Load	Power Supply Transformer/Converter	5,240	0.3%	80.8%	80.0%	7	$14	0.02
New	Single Family	Plug Load	Efficient DVD systems	5,240	0.1%	42.5%	95.0%	7	$1	0.00
Existing	Single Family	Plug Load	Efficient DVD systems	5,240	0.1%	42.5%	95.0%	7	$9	0.00
Existing	Single Family	Plug Load	1-Watt Standby Power	5,240	4.0%	71.2%	21.0%	7	$977	0.00
New	Single Family	Plug Load	1-Watt Standby Power	5,240	4.0%	71.2%	21.0%	7	$126	0.00
New	Single Family	Plug Load	Power Supply Transformer/Converter	5,240	0.3%	80.8%	80.0%	7	$2	0.00
New	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	506	14.7%	61.0%	100.0%	18	$4,514	0.00
New	Single Family	Refrigerator	1 kWh/day Refrigerator	506	30.1%	90.3%	90.0%	18	$2,254	0.00
Existing	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	516	14.7%	61.0%	100.0%	18	$48434	0.01
Existing	Single Family	Refrigerator	1 kWh/day Refrigerator	516	30.1%	90.3%	90.0%	18	$24185	0.03
Existing	Single Family	Refrigerator	Removal of Secondary Refrigerator	516	100.0%	90.3%	5.0%	10	$10069	0.05
Existing	Single Family	Room AC	Cool Roof	770	12.0%	85.5%	80.0%	20	$1,507	0.01

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Room AC	Cool Roof	713	12.0%	85.5%	80.0%	20	$240	0.00
Existing	Single Family	Room Heat	Ductless Heat Pump	7,446	32.0%	98.0%	40.0%	15	$45460	0.13
New	Single Family	Room Heat	Windows, ENERGY STAR or better	5,148	5.0%	55.6%	95.0%	20	$1,025	0.00
Existing	Single Family	Room Heat	Windows, ENERGY STAR or better	7,446	21.0%	55.6%	75.0%	20	$42333	0.01
Existing	Single Family	Room Heat	Whole house air sealing	7,446	28.0%	51.0%	80.0%	10	$65131	0.06
New	Single Family	Water Heat	High Efficiency Water Heater	2,428	2.2%	80.8%	100.0%	10	$1,910	0.00
Existing	Single Family	Water Heat	Low-Flow Showerheads	2,429	12.5%	30.3%	95.0%	10	$6,628	0.11
Existing	Single Family	Water Heat	Water Heater Temperature Setback	2,429	3.0%	42.5%	95.0%	5	$11971	0.01
New	Single Family	Water Heat	ENERGY STAR Clothes Washer - Premium Efficiency	2,428	17.6%	62.0%	91.0%	14	$6,569	0.00
New	Single Family	Water Heat	Water Heater Temperature Setback	2,428	3.0%	42.5%	95.0%	5	$1,850	0.00
New	Single Family	Water Heat	Heat Trap	2,428	10.0%	63.7%	70.0%	15	$3,564	0.02
New	Single Family	Water Heat	ENERGY STAR Dishwasher	2,428	5.7%	80.0%	68.0%	13	$1,547	0.01
Existing	Single Family	Water Heat	Heat Trap	2,429	10.0%	76.5%	95.0%	15	$78245	0.21
Existing	Single Family	Water Heat	Faucet Aerators	2,429	2.5%	14.7%	95.0%	9	$1,639	0.01
Existing	Single Family	Water Heat	ENERGY STAR Dishwasher	2,429	5.7%	80.0%	68.0%	13	$13522	0.09

Table C.41. Residential Measure Details: Idaho, Rural

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Central AC	Duct Insulation Upgrade	1,213	3.0%	63.3%	50.0%	20	$1,540	0.00
Existing	Single Family	Central AC	Evaporative coolers	1,093	70.0%	90.0%	100.0%	18	$0	0.02
New	Single Family	Central AC	Cool Roof	1,213	12.0%	85.5%	80.0%	20	$1,941	0.01
Existing	Single Family	Central AC	Cool Roof	1,093	12.0%	85.5%	80.0%	20	$1,471	0.01
New	Single Family	Central AC	Evaporative coolers	1,213	70.0%	90.0%	100.0%	18	$0	0.03
New	Single Family	Central AC	Central AC – Premium Efficiency	1,303	6.0%	NA	NA	18	$12353	0.01
New	Single Family	Central Heat	Whole house air sealing	12,762	16.0%	61.9%	80.0%	10	$23673	0.04
Existing	Single Family	Central Heat	ECPM Furnace Fan Motor	16,632	7.5%	85.5%	70.0%	20	$11046	0.10
Existing	Single Family	Central Heat	Windows, ENERGY STAR or better	16,632	21.0%	48.9%	75.0%	20	$35489	0.14
Existing	Single Family	Central Heat	Whole house air sealing	16,632	28.0%	61.9%	80.0%	10	$59987	0.30
New	Single Family	Central Heat	Duct Insulation Upgrade	12,762	3.6%	63.3%	50.0%	20	$453	0.01
Existing	Single Family	Central Heat	VFD Furnace Fan Motor	16,632	10.5%	63.7%	75.0%	20	$10508	0.12

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Central Heat	Air-to-Air Heat Exchangers	12,762	10.0%	85.5%	65.0%	18	$8,982	0.03
Existing	Single Family	Central Heat	Insulation-Ceiling To Code	16,632	8.0%	69.5%	80.0%	30	$29478	0.07
Existing	Single Family	Central Heat	Duct Insulation Upgrade	16,632	3.6%	63.3%	50.0%	20	$5,784	0.02
Existing	Single Family	Central Heat	Check Me Tune-up/Maintenance	16,632	10.0%	63.7%	90.0%	5	$29165	0.11
New	Single Family	Central Heat	VFD Furnace Fan Motor	12,762	9.0%	80.8%	75.0%	20	$5,458	0.03
Existing	Single Family	Central Heat	Check Me Duct Sealing	16,632	5.0%	72.2%	45.0%	20	$8,045	0.03
Existing	Single Family	Central Heat	Below Grade Wall Insulation	16,632	4.0%	72.2%	60.0%	20	$12634	0.02
New	Single Family	Central Heat	Insulation-Ceiling Above Code	12,762	2.0%	69.5%	80.0%	30	$3,909	0.00
New	Single Family	Central Heat	Windows, ENERGY STAR or better	12,762	5.0%	48.9%	95.0%	20	$2,880	0.01
Existing	Single Family	Central Heat	Insulation-Floor	16,632	5.3%	84.5%	55.0%	30	$25924	0.02
New	Single Family	Central Heat	ECPM Furnace Fan Motor	12,762	7.5%	85.5%	70.0%	20	$4,529	0.03
New	Single Family	Central Heat	ENERGY STAR New Construction – Site Built	12,762	36.0%	90.3%	50.0%	25	$63098	0.04
Existing	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	874	13.8%	NA	NA	18	$23688	0.03
New	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	874	13.8%	NA	NA	18	$7,669	0.01
Existing	Single Family	Freezer	Removal of Secondary Freezer	542	100.0%	90.3%	65.0%	10	$57230	0.58
New	Single Family	Freezer	Freezer – ENERGY STAR or better	564	10.0%	NA	NA	11	$10180	0.02
Existing	Single Family	Freezer	Freezer – ENERGY STAR or better	564	10.0%	NA	NA	11	$55462	0.06
New	Single Family	Heat Pump	Duct Insulation Upgrade	10,154	3.0%	63.3%	50.0%	20	$87	0.00
Existing	Single Family	Heat Pump	Whole house air sealing	12,631	21.0%	61.9%	80.0%	10	$11505	0.03
Existing	Single Family	Heat Pump	Heat Pumps – Service Contracts	12,631	10.0%	72.2%	90.0%	5	$6,535	0.02
Existing	Single Family	Heat Pump	Windows, ENERGY STAR or better	12,631	16.0%	48.9%	75.0%	20	$6,759	0.02
New	Single Family	Heat Pump	Advanced Cold-Climate Heat Pump	10,154	24.5%	98.0%	29.0%	15	$682	0.00
New	Single Family	Heat Pump	Air-to-Air Heat Exchangers	10,154	10.0%	85.5%	65.0%	18	$1,720	0.01
Existing	Single Family	Heat Pump	Insulation-Ceiling To Code	12,631	6.0%	69.5%	80.0%	30	$5,615	0.01
Existing	Single Family	Heat Pump	Cool Roof	12,631	1.1%	85.5%	80.0%	20	$265	0.00
Existing	Single Family	Heat Pump	Duct Insulation Upgrade	12,631	3.0%	63.3%	50.0%	20	$1,102	0.00
Existing	Single Family	Heat Pump	Check Me Duct Sealing	12,631	5.0%	72.2%	45.0%	20	$1,532	0.00
New	Single Family	Heat Pump	Insulation-Ceiling Above Code	10,154	1.5%	69.5%	80.0%	30	$748	0.00
Existing	Single Family	Heat Pump	Below Grade Wall Insulation	12,631	3.0%	72.2%	60.0%	20	$2,406	0.00
Existing	Single Family	Heat Pump	Advanced Cold-Climate Heat Pump	12,631	24.5%	98.0%	29.0%	15	$1,655	0.00
New	Single Family	Heat Pump	Cool Roof	10,154	1.1%	85.5%	80.0%	20	$109	0.00
New	Single Family	Heat Pump	ASHP – Premium Efficiency	11,327	5.0%	NA	NA	15	$3,300	0.01
Existing	Single Family	Heat Pump	ASHP – Premium Efficiency	13,566	5.0%	NA	NA	15	$12808	0.03
Existing	Single Family	Lighting	CFL Fixtures	2,368	7.5%	84.1%	80.0%	16	$38356	0.23
Existing	Single Family	Lighting	LED Interior Lighting	2,368	79.1%	88.8%	65.0%	12	114161	0.24

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Lighting	CFL Torchieries	2,842	4.2%	84.1%	50.0%	5	$3,030	0.04
New	Single Family	Lighting	CFL Lamps	2,842	63.6%	72.9%	80.0%	6	$65303	0.63
Existing	Single Family	Lighting	CFL Torchieries	2,368	4.2%	84.1%	50.0%	5	$6,390	0.08
Existing	Single Family	Lighting	CFL Lamps	2,368	63.6%	72.9%	80.0%	6	192145	1.47
New	Single Family	Lighting	LED Interior Lighting	2,842	79.1%	88.8%	65.0%	12	$55271	0.12
New	Single Family	Lighting	CFL Fixtures	2,842	7.5%	84.1%	80.0%	16	$16794	0.10
New	Single Family	Plug Load	1-Watt Standby Power	5,173	4.0%	71.2%	21.0%	7	$426	0.00
New	Single Family	Plug Load	Efficient DVD systems	5,173	0.1%	42.5%	95.0%	7	$4	0.00
Existing	Single Family	Plug Load	Efficient DVD systems	5,173	0.1%	42.5%	95.0%	7	$10	0.00
Existing	Single Family	Plug Load	1-Watt Standby Power	5,173	4.0%	71.2%	21.0%	7	$1,161	0.01
New	Single Family	Plug Load	Power Supply Transformer/Converter	5,173	0.3%	80.8%	80.0%	7	$6	0.01
Existing	Single Family	Plug Load	Power Supply Transformer/Converter	5,173	0.3%	80.8%	80.0%	7	$16	0.02
Existing	Single Family	Refrigerator	1 kWh/day Refrigerator	510	30.1%	90.3%	90.0%	18	$22562	0.03
New	Single Family	Refrigerator	1 kWh/day Refrigerator	499	30.1%	90.3%	90.0%	18	$8,335	0.01
Existing	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	510	14.7%	66.0%	100.0%	18	$48888	0.07
Existing	Single Family	Refrigerator	Removal of Secondary Refrigerator	510	100.0%	90.3%	11.0%	10	$14356	0.11
New	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	499	14.7%	66.0%	100.0%	18	$18060	0.02
New	Single Family	Room AC	Cool Roof	654	12.0%	85.5%	80.0%	20	$615	0.00
Existing	Single Family	Room AC	Cool Roof	617	12.0%	85.5%	80.0%	20	$1,941	0.01
Existing	Single Family	Room Heat	Below Grade Wall Insulation	12,807	4.0%	72.2%	60.0%	20	$53640	0.04
Existing	Single Family	Room Heat	Whole house air sealing	12,807	28.0%	61.9%	80.0%	10	246649	0.92
Existing	Single Family	Room Heat	Ductless Heat Pump	12,807	32.0%	98.0%	40.0%	15	192914	0.95
Existing	Single Family	Room Heat	Windows, ENERGY STAR or better	12,807	21.0%	48.9%	75.0%	20	150672	0.41
Existing	Single Family	Room Heat	Insulation-Floor	12,807	5.3%	84.5%	55.0%	30	110063	0.01
Existing	Single Family	Room Heat	Insulation-Ceiling To Code	12,807	10.0%	69.5%	80.0%	30	125152	0.32
New	Single Family	Room Heat	Insulation-Ceiling Above Code	9,827	2.0%	69.5%	80.0%	30	$15218	0.01
New	Single Family	Room Heat	ENERGY STAR New Construction – Site Built	9,827	36.0%	90.3%	50.0%	25	245629	0.10
New	Single Family	Room Heat	Whole house air sealing	9,827	16.0%	61.9%	80.0%	10	$90020	0.12
New	Single Family	Room Heat	Windows, ENERGY STAR or better	9,827	5.0%	48.9%	95.0%	20	$11211	0.04
New	Single Family	Water Heat	ENERGY STAR Clothes Washer – High Efficiency	2,870	11.0%	64.0%	94.0%	14	$23705	0.00
Existing	Single Family	Water Heat	Water Heater Temperature Setback	2,872	3.0%	42.5%	95.0%	5	$11633	0.03
New	Single Family	Water Heat	Drain Water Heat Recovery (GFX)	2,870	20.0%	98.0%	45.0%	15	$60586	0.08
Existing	Single Family	Water Heat	Low-Flow Showerheads	2,872	12.5%	24.9%	95.0%	10	$4,930	0.09
Existing	Single Family	Water Heat	ENERGY STAR Dishwasher	2,872	5.7%	80.0%	71.0%	13	$12203	0.10
Existing	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	2,872	17.6%	64.0%	94.0%	14	$44495	0.07
Existing	Single Family	Water Heat	Heat Trap	2,872	10.0%	76.5%	95.0%	15	$47006	0.21

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Water Heat	High Efficiency Water Heater	2,870	2.2%	80.8%	100.0%	10	$8,332	0.01
Existing	Single Family	Water Heat	Faucet Aerators	2,872	2.5%	9.4%	95.0%	9	$916	0.01
New	Single Family	Water Heat	Water Heater Temperature Setback	2,870	3.0%	42.5%	95.0%	5	$4,088	0.01
Existing	Single Family	Water Heat	ENERGY STAR Clothes Washer – High Efficiency	2,872	11.0%	64.0%	94.0%	14	$64270	0.02
New	Single Family	Water Heat	Heat Trap	2,870	10.0%	63.7%	70.0%	15	$9,795	0.04
New	Single Family	Water Heat	ENERGY STAR Dishwasher	2,870	5.7%	80.0%	71.0%	13	$4,128	0.03
New	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	2,870	17.6%	64.0%	94.0%	14	$16411	0.02

Table C.42. Residential Measure Details: Idaho, Urban

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Central AC	Duct Insulation Upgrade	1,247	3.0%	63.3%	50.0%	20	$568	0.00
New	Single Family	Central AC	Cool Roof	1,247	12.0%	85.5%	80.0%	20	$717	0.00
Existing	Single Family	Central AC	Evaporative coolers	1,148	70.0%	90.0%	100.0%	18	$0	0.01
New	Single Family	Central AC	Evaporative coolers	1,247	70.0%	90.0%	100.0%	18	$0	0.01
Existing	Single Family	Central AC	Cool Roof	1,148	12.0%	85.5%	80.0%	20	$533	0.00
New	Single Family	Central AC	Central AC – Premium Efficiency	1,369	6.0%	NA	NA	18	$4,472	0.01
New	Single Family	Central Heat	Windows, ENERGY STAR or better	13,399	5.0%	48.9%	95.0%	20	$1,056	0.01
New	Single Family	Central Heat	Whole house air sealing	13,399	16.0%	61.9%	80.0%	10	$8,358	0.02
New	Single Family	Central Heat	VFD Furnace Fan Motor	13,399	9.0%	80.8%	75.0%	20	$2,001	0.01
New	Single Family	Central Heat	Insulation-Ceiling Above Code	13,399	2.0%	69.5%	80.0%	30	$1,433	0.00
New	Single Family	Central Heat	ENERGY STAR New Construction – Site Built	13,399	36.0%	90.3%	50.0%	25	$23137	0.02
New	Single Family	Central Heat	ECPM Furnace Fan Motor	13,399	7.5%	85.5%	70.0%	20	$1,661	0.01
New	Single Family	Central Heat	Duct Insulation Upgrade	13,399	3.6%	63.3%	50.0%	20	$166	0.00
New	Single Family	Central Heat	Air-to-Air Heat Exchangers	13,399	10.0%	85.5%	65.0%	18	$3,293	0.01
Existing	Single Family	Central Heat	Windows, ENERGY STAR or better	17,463	21.0%	48.9%	75.0%	20	$12811	0.05
Existing	Single Family	Central Heat	Whole house air sealing	17,463	28.0%	61.9%	80.0%	10	$21527	0.11
Existing	Single Family	Central Heat	VFD Furnace Fan Motor	17,463	10.5%	63.7%	75.0%	20	$3,793	0.05
Existing	Single Family	Central Heat	Insulation-Ceiling To Code	17,463	8.0%	69.5%	80.0%	30	$10641	0.03
Existing	Single Family	Central Heat	ECPM Furnace Fan Motor	17,463	7.5%	85.5%	70.0%	20	$3,987	0.04
Existing	Single Family	Central Heat	Duct Insulation Upgrade	17,463	3.6%	63.3%	50.0%	20	$2,088	0.01

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Single Family	Central Heat	Check Me Duct Sealing	17,463	5.0%	72.2%	45.0%	20	$2,904	0.01
Existing	Single Family	Central Heat	Insulation-Floor	17,463	5.3%	84.5%	55.0%	30	$9,358	0.01
Existing	Single Family	Central Heat	Check Me Tune-up/Maintenance	17,463	10.0%	63.7%	90.0%	5	$10521	0.04
Existing	Single Family	Central Heat	Below Grade Wall Insulation	17,463	4.0%	72.2%	60.0%	20	$4,561	0.01
New	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	918	13.8%	NA	NA	18	$2,777	0.01
Existing	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	918	13.8%	NA	NA	18	$8,577	0.01
Existing	Single Family	Freezer	Removal of Secondary Freezer	568	100.0%	90.3%	65.0%	10	$20783	0.22
New	Single Family	Freezer	Freezer – ENERGY STAR or better	592	10.0%	NA	NA	11	$3,686	0.01
Existing	Single Family	Freezer	Freezer – ENERGY STAR or better	592	10.0%	NA	NA	11	$20081	0.02
New	Single Family	Heat Pump	Insulation-Ceiling Above Code	10,622	1.5%	69.5%	80.0%	30	$273	0.00
New	Single Family	Heat Pump	Duct Insulation Upgrade	10,622	3.0%	63.3%	50.0%	20	$32	0.00
New	Single Family	Heat Pump	Cool Roof	10,622	1.1%	85.5%	80.0%	20	$40	0.00
New	Single Family	Heat Pump	Air-to-Air Heat Exchangers	10,622	10.0%	85.5%	65.0%	18	$628	0.00
New	Single Family	Heat Pump	Advanced Cold-Climate Heat Pump	10,622	24.5%	98.0%	29.0%	15	$249	0.00
Existing	Single Family	Heat Pump	Windows, ENERGY STAR or better	13,249	16.0%	48.9%	75.0%	20	$2,418	0.01
Existing	Single Family	Heat Pump	Whole house air sealing	13,249	21.0%	61.9%	80.0%	10	$4,096	0.01
Existing	Single Family	Heat Pump	Insulation-Ceiling To Code	13,249	6.0%	69.5%	80.0%	30	$2,009	0.00
Existing	Single Family	Heat Pump	Heat Pumps – Service Contracts	13,249	10.0%	72.2%	90.0%	5	$2,303	0.01
Existing	Single Family	Heat Pump	Duct Insulation Upgrade	13,249	3.0%	63.3%	50.0%	20	$394	0.00
Existing	Single Family	Heat Pump	Check Me Duct Sealing	13,249	5.0%	72.2%	45.0%	20	$548	0.00
Existing	Single Family	Heat Pump	Cool Roof	13,249	1.1%	85.5%	80.0%	20	$95	0.00
Existing	Single Family	Heat Pump	Advanced Cold-Climate Heat Pump	13,249	24.5%	98.0%	29.0%	15	$592	0.00
Existing	Single Family	Heat Pump	Below Grade Wall Insulation	13,249	3.0%	72.2%	60.0%	20	$861	0.00
New	Single Family	Heat Pump	ASHP – Premium Efficiency	11,893	5.0%	NA	NA	15	$1,195	0.00
Existing	Single Family	Heat Pump	ASHP – Premium Efficiency	14,244	5.0%	NA	NA	15	$4,637	0.01
New	Single Family	Lighting	LED Interior Lighting	2,983	79.1%	88.8%	65.0%	12	$21023	0.05
New	Single Family	Lighting	CFL Torchieries	2,983	4.2%	84.1%	50.0%	5	$1,152	0.01
New	Single Family	Lighting	CFL Lamps	2,983	63.6%	72.9%	80.0%	6	$24830	0.24
New	Single Family	Lighting	CFL Fixtures	2,983	7.5%	84.1%	80.0%	16	$6,386	0.04
Existing	Single Family	Lighting	LED Interior Lighting	2,486	79.1%	88.8%	65.0%	12	$43426	0.09
Existing	Single Family	Lighting	CFL Fixtures	2,486	7.5%	84.1%	80.0%	16	$14584	0.09
Existing	Single Family	Lighting	CFL Lamps	2,486	63.6%	72.9%	80.0%	6	$73043	0.56
Existing	Single Family	Lighting	CFL Torchieries	2,486	4.2%	84.1%	50.0%	5	$2,429	0.03
New	Single Family	Plug Load	Power Supply Transformer/Converter	5,432	0.3%	80.8%	80.0%	7	$2	0.00
New	Single Family	Plug Load	1-Watt Standby Power	5,432	4.0%	71.2%	21.0%	7	$154	0.00

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Plug Load	Efficient DVD systems	5,432	0.1%	42.5%	95.0%	7	$1	0.00
Existing	Single Family	Plug Load	Power Supply Transformer/Converter	5,432	0.3%	80.8%	80.0%	7	$6	0.01
Existing	Single Family	Plug Load	Efficient DVD systems	5,432	0.1%	42.5%	95.0%	7	$4	0.00
Existing	Single Family	Plug Load	1-Watt Standby Power	5,432	4.0%	71.2%	21.0%	7	$421	0.00
New	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	524	14.7%	66.0%	100.0%	18	$6,640	0.01
New	Single Family	Refrigerator	1 kWh/day Refrigerator	524	30.1%	90.3%	90.0%	18	$3,065	0.00
Existing	Single Family	Refrigerator	Removal of Secondary Refrigerator	535	100.0%	90.3%	11.0%	10	$5,033	0.04
Existing	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	535	14.7%	66.0%	100.0%	18	$17489	0.03
Existing	Single Family	Refrigerator	1 kWh/day Refrigerator	535	30.1%	90.3%	90.0%	18	$8,071	0.01
New	Single Family	Room AC	Cool Roof	687	12.0%	85.5%	80.0%	20	$223	0.00
Existing	Single Family	Room AC	Cool Roof	647	12.0%	85.5%	80.0%	20	$704	0.00
New	Single Family	Room Heat	Windows, ENERGY STAR or better	10,318	5.0%	48.9%	95.0%	20	$4,125	0.02
New	Single Family	Room Heat	Whole house air sealing	10,318	16.0%	61.9%	80.0%	10	$33292	0.05
New	Single Family	Room Heat	Insulation-Ceiling Above Code	10,318	2.0%	69.5%	80.0%	30	$5,599	0.01
New	Single Family	Room Heat	ENERGY STAR New Construction – Site Built	10,318	36.0%	90.3%	50.0%	25	$90370	0.05
Existing	Single Family	Room Heat	Windows, ENERGY STAR or better	13,446	21.0%	48.9%	75.0%	20	$54115	0.16
Existing	Single Family	Room Heat	Whole house air sealing	13,446	28.0%	61.9%	80.0%	10	$89958	0.35
Existing	Single Family	Room Heat	Insulation-Floor	13,446	5.3%	84.5%	55.0%	30	$39530	0.01
Existing	Single Family	Room Heat	Insulation-Ceiling To Code	13,446	10.0%	69.5%	80.0%	30	$44950	0.12
Existing	Single Family	Room Heat	Ductless Heat Pump	13,446	32.0%	98.0%	40.0%	15	$69531	0.36
Existing	Single Family	Room Heat	Below Grade Wall Insulation	13,446	4.0%	72.2%	60.0%	20	$19265	0.02
New	Single Family	Water Heat	Water Heater Temperature Setback	3,013	3.0%	42.5%	95.0%	5	$1,529	0.00
New	Single Family	Water Heat	High Efficiency Water Heater	3,013	2.2%	80.8%	100.0%	10	$3,087	0.01
New	Single Family	Water Heat	Heat Trap	3,013	10.0%	63.7%	70.0%	15	$3,691	0.02
New	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	3,013	17.6%	64.0%	94.0%	14	$6,024	0.01
New	Single Family	Water Heat	Drain Water Heat Recovery (GFX)	3,013	20.0%	98.0%	45.0%	15	$22832	0.03
New	Single Family	Water Heat	ENERGY STAR Clothes Washer – High Efficiency	3,013	11.0%	64.0%	94.0%	14	$8,702	0.00
New	Single Family	Water Heat	ENERGY STAR Dishwasher	3,013	5.7%	80.0%	71.0%	13	$1,523	0.01
Existing	Single Family	Water Heat	Low-Flow Showerheads	3,015	12.5%	24.9%	95.0%	10	$1,746	0.04
Existing	Single Family	Water Heat	Heat Trap	3,015	10.0%	76.5%	95.0%	15	$16793	0.08
Existing	Single Family	Water Heat	Faucet Aerators	3,015	2.5%	9.4%	95.0%	9	$327	0.00
Existing	Single Family	Water Heat	ENERGY STAR Dishwasher	3,015	5.7%	80.0%	71.0%	13	$4,626	0.04
Existing	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	3,015	17.6%	64.0%	94.0%	14	$15728	0.03
Existing	Single Family	Water Heat	ENERGY STAR Clothes Washer – High Efficiency	3,015	11.0%	64.0%	94.0%	14	$22719	0.01
Existing	Single Family	Water Heat	Water Heater Temperature Setback	3,015	3.0%	42.5%	95.0%	5	$4,283	0.01

Table C.43. Residential Measure Details: Utah, Rural

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Central AC	Duct Insulation Upgrade	1,768	3.0%	63.7%	50.0%	20	$11127	0.03
New	Single Family	Central AC	Evaporative coolers	1,768	70.0%	90.0%	100.0%	18	$3	0.45
New	Single Family	Central AC	Cool Roof	1,768	12.0%	85.5%	80.0%	20	$13929	0.18
Existing	Single Family	Central AC	Evaporative coolers	1,691	70.0%	90.0%	100.0%	18	$4	0.62
Existing	Single Family	Central AC	Cool Roof	1,691	12.0%	85.5%	80.0%	20	$34014	0.35
Existing	Single Family	Central AC	Central AC – Premium Efficiency	1,825	6.0%	NA	NA	18	281684	0.54
New	Single Family	Central AC	Central AC – Premium Efficiency	2,129	6.0%	NA	NA	18	$84754	0.49
Existing	Single Family	Central Heat	Check Me Tune-up/Maintenance	11,503	10.0%	63.7%	90.0%	5	$70970	0.18
Existing	Single Family	Central Heat	Check Me Duct Sealing	11,503	5.0%	72.2%	45.0%	20	$18652	0.03
Existing	Single Family	Central Heat	Duct Insulation Upgrade	11,503	3.6%	63.7%	50.0%	20	$12544	0.03
New	Single Family	Central Heat	Windows, ENERGY STAR or better	8,405	5.0%	58.1%	95.0%	20	$6,863	0.03
New	Single Family	Central Heat	VFD Furnace Fan Motor	8,405	9.0%	80.8%	75.0%	20	$10931	0.07
New	Single Family	Central Heat	Duct Insulation Upgrade	8,405	3.6%	63.7%	50.0%	20	$914	0.01
New	Single Family	Central Heat	Air-to-Air Heat Exchangers	8,405	10.0%	85.5%	65.0%	18	$42558	0.06
Existing	Single Family	Central Heat	Whole house air sealing	11,503	28.0%	63.7%	80.0%	10	143023	0.52
Existing	Single Family	Central Heat	Windows, ENERGY STAR or better	11,503	21.0%	58.1%	75.0%	20	$97895	0.27
New	Single Family	Central Heat	ECPM Furnace Fan Motor	8,405	7.5%	85.5%	70.0%	20	$9,071	0.05
Existing	Single Family	Central Heat	VFD Furnace Fan Motor	11,503	10.5%	63.7%	75.0%	20	$24364	0.20
Existing	Single Family	Central Heat	Insulation-Ceiling To Code	11,503	8.0%	75.6%	80.0%	30	$72773	0.09
Existing	Single Family	Central Heat	ECPM Furnace Fan Motor	11,503	7.5%	85.5%	70.0%	20	$25610	0.17
New	Single Family	Central Heat	Whole house air sealing	8,405	16.0%	63.7%	80.0%	10	$24797	0.03
New	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	816	13.8%	NA	NA	18	$17095	0.03
Existing	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	816	13.8%	NA	NA	18	$76976	0.08
Existing	Single Family	Freezer	Removal of Secondary Freezer	511	100.0%	90.3%	60.0%	10	$93725	1.00
New	Single Family	Freezer	Freezer – ENERGY STAR or better	526	10.0%	NA	NA	11	$16003	0.02
Existing	Single Family	Freezer	Freezer – ENERGY STAR or better	526	10.0%	NA	NA	11	122774	0.10
Existing	Single Family	Heat Pump	Check Me Duct Sealing	10,328	5.0%	72.2%	45.0%	20	$1,830	0.00
New	Single Family	Heat Pump	Duct Insulation Upgrade	9,856	3.0%	63.7%	50.0%	20	$77	0.00
New	Single Family	Heat Pump	Air-to-Air Heat Exchangers	9,856	10.0%	85.5%	65.0%	18	$3,830	0.01
Existing	Single Family	Heat Pump	Windows, ENERGY STAR or better	10,328	16.0%	58.1%	75.0%	20	$9,605	0.01
Existing	Single Family	Heat Pump	Whole house air sealing	10,328	21.0%	63.7%	80.0%	10	$14111	0.04
Existing	Single Family	Heat Pump	Insulation-Ceiling To Code	10,328	6.0%	75.6%	80.0%	30	$7,140	0.00
New	Single Family	Heat Pump	Cool Roof	9,856	1.1%	85.5%	80.0%	20	$96	0.00
Existing	Single Family	Heat Pump	Heat Pumps – Service Contracts	10,328	10.0%	72.2%	90.0%	5	$7,854	0.02

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Single Family	Heat Pump	Duct Insulation Upgrade	10,328	3.0%	63.7%	50.0%	20	$1,231	0.00
Existing	Single Family	Heat Pump	Cool Roof	10,328	1.1%	85.5%	80.0%	20	$317	0.00
Existing	Single Family	Heat Pump	ASHP – High Efficiency	11,005	8.0%	NA	NA	15	$11614	0.03
New	Single Family	Heat Pump	ASHP – Premium Efficiency	11,158	5.0%	NA	NA	15	$3,038	0.01
Existing	Single Family	Lighting	CFL Torchieries	2,211	4.2%	84.1%	50.0%	5	$20180	0.25
Existing	Single Family	Lighting	CFL Lamps	2,211	63.6%	73.2%	80.0%	6	619902	4.64
Existing	Single Family	Lighting	CFL Fixtures	2,211	7.5%	84.1%	80.0%	16	121746	0.71
New	Single Family	Lighting	LED Interior Lighting	2,464	79.1%	88.8%	65.0%	12	137366	0.35
New	Single Family	Lighting	CFL Torchieries	2,464	4.2%	84.1%	50.0%	5	$9,655	0.12
New	Single Family	Lighting	CFL Lamps	2,464	63.6%	73.2%	80.0%	6	291464	2.29
New	Single Family	Lighting	CFL Fixtures	2,464	7.5%	84.1%	80.0%	16	$53807	0.35
Existing	Single Family	Lighting	LED Interior Lighting	2,211	79.1%	88.8%	65.0%	12	350218	0.73
Existing	Single Family	Plug Load	1-Watt Standby Power	4,829	4.0%	71.2%	21.0%	7	$3,891	0.02
New	Single Family	Plug Load	Power Supply Transformer/Converter	4,829	0.3%	80.8%	80.0%	7	$21	0.03
New	Single Family	Plug Load	Efficient DVD systems	4,829	0.1%	42.5%	95.0%	7	$13	0.01
New	Single Family	Plug Load	1-Watt Standby Power	4,829	4.0%	71.2%	21.0%	7	$1,426	0.01
Existing	Single Family	Plug Load	Power Supply Transformer/Converter	4,829	0.3%	80.8%	80.0%	7	$55	0.07
Existing	Single Family	Plug Load	Efficient DVD systems	4,829	0.1%	42.5%	95.0%	7	$35	0.01
Existing	Single Family	Refrigerator	1 kWh/day Refrigerator	476	30.1%	90.3%	90.0%	18	$96954	0.11
New	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	466	14.7%	71.0%	100.0%	18	$69839	0.02
New	Single Family	Refrigerator	1 kWh/day Refrigerator	466	30.1%	90.3%	90.0%	18	$29961	0.03
Existing	Single Family	Refrigerator	Removal of Secondary Refrigerator	476	100.0%	90.3%	2.0%	10	$8,982	0.08
Existing	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	476	14.7%	71.0%	100.0%	18	225997	0.14
Existing	Single Family	Room AC	Cool Roof	1,028	12.0%	85.5%	80.0%	20	$1,546	0.01
New	Single Family	Room AC	Cool Roof	1,069	12.0%	85.5%	80.0%	20	$218	0.00
New	Single Family	Room Heat	Windows, ENERGY STAR or better	6,472	5.0%	58.1%	95.0%	20	$2,125	0.01
Existing	Single Family	Room Heat	Windows, ENERGY STAR or better	8,858	21.0%	58.1%	75.0%	20	$33101	0.04
Existing	Single Family	Room Heat	Whole house air sealing	8,858	28.0%	63.7%	80.0%	10	$49768	0.13
Existing	Single Family	Room Heat	Insulation-Ceiling To Code	8,858	10.0%	75.6%	80.0%	30	$24607	0.04
Existing	Single Family	Room Heat	Ductless Heat Pump	8,858	32.0%	98.0%	40.0%	15	$38051	0.13
New	Single Family	Water Heat	Water Heater Temperature Setback	2,679	3.0%	42.5%	95.0%	5	$3,209	0.01
New	Single Family	Water Heat	High Efficiency Water Heater	2,679	2.2%	80.8%	100.0%	10	$6,540	0.01
New	Single Family	Water Heat	Heat Trap	2,679	10.0%	63.7%	70.0%	15	$7,891	0.04
New	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	2,679	17.6%	67.0%	91.0%	14	$10523	0.01
New	Single Family	Water Heat	ENERGY STAR Dishwasher	2,679	5.7%	80.0%	77.0%	13	$3,818	0.03
New	Single Family	Water Heat	Drain Water Heat Recovery (GFX)	2,679	20.0%	98.0%	45.0%	15	$22185	0.05

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Single Family	Water Heat	Water Heater Temperature Setback	2,681	3.0%	42.5%	95.0%	5	$7,669	0.02
Existing	Single Family	Water Heat	Low-Flow Showerheads	2,681	12.5%	30.6%	95.0%	10	$4,206	0.08
Existing	Single Family	Water Heat	Heat Trap	2,681	10.0%	76.5%	95.0%	15	$32211	0.14
Existing	Single Family	Water Heat	Faucet Aerators	2,681	2.5%	11.9%	95.0%	9	$846	0.01
Existing	Single Family	Water Heat	ENERGY STAR Dishwasher	2,681	5.7%	80.0%	77.0%	13	$9,660	0.07
Existing	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	2,681	17.6%	67.0%	91.0%	14	$30940	0.03

Table C.44. Residential Measure Details: Utah, Urban

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Central AC	Evaporative coolers	1,768	70.0%	90.0%	100.0%	18	$12	2.00
New	Single Family	Central AC	Duct Insulation Upgrade	1,768	3.0%	63.7%	50.0%	20	$50038	0.13
New	Single Family	Central AC	Cool Roof	1,768	12.0%	85.5%	80.0%	20	$62636	0.80
Existing	Single Family	Central AC	Evaporative coolers	1,691	70.0%	90.0%	100.0%	18	$19	2.79
Existing	Single Family	Central AC	Cool Roof	1,691	12.0%	85.5%	80.0%	20	152956	1.59
New	Single Family	Central AC	Central AC – Premium Efficiency	2,129	6.0%	NA	NA	18	381130	2.20
Existing	Single Family	Central AC	Central AC – Premium Efficiency	1,825	6.0%	NA	NA	18	1.27E6	2.44
New	Single Family	Central Heat	Windows, ENERGY STAR or better	8,405	5.0%	58.1%	95.0%	20	$30862	0.14
New	Single Family	Central Heat	Whole house air sealing	8,405	16.0%	63.7%	80.0%	10	111509	0.11
New	Single Family	Central Heat	VFD Furnace Fan Motor	8,405	9.0%	80.8%	75.0%	20	$49157	0.31
New	Single Family	Central Heat	ECPM Furnace Fan Motor	8,405	7.5%	85.5%	70.0%	20	$40793	0.24
New	Single Family	Central Heat	Duct Insulation Upgrade	8,405	3.6%	63.7%	50.0%	20	$4,112	0.07
New	Single Family	Central Heat	Air-to-Air Heat Exchangers	8,405	10.0%	85.5%	65.0%	18	191377	0.28
Existing	Single Family	Central Heat	Windows, ENERGY STAR or better	11,503	21.0%	58.1%	75.0%	20	440222	1.22
Existing	Single Family	Central Heat	Whole house air sealing	11,503	28.0%	63.7%	80.0%	10	643160	2.35
Existing	Single Family	Central Heat	VFD Furnace Fan Motor	11,503	10.5%	63.7%	75.0%	20	109562	0.91
Existing	Single Family	Central Heat	Duct Insulation Upgrade	11,503	3.6%	63.7%	50.0%	20	$56410	0.12
Existing	Single Family	Central Heat	ECPM Furnace Fan Motor	11,503	7.5%	85.5%	70.0%	20	115166	0.77
Existing	Single Family	Central Heat	Insulation-Ceiling To Code	11,503	8.0%	75.6%	80.0%	30	327251	0.40
Existing	Single Family	Central Heat	Check Me Duct Sealing	11,503	5.0%	72.2%	45.0%	20	$83877	0.15
Existing	Single Family	Central Heat	Check Me Tune-up/Maintenance	11,503	10.0%	63.7%	90.0%	5	319144	0.81

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	816	13.8%	NA	NA	18	$76874	0.16
Existing	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	816	13.8%	NA	NA	18	346152	0.35
Existing	Single Family	Freezer	Removal of Secondary Freezer	511	100.0%	90.3%	60.0%	10	421470	4.48
New	Single Family	Freezer	Freezer – ENERGY STAR or better	526	10.0%	NA	NA	11	$71963	0.09
Existing	Single Family	Freezer	Freezer – ENERGY STAR or better	526	10.0%	NA	NA	11	552102	0.44
New	Single Family	Heat Pump	Duct Insulation Upgrade	9,856	3.0%	63.7%	50.0%	20	$346	0.01
New	Single Family	Heat Pump	Cool Roof	9,856	1.1%	85.5%	80.0%	20	$433	0.00
New	Single Family	Heat Pump	Air-to-Air Heat Exchangers	9,856	10.0%	85.5%	65.0%	18	$17224	0.03
Existing	Single Family	Heat Pump	Windows, ENERGY STAR or better	10,328	16.0%	58.1%	75.0%	20	$43192	0.06
Existing	Single Family	Heat Pump	Whole house air sealing	10,328	21.0%	63.7%	80.0%	10	$63456	0.16
Existing	Single Family	Heat Pump	Insulation-Ceiling To Code	10,328	6.0%	75.6%	80.0%	30	$32108	0.01
Existing	Single Family	Heat Pump	Duct Insulation Upgrade	10,328	3.0%	63.7%	50.0%	20	$5,535	0.01
Existing	Single Family	Heat Pump	Cool Roof	10,328	1.1%	85.5%	80.0%	20	$1,426	0.01
Existing	Single Family	Heat Pump	Check Me Duct Sealing	10,328	5.0%	72.2%	45.0%	20	$8,229	0.02
Existing	Single Family	Heat Pump	Heat Pumps – Service Contracts	10,328	10.0%	72.2%	90.0%	5	$35317	0.10
New	Single Family	Heat Pump	ASHP – Premium Efficiency	11,158	5.0%	NA	NA	15	$13661	0.05
Existing	Single Family	Heat Pump	ASHP – High Efficiency	11,005	8.0%	NA	NA	15	$52228	0.11
New	Single Family	Lighting	LED Interior Lighting	2,464	79.1%	88.8%	65.0%	12	617719	1.56
New	Single Family	Lighting	CFL Torchieries	2,464	4.2%	84.1%	50.0%	5	$43417	0.56
New	Single Family	Lighting	CFL Lamps	2,464	63.6%	73.2%	80.0%	6	1.31E6	10.28
New	Single Family	Lighting	CFL Fixtures	2,464	7.5%	84.1%	80.0%	16	241966	1.56
Existing	Single Family	Lighting	LED Interior Lighting	2,211	79.1%	88.8%	65.0%	12	1.57E6	3.28
Existing	Single Family	Lighting	CFL Torchieries	2,211	4.2%	84.1%	50.0%	5	$90747	1.13
Existing	Single Family	Lighting	CFL Lamps	2,211	63.6%	73.2%	80.0%	6	2.79E6	20.86
Existing	Single Family	Lighting	CFL Fixtures	2,211	7.5%	84.1%	80.0%	16	547478	3.19
New	Single Family	Plug Load	Power Supply Transformer/Converter	4,829	0.3%	80.8%	80.0%	7	$96	0.13
New	Single Family	Plug Load	Efficient DVD systems	4,829	0.1%	42.5%	95.0%	7	$60	0.02
New	Single Family	Plug Load	1-Watt Standby Power	4,829	4.0%	71.2%	21.0%	7	$6,410	0.03
Existing	Single Family	Plug Load	Power Supply Transformer/Converter	4,829	0.3%	80.8%	80.0%	7	$249	0.31
Existing	Single Family	Plug Load	Efficient DVD systems	4,829	0.1%	42.5%	95.0%	7	$156	0.05
Existing	Single Family	Plug Load	1-Watt Standby Power	4,829	4.0%	71.2%	21.0%	7	$17497	0.07
New	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	466	14.7%	71.0%	100.0%	18	314059	0.09
New	Single Family	Refrigerator	1 kWh/day Refrigerator	466	30.1%	90.3%	90.0%	18	134733	0.16
Existing	Single Family	Refrigerator	Removal of Secondary Refrigerator	476	100.0%	90.3%	2.0%	10	$40392	0.34
Existing	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	476	14.7%	71.0%	100.0%	18	1.02E6	0.61

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Single Family	Refrigerator	1 kWh/day Refrigerator	476	30.1%	90.3%	90.0%	18	435991	0.51
New	Single Family	Room AC	Cool Roof	1,069	12.0%	85.5%	80.0%	20	$980	0.01
Existing	Single Family	Room AC	Cool Roof	1,028	12.0%	85.5%	80.0%	20	$6,953	0.04
New	Single Family	Room Heat	Windows, ENERGY STAR or better	6,472	5.0%	58.1%	95.0%	20	$9,558	0.04
Existing	Single Family	Room Heat	Windows, ENERGY STAR or better	8,858	21.0%	58.1%	75.0%	20	148852	0.19
Existing	Single Family	Room Heat	Whole house air sealing	8,858	28.0%	63.7%	80.0%	10	223802	0.59
Existing	Single Family	Room Heat	Insulation-Ceiling To Code	8,858	10.0%	75.6%	80.0%	30	110653	0.19
Existing	Single Family	Room Heat	Ductless Heat Pump	8,858	32.0%	98.0%	40.0%	15	171110	0.60
New	Single Family	Water Heat	Water Heater Temperature Setback	2,679	3.0%	42.5%	95.0%	5	$14433	0.05
New	Single Family	Water Heat	High Efficiency Water Heater	2,679	2.2%	80.8%	100.0%	10	$29410	0.04
New	Single Family	Water Heat	Heat Trap	2,679	10.0%	63.7%	70.0%	15	$35485	0.18
New	Single Family	Water Heat	ENERGY STAR Dishwasher	2,679	5.7%	80.0%	77.0%	13	$17169	0.14
New	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	2,679	17.6%	67.0%	91.0%	14	$47320	0.04
New	Single Family	Water Heat	Drain Water Heat Recovery (GFX)	2,679	20.0%	98.0%	45.0%	15	$99763	0.23
Existing	Single Family	Water Heat	Water Heater Temperature Setback	2,681	3.0%	42.5%	95.0%	5	$34485	0.10
Existing	Single Family	Water Heat	Low-Flow Showerheads	2,681	12.5%	30.6%	95.0%	10	$18913	0.35
Existing	Single Family	Water Heat	Heat Trap	2,681	10.0%	76.5%	95.0%	15	144849	0.65
Existing	Single Family	Water Heat	Faucet Aerators	2,681	2.5%	11.9%	95.0%	9	$3,807	0.03
Existing	Single Family	Water Heat	ENERGY STAR Dishwasher	2,681	5.7%	80.0%	77.0%	13	$43440	0.32
Existing	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	2,681	17.6%	67.0%	91.0%	14	139134	0.13

Table C.45. Residential Measure Details: Washington, Rural

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Central AC	Evaporative coolers	1,225	70.0%	90.0%	100.0%	18	$0	0.02
New	Single Family	Central AC	Cool Roof	1,225	12.0%	85.5%	80.0%	20	$962	0.01
Existing	Single Family	Central AC	Evaporative coolers	1,218	70.0%	90.0%	100.0%	18	$1	0.14
Existing	Single Family	Central AC	Cool Roof	1,218	12.0%	85.5%	80.0%	20	$12085	0.08
New	Single Family	Central Heat	Windows, ENERGY STAR or better	9,747	5.0%	63.3%	95.0%	20	$2,407	0.01
New	Single Family	Central Heat	VFD Furnace Fan Motor	9,747	9.0%	80.8%	75.0%	20	$3,523	0.02

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Central Heat	ECPM Furnace Fan Motor	9,747	7.5%	85.5%	70.0%	20	$2,924	0.02
New	Single Family	Central Heat	Duct Insulation Upgrade	9,747	3.6%	48.0%	50.0%	20	$222	0.00
New	Single Family	Central Heat	Air-to-Air Heat Exchangers	9,747	10.0%	85.5%	65.0%	18	$6,213	0.01
Existing	Single Family	Central Heat	Windows, ENERGY STAR or better	13,602	21.0%	63.3%	75.0%	20	112841	0.36
Existing	Single Family	Central Heat	Whole house air sealing	13,602	28.0%	53.3%	80.0%	10	140892	0.49
Existing	Single Family	Central Heat	VFD Furnace Fan Motor	13,602	10.5%	63.7%	75.0%	20	$25805	0.24
Existing	Single Family	Central Heat	Insulation-Ceiling To Code	13,602	8.0%	75.8%	80.0%	30	$84704	0.10
Existing	Single Family	Central Heat	ECPM Furnace Fan Motor	13,602	7.5%	85.5%	70.0%	20	$27125	0.20
Existing	Single Family	Central Heat	Duct Insulation Upgrade	13,602	3.6%	48.0%	50.0%	20	$13318	0.01
Existing	Single Family	Central Heat	Check Me Tune-up/Maintenance	13,602	10.0%	63.7%	90.0%	5	$71686	0.25
Existing	Single Family	Central Heat	Check Me Duct Sealing	13,602	5.0%	72.2%	45.0%	20	$19756	0.04
New	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	919	13.8%	NA	NA	18	$2,228	0.00
Existing	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	919	13.8%	NA	NA	18	$25196	0.03
Existing	Single Family	Freezer	Removal of Secondary Freezer	577	100.0%	90.3%	70.0%	10	$73941	0.57
New	Single Family	Freezer	Freezer – ENERGY STAR or better	593	10.0%	NA	NA	11	$2,224	0.00
Existing	Single Family	Freezer	Freezer – ENERGY STAR or better	593	10.0%	NA	NA	11	$41156	0.03
New	Single Family	Heat Pump	Duct Insulation Upgrade	8,159	3.0%	48.0%	50.0%	20	$157	0.00
New	Single Family	Heat Pump	Cool Roof	8,159	1.1%	85.5%	80.0%	20	$260	0.00
New	Single Family	Heat Pump	Air-to-Air Heat Exchangers	8,159	10.0%	85.5%	65.0%	18	$4,385	0.01
Existing	Single Family	Heat Pump	Windows, ENERGY STAR or better	10,838	16.0%	63.3%	75.0%	20	$84241	0.11
Existing	Single Family	Heat Pump	Whole house air sealing	10,838	21.0%	53.3%	80.0%	10	116639	0.21
Existing	Single Family	Heat Pump	Heat Pumps – Service Contracts	10,838	10.0%	72.2%	90.0%	5	$71044	0.20
Existing	Single Family	Heat Pump	Cool Roof	10,838	1.1%	85.5%	80.0%	20	$2,555	0.02
Existing	Single Family	Heat Pump	Check Me Duct Sealing	10,838	5.0%	72.2%	45.0%	20	$14748	0.04
New	Single Family	Heat Pump	ASHP – High Efficiency	8,861	8.0%	NA	NA	15	$5,233	0.01
Existing	Single Family	Heat Pump	ASHP – High Efficiency	11,446	8.0%	NA	NA	15	$71609	0.15
New	Single Family	Lighting	LED Interior Lighting	2,491	79.1%	88.8%	65.0%	12	$16707	0.03
New	Single Family	Lighting	CFL Torchieries	2,491	4.2%	84.1%	50.0%	5	$928	0.01
New	Single Family	Lighting	CFL Lamps	2,491	63.6%	73.8%	80.0%	6	$31600	0.23
New	Single Family	Lighting	CFL Fixtures	2,491	7.5%	84.1%	80.0%	16	$6,478	0.03
Existing	Single Family	Lighting	LED Interior Lighting	2,242	79.1%	88.8%	65.0%	12	137632	0.29
Existing	Single Family	Lighting	CFL Torchieries	2,242	4.2%	84.1%	50.0%	5	$7,695	0.10
Existing	Single Family	Lighting	CFL Lamps	2,242	63.6%	73.8%	80.0%	6	234719	1.78
Existing	Single Family	Lighting	CFL Fixtures	2,242	7.5%	84.1%	80.0%	16	$46242	0.27
New	Single Family	Plug Load	Power Supply Transformer/Converter	5,441	0.3%	80.8%	80.0%	7	$2	0.00

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Plug Load	Efficient DVD systems	5,441	0.1%	42.5%	95.0%	7	$1	0.00
New	Single Family	Plug Load	1-Watt Standby Power	5,441	4.0%	71.2%	21.0%	7	$152	0.00
Existing	Single Family	Plug Load	Power Supply Transformer/Converter	5,441	0.3%	80.8%	80.0%	7	$21	0.03
Existing	Single Family	Plug Load	Efficient DVD systems	5,441	0.1%	42.5%	95.0%	7	$13	0.01
Existing	Single Family	Plug Load	1-Watt Standby Power	5,441	4.0%	71.2%	21.0%	7	$1,479	0.01
New	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	525	14.7%	66.0%	100.0%	18	$6,764	0.00
New	Single Family	Refrigerator	1 kWh/day Refrigerator	525	30.1%	90.3%	90.0%	18	$3,122	0.00
Existing	Single Family	Refrigerator	Removal of Secondary Refrigerator	536	100.0%	90.3%	7.0%	10	$17094	0.10
Existing	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	536	14.7%	66.0%	100.0%	18	$78085	0.04
Existing	Single Family	Refrigerator	1 kWh/day Refrigerator	536	30.1%	90.3%	90.0%	18	$36036	0.04
New	Single Family	Room AC	Cool Roof	637	12.0%	85.5%	80.0%	20	$321	0.00
Existing	Single Family	Room AC	Cool Roof	687	12.0%	85.5%	80.0%	20	$5,912	0.02
New	Single Family	Room Heat	Windows, ENERGY STAR or better	7,505	5.0%	63.3%	95.0%	20	$2,265	0.01
Existing	Single Family	Room Heat	Windows, ENERGY STAR or better	10,474	21.0%	63.3%	75.0%	20	108345	0.20
Existing	Single Family	Room Heat	Whole house air sealing	10,474	28.0%	53.3%	80.0%	10	140421	0.35
Existing	Single Family	Room Heat	Insulation-Ceiling To Code	10,474	10.0%	75.8%	80.0%	30	$81329	0.10
Existing	Single Family	Room Heat	Ductless Heat Pump	10,474	32.0%	98.0%	40.0%	15	111399	0.47
New	Single Family	Water Heat	Water Heater Temperature Setback	2,813	3.0%	42.5%	95.0%	5	$2,014	0.00
New	Single Family	Water Heat	High Efficiency Water Heater	2,813	2.2%	80.8%	100.0%	10	$3,802	0.00
New	Single Family	Water Heat	Heat Trap	2,813	10.0%	63.7%	70.0%	15	$6,721	0.02
New	Single Family	Water Heat	ENERGY STAR Dishwasher	2,813	5.7%	78.0%	69.0%	13	$2,086	0.02
New	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	2,813	17.6%	55.0%	95.0%	14	$6,308	0.00
New	Single Family	Water Heat	Drain Water Heat Recovery (GFX)	2,813	20.0%	98.0%	45.0%	15	$17691	0.02
Existing	Single Family	Water Heat	Water Heater Temperature Setback	2,815	3.0%	42.5%	95.0%	5	$19758	0.04
Existing	Single Family	Water Heat	Low-Flow Showerheads	2,815	12.5%	34.5%	95.0%	10	$10846	0.20
Existing	Single Family	Water Heat	Heat Trap	2,815	10.0%	76.5%	95.0%	15	$94104	0.33
Existing	Single Family	Water Heat	Faucet Aerators	2,815	2.5%	17.4%	95.0%	9	$2,744	0.02
Existing	Single Family	Water Heat	ENERGY STAR Dishwasher	2,815	5.7%	78.0%	69.0%	13	$19364	0.14
Existing	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	2,815	17.6%	55.0%	95.0%	14	$62706	0.03

Table C.46. Residential Measure Details: Washington, Urban

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Single Family	Central AC	Evaporative coolers	1,218	70.0%	90.0%	100.0%	18	$1	0.15
Existing	Single Family	Central AC	Cool Roof	1,218	12.0%	85.5%	80.0%	20	$12833	0.08
New	Single Family	Central AC	Evaporative coolers	1,225	70.0%	90.0%	100.0%	18	$0	0.02
New	Single Family	Central AC	Cool Roof	1,225	12.0%	85.5%	80.0%	20	$1,022	0.01
New	Single Family	Central Heat	Air-to-Air Heat Exchangers	9,747	10.0%	85.5%	65.0%	18	$6,597	0.01
Existing	Single Family	Central Heat	Windows, ENERGY STAR or better	13,602	21.0%	63.3%	75.0%	20	119827	0.38
Existing	Single Family	Central Heat	Whole house air sealing	13,602	28.0%	53.3%	80.0%	10	149614	0.52
Existing	Single Family	Central Heat	VFD Furnace Fan Motor	13,602	10.5%	63.7%	75.0%	20	$27403	0.25
Existing	Single Family	Central Heat	Insulation-Ceiling To Code	13,602	8.0%	75.8%	80.0%	30	$89948	0.10
Existing	Single Family	Central Heat	ECPM Furnace Fan Motor	13,602	7.5%	85.5%	70.0%	20	$28804	0.22
Existing	Single Family	Central Heat	Duct Insulation Upgrade	13,602	3.6%	48.0%	50.0%	20	$14142	0.01
Existing	Single Family	Central Heat	Check Me Tune-up/Maintenance	13,602	10.0%	63.7%	90.0%	5	$76124	0.26
Existing	Single Family	Central Heat	Check Me Duct Sealing	13,602	5.0%	72.2%	45.0%	20	$20978	0.04
New	Single Family	Central Heat	Windows, ENERGY STAR or better	9,747	5.0%	63.3%	95.0%	20	$2,556	0.01
New	Single Family	Central Heat	VFD Furnace Fan Motor	9,747	9.0%	80.8%	75.0%	20	$3,741	0.02
New	Single Family	Central Heat	ECPM Furnace Fan Motor	9,747	7.5%	85.5%	70.0%	20	$3,105	0.02
New	Single Family	Central Heat	Duct Insulation Upgrade	9,747	3.6%	48.0%	50.0%	20	$236	0.00
Existing	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	919	13.8%	NA	NA	18	$26756	0.03
New	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	919	13.8%	NA	NA	18	$2,366	0.00
Existing	Single Family	Freezer	Removal of Secondary Freezer	577	100.0%	90.3%	70.0%	10	$78518	0.60
Existing	Single Family	Freezer	Freezer - ENERGY STAR or better	593	10.0%	NA	NA	11	$43704	0.04
New	Single Family	Freezer	Freezer - ENERGY STAR or better	593	10.0%	NA	NA	11	$2,362	0.00
New	Single Family	Heat Pump	Air-to-Air Heat Exchangers	8,159	10.0%	85.5%	65.0%	18	$4,656	0.01
Existing	Single Family	Heat Pump	Windows, ENERGY STAR or better	10,838	16.0%	63.3%	75.0%	20	$89456	0.12
Existing	Single Family	Heat Pump	Whole house air sealing	10,838	21.0%	53.3%	80.0%	10	123859	0.23
Existing	Single Family	Heat Pump	Heat Pumps - Service Contracts	10,838	10.0%	72.2%	90.0%	5	$75442	0.22
Existing	Single Family	Heat Pump	Cool Roof	10,838	1.1%	85.5%	80.0%	20	$2,713	0.02
Existing	Single Family	Heat Pump	Check Me Duct Sealing	10,838	5.0%	72.2%	45.0%	20	$15661	0.04
New	Single Family	Heat Pump	Duct Insulation Upgrade	8,159	3.0%	48.0%	50.0%	20	$166	0.00
New	Single Family	Heat Pump	Cool Roof	8,159	1.1%	85.5%	80.0%	20	$276	0.00
New	Single Family	Heat Pump	ASHP - High Efficiency	8,861	8.0%	NA	NA	15	$5,557	0.01
Existing	Single Family	Heat Pump	ASHP - High Efficiency	11,446	8.0%	NA	NA	15	$76041	0.16
Existing	Single Family	Lighting	LED Interior Lighting	2,242	79.1%	88.8%	65.0%	12	146151	0.30
Existing	Single Family	Lighting	CFL Torchieries	2,242	4.2%	84.1%	50.0%	5	$8,171	0.10
Existing	Single Family	Lighting	CFL Lamps	2,242	63.6%	73.8%	80.0%	6	249249	1.89
Existing	Single Family	Lighting	CFL Fixtures	2,242	7.5%	84.1%	80.0%	16	$49105	0.29

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Lighting	LED Interior Lighting	2,491	79.1%	88.8%	65.0%	12	$17741	0.03
New	Single Family	Lighting	CFL Torchieries	2,491	4.2%	84.1%	50.0%	5	$986	0.01
New	Single Family	Lighting	CFL Lamps	2,491	63.6%	73.8%	80.0%	6	$33556	0.25
New	Single Family	Lighting	CFL Fixtures	2,491	7.5%	84.1%	80.0%	16	$6,880	0.04
New	Single Family	Plug Load	1-Watt Standby Power	5,441	4.0%	71.2%	21.0%	7	$161	0.00
Existing	Single Family	Plug Load	Power Supply Transformer/Converter	5,441	0.3%	80.8%	80.0%	7	$22	0.03
Existing	Single Family	Plug Load	Efficient DVD systems	5,441	0.1%	42.5%	95.0%	7	$14	0.01
Existing	Single Family	Plug Load	1-Watt Standby Power	5,441	4.0%	71.2%	21.0%	7	$1,570	0.01
New	Single Family	Plug Load	Power Supply Transformer/Converter	5,441	0.3%	80.8%	80.0%	7	$2	0.00
New	Single Family	Plug Load	Efficient DVD systems	5,441	0.1%	42.5%	95.0%	7	$1	0.00
New	Single Family	Refrigerator	1 kWh/day Refrigerator	525	30.1%	90.3%	90.0%	18	$3,315	0.00
Existing	Single Family	Refrigerator	Removal of Secondary Refrigerator	536	100.0%	90.3%	7.0%	10	$18153	0.11
Existing	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	536	14.7%	66.0%	100.0%	18	$82918	0.05
Existing	Single Family	Refrigerator	1 kWh/day Refrigerator	536	30.1%	90.3%	90.0%	18	$38267	0.05
New	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	525	14.7%	66.0%	100.0%	18	$7,183	0.00
Existing	Single Family	Room AC	Cool Roof	687	12.0%	85.5%	80.0%	20	$6,278	0.03
New	Single Family	Room AC	Cool Roof	637	12.0%	85.5%	80.0%	20	$341	0.00
Existing	Single Family	Room Heat	Windows, ENERGY STAR or better	10,474	21.0%	63.3%	75.0%	20	115052	0.22
Existing	Single Family	Room Heat	Whole house air sealing	10,474	28.0%	53.3%	80.0%	10	149113	0.38
Existing	Single Family	Room Heat	Insulation-Ceiling To Code	10,474	10.0%	75.8%	80.0%	30	$86364	0.10
Existing	Single Family	Room Heat	Ductless Heat Pump	10,474	32.0%	98.0%	40.0%	15	118295	0.49
New	Single Family	Room Heat	Windows, ENERGY STAR or better	7,505	5.0%	63.3%	95.0%	20	$2,405	0.01
Existing	Single Family	Water Heat	Water Heater Temperature Setback	2,815	3.0%	42.5%	95.0%	5	$20981	0.04
Existing	Single Family	Water Heat	Low-Flow Showerheads	2,815	12.5%	34.5%	95.0%	10	$11517	0.21
Existing	Single Family	Water Heat	Heat Trap	2,815	10.0%	76.5%	95.0%	15	$99929	0.35
Existing	Single Family	Water Heat	Faucet Aerators	2,815	2.5%	17.4%	95.0%	9	$2,914	0.02
Existing	Single Family	Water Heat	ENERGY STAR Dishwasher	2,815	5.7%	78.0%	69.0%	13	$20563	0.15
Existing	Single Family	Water Heat	ENERGY STAR Clothes Washer - Premium Efficiency	2,815	17.6%	55.0%	95.0%	14	$66587	0.03
New	Single Family	Water Heat	Water Heater Temperature Setback	2,813	3.0%	42.5%	95.0%	5	$2,139	0.00
New	Single Family	Water Heat	High Efficiency Water Heater	2,813	2.2%	80.8%	100.0%	10	$4,037	0.00
New	Single Family	Water Heat	Heat Trap	2,813	10.0%	63.7%	70.0%	15	$7,137	0.03
New	Single Family	Water Heat	ENERGY STAR Dishwasher	2,813	5.7%	78.0%	69.0%	13	$2,216	0.02
New	Single Family	Water Heat	ENERGY STAR Clothes Washer - Premium Efficiency	2,813	17.6%	55.0%	95.0%	14	$6,698	0.00
New	Single Family	Water Heat	Drain Water Heat Recovery (GFX)	2,813	20.0%	98.0%	45.0%	15	$18786	0.02

Table C.47. Residential Measure Details: Wyoming, Rural

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Central AC	Evaporative coolers	672	70.0%	90.0%	100.0%	18	$0	0.04
New	Single Family	Central AC	Cool Roof	672	12.0%	85.5%	80.0%	20	$6,149	0.02
Existing	Single Family	Central AC	Evaporative coolers	643	70.0%	90.0%	100.0%	18	$1	0.04
Existing	Single Family	Central AC	Cool Roof	643	12.0%	85.5%	80.0%	20	$6,431	0.02
New	Single Family	Central Heat	Windows, ENERGY STAR or better	12,748	5.0%	46.9%	95.0%	20	$2,960	0.01
New	Single Family	Central Heat	Whole house air sealing	12,748	16.0%	63.7%	80.0%	10	$22983	0.04
New	Single Family	Central Heat	VFD Furnace Fan Motor	12,748	9.0%	80.8%	75.0%	20	$5,837	0.03
New	Single Family	Central Heat	Insulation-Ceiling Above Code	12,748	2.0%	76.8%	80.0%	30	$4,419	0.00
New	Single Family	Central Heat	ENERGY STAR New Construction – Site Built	12,748	36.0%	90.3%	50.0%	25	$67481	0.02
New	Single Family	Central Heat	ECPM Furnace Fan Motor	12,748	7.5%	85.5%	70.0%	20	$4,844	0.02
New	Single Family	Central Heat	Duct Insulation Upgrade	12,748	3.6%	63.7%	50.0%	20	$488	0.01
New	Single Family	Central Heat	Air-to-Air Heat Exchangers	12,748	10.0%	85.5%	65.0%	18	$9,304	0.03
Existing	Single Family	Central Heat	Windows, ENERGY STAR or better	16,879	21.0%	46.9%	75.0%	20	$30617	0.12
Existing	Single Family	Central Heat	Whole house air sealing	16,879	28.0%	63.7%	80.0%	10	$53320	0.29
Existing	Single Family	Central Heat	VFD Furnace Fan Motor	16,879	10.5%	63.7%	75.0%	20	$9,434	0.11
Existing	Single Family	Central Heat	Insulation-Floor	16,879	5.3%	86.8%	55.0%	30	$22985	0.02
Existing	Single Family	Central Heat	Insulation-Ceiling To Code	16,879	8.0%	76.8%	80.0%	30	$28369	0.07
Existing	Single Family	Central Heat	ECPM Furnace Fan Motor	16,879	7.5%	85.5%	70.0%	20	$9,917	0.09
Existing	Single Family	Central Heat	Duct Insulation Upgrade	16,879	3.6%	63.7%	50.0%	20	$4,703	0.02
Existing	Single Family	Central Heat	Check Me Tune-up/Maintenance	16,879	10.0%	63.7%	90.0%	5	$26876	0.10
Existing	Single Family	Central Heat	Check Me Duct Sealing	16,879	5.0%	72.2%	45.0%	20	$7,223	0.02
Existing	Single Family	Central Heat	Below Grade Wall Insulation	16,879	4.0%	72.2%	60.0%	20	$10843	0.02
New	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	868	13.8%	NA	NA	18	$15891	0.02
Existing	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	868	13.8%	NA	NA	18	$38634	0.05
Existing	Single Family	Freezer	Removal of Secondary Freezer	542	100.0%	90.3%	63.0%	10	$60200	0.70
New	Single Family	Freezer	Freezer – ENERGY STAR or better	560	10.0%	NA	NA	11	$16532	0.02
Existing	Single Family	Freezer	Freezer – ENERGY STAR or better	560	10.0%	NA	NA	11	$71270	0.06
New	Single Family	Heat Pump	Duct Insulation Upgrade	8,131	3.0%	63.7%	50.0%	20	$125	0.00
New	Single Family	Heat Pump	Cool Roof	8,131	1.1%	85.5%	80.0%	20	$157	0.00
New	Single Family	Heat Pump	Air-to-Air Heat Exchangers	8,131	10.0%	85.5%	65.0%	18	$2,392	0.00
Existing	Single Family	Heat Pump	Windows, ENERGY STAR or better	10,991	16.0%	46.9%	75.0%	20	$7,248	0.01
Existing	Single Family	Heat Pump	Whole house air sealing	10,991	21.0%	63.7%	80.0%	10	$12939	0.04
Existing	Single Family	Heat Pump	Insulation-Ceiling To Code	10,991	6.0%	76.8%	80.0%	30	$6,716	0.00
Existing	Single Family	Heat Pump	Heat Pumps – Service Contracts	10,991	10.0%	72.2%	90.0%	5	$7,463	0.02
Existing	Single Family	Heat Pump	Duct Insulation Upgrade	10,991	3.0%	63.7%	50.0%	20	$1,113	0.00

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Single Family	Heat Pump	Cool Roof	10,991	1.1%	85.5%	80.0%	20	$296	0.00
Existing	Single Family	Heat Pump	Check Me Duct Sealing	10,991	5.0%	72.2%	45.0%	20	$1,710	0.00
Existing	Single Family	Heat Pump	Advanced Cold-Climate Heat Pump	10,991	24.5%	98.0%	29.0%	15	$1,847	0.00
New	Single Family	Heat Pump	ASHP – High Efficiency	8,792	8.0%	NA	NA	15	$3,204	0.00
Existing	Single Family	Heat Pump	ASHP – Premium Efficiency	11,560	5.0%	NA	NA	15	$14271	0.02
New	Single Family	Lighting	LED Interior Lighting	2,351	79.1%	88.8%	65.0%	12	$93998	0.19
New	Single Family	Lighting	CFL Torchieries	2,351	4.2%	84.1%	50.0%	5	$4,713	0.05
New	Single Family	Lighting	CFL Lamps	2,351	63.6%	72.2%	80.0%	6	103701	0.89
New	Single Family	Lighting	CFL Fixtures	2,351	7.5%	84.1%	80.0%	16	$26040	0.14
Existing	Single Family	Lighting	LED Interior Lighting	2,116	79.1%	88.8%	65.0%	12	173990	0.36
Existing	Single Family	Lighting	CFL Torchieries	2,116	4.2%	84.1%	50.0%	5	$9,952	0.12
Existing	Single Family	Lighting	CFL Lamps	2,116	63.6%	72.2%	80.0%	6	298778	2.24
Existing	Single Family	Lighting	CFL Fixtures	2,116	7.5%	84.1%	80.0%	16	$59793	0.35
New	Single Family	Plug Load	Power Supply Transformer/Converter	5,137	0.3%	80.8%	80.0%	7	$11	0.01
New	Single Family	Plug Load	Efficient DVD systems	5,137	0.1%	42.5%	95.0%	7	$7	0.00
New	Single Family	Plug Load	1-Watt Standby Power	5,137	4.0%	71.2%	21.0%	7	$819	0.00
Existing	Single Family	Plug Load	Power Supply Transformer/Converter	5,137	0.3%	80.8%	80.0%	7	$28	0.04
Existing	Single Family	Plug Load	Efficient DVD systems	5,137	0.1%	42.5%	95.0%	7	$18	0.01
Existing	Single Family	Plug Load	1-Watt Standby Power	5,137	4.0%	71.2%	21.0%	7	$2,007	0.01
New	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	496	14.7%	65.0%	100.0%	18	$32578	0.02
New	Single Family	Refrigerator	1 kWh/day Refrigerator	496	30.1%	90.3%	90.0%	18	$15266	0.01
Existing	Single Family	Refrigerator	Removal of Secondary Refrigerator	506	100.0%	90.3%	7.0%	10	$12966	0.13
Existing	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	506	14.7%	65.0%	100.0%	18	$90250	0.08
Existing	Single Family	Refrigerator	1 kWh/day Refrigerator	506	30.1%	90.3%	90.0%	18	$42292	0.05
New	Single Family	Room AC	Cool Roof	350	12.0%	85.5%	80.0%	20	$838	0.00
Existing	Single Family	Room AC	Cool Roof	362	12.0%	85.5%	80.0%	20	$2,770	0.01
New	Single Family	Room Heat	Windows, ENERGY STAR or better	9,816	5.0%	46.9%	95.0%	20	$7,453	0.02
New	Single Family	Room Heat	Whole house air sealing	9,816	16.0%	63.7%	80.0%	10	$53631	0.07
New	Single Family	Room Heat	Insulation-Ceiling Above Code	9,816	2.0%	76.8%	80.0%	30	$11128	0.01
Existing	Single Family	Room Heat	Windows, ENERGY STAR or better	12,997	21.0%	46.9%	75.0%	20	$76033	0.22
Existing	Single Family	Room Heat	Whole house air sealing	12,997	28.0%	63.7%	80.0%	10	132090	0.53
Existing	Single Family	Room Heat	Insulation-Ceiling To Code	12,997	10.0%	76.8%	80.0%	30	$70452	0.19
Existing	Single Family	Room Heat	Ductless Heat Pump	12,997	32.0%	98.0%	40.0%	15	106149	0.53
Existing	Single Family	Room Heat	Below Grade Wall Insulation	12,997	4.0%	72.2%	60.0%	20	$26927	0.02
New	Single Family	Water Heat	Water Heater Temperature Setback	2,850	3.0%	42.5%	95.0%	5	$3,279	0.01
New	Single Family	Water Heat	High Efficiency Water Heater	2,850	2.2%	80.8%	100.0%	10	$8,318	0.01
New	Single Family	Water Heat	Heat Trap	2,850	10.0%	63.7%	70.0%	15	$8,209	0.04
New	Single Family	Water Heat	ENERGY STAR Dishwasher	2,850	5.7%	82.0%	71.0%	13	$4,204	0.03

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	2,850	17.6%	62.0%	92.0%	14	$17022	0.02
New	Single Family	Water Heat	Drain Water Heat Recovery (GFX)	2,850	20.0%	98.0%	45.0%	15	$53606	0.07
Existing	Single Family	Water Heat	Water Heater Temperature Setback	2,852	3.0%	42.5%	95.0%	5	$8,603	0.03
Existing	Single Family	Water Heat	Low-Flow Showerheads	2,852	12.5%	27.7%	95.0%	10	$4,530	0.09
Existing	Single Family	Water Heat	Heat Trap	2,852	10.0%	76.5%	95.0%	15	$37016	0.18
Existing	Single Family	Water Heat	Faucet Aerators	2,852	2.5%	10.6%	95.0%	9	$933	0.01
Existing	Single Family	Water Heat	ENERGY STAR Dishwasher	2,852	5.7%	82.0%	71.0%	13	$10845	0.09
Existing	Single Family	Water Heat	ENERGY STAR Clothes Washer – Premium Efficiency	2,852	17.6%	62.0%	92.0%	14	$34424	0.04

Table C.48. Residential Measure Details: Wyoming, Urban

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
New	Single Family	Central AC	Evaporative coolers	672	70.0%	90.0%	100.0%	18	$0	0.02
New	Single Family	Central AC	Cool Roof	672	12.0%	85.5%	80.0%	20	$2,635	0.01
Existing	Single Family	Central AC	Evaporative coolers	643	70.0%	90.0%	100.0%	18	$0	0.02
Existing	Single Family	Central AC	Cool Roof	643	12.0%	85.5%	80.0%	20	$2,755	0.01
New	Single Family	Central Heat	Windows, ENERGY STAR or better	12,748	5.0%	46.9%	95.0%	20	$1,268	0.00
New	Single Family	Central Heat	Whole house air sealing	12,748	16.0%	63.7%	80.0%	10	$9,847	0.02
New	Single Family	Central Heat	Insulation-Ceiling Above Code	12,748	2.0%	76.8%	80.0%	30	$1,893	0.00
New	Single Family	Central Heat	ENERGY STAR New Construction - Site Built	12,748	36.0%	90.3%	50.0%	25	$28912	0.01
New	Single Family	Central Heat	ECPM Furnace Fan Motor	12,748	7.5%	85.5%	70.0%	20	$2,075	0.01
New	Single Family	Central Heat	Duct Insulation Upgrade	12,748	3.6%	63.7%	50.0%	20	$209	0.00
New	Single Family	Central Heat	Air-to-Air Heat Exchangers	12,748	10.0%	85.5%	65.0%	18	$3,986	0.01
Existing	Single Family	Central Heat	Windows, ENERGY STAR or better	16,879	21.0%	46.9%	75.0%	20	$13118	0.05
Existing	Single Family	Central Heat	Whole house air sealing	16,879	28.0%	63.7%	80.0%	10	$22845	0.12
Existing	Single Family	Central Heat	VFD Furnace Fan Motor	16,879	10.5%	63.7%	75.0%	20	$4,042	0.05
New	Single Family	Central Heat	VFD Furnace Fan Motor	12,748	9.0%	80.8%	75.0%	20	$2,501	0.01
Existing	Single Family	Central Heat	Insulation-Floor	16,879	5.3%	86.8%	55.0%	30	$9,848	0.01
Existing	Single Family	Central Heat	Insulation-Ceiling To Code	16,879	8.0%	76.8%	80.0%	30	$12155	0.03
Existing	Single Family	Central Heat	ECPM Furnace Fan Motor	16,879	7.5%	85.5%	70.0%	20	$4,249	0.04
Existing	Single Family	Central Heat	Duct Insulation Upgrade	16,879	3.6%	63.7%	50.0%	20	$2,015	0.01
Existing	Single Family	Central Heat	Check Me Tune-up/Maintenance	16,879	10.0%	63.7%	90.0%	5	$11515	0.04

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Single Family	Central Heat	Check Me Duct Sealing	16,879	5.0%	72.2%	45.0%	20	$3,095	0.01
Existing	Single Family	Central Heat	Below Grade Wall Insulation	16,879	4.0%	72.2%	60.0%	20	$4,645	0.01
New	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	868	13.8%	NA	NA	18	$6,809	0.01
Existing	Single Family	Dryer	High Efficiency Dryer w/ Moisture Sensor EF = 3.49	868	13.8%	NA	NA	18	$16553	0.02
Existing	Single Family	Freezer	Removal of Secondary Freezer	542	100.0%	90.3%	63.0%	10	$25793	0.30
New	Single Family	Freezer	Freezer - ENERGY STAR or better	560	10.0%	NA	NA	11	$7,083	0.01
Existing	Single Family	Freezer	Freezer - ENERGY STAR or better	560	10.0%	NA	NA	11	$30536	0.03
New	Single Family	Heat Pump	Duct Insulation Upgrade	8,131	3.0%	63.7%	50.0%	20	$54	0.00
New	Single Family	Heat Pump	Cool Roof	8,131	1.1%	85.5%	80.0%	20	$67	0.00
New	Single Family	Heat Pump	Air-to-Air Heat Exchangers	8,131	10.0%	85.5%	65.0%	18	$1,025	0.00
Existing	Single Family	Heat Pump	Windows, ENERGY STAR or better	10,991	16.0%	46.9%	75.0%	20	$3,106	0.01
Existing	Single Family	Heat Pump	Whole house air sealing	10,991	21.0%	63.7%	80.0%	10	$5,544	0.02
Existing	Single Family	Heat Pump	Insulation-Ceiling To Code	10,991	6.0%	76.8%	80.0%	30	$2,878	0.00
Existing	Single Family	Heat Pump	Heat Pumps - Service Contracts	10,991	10.0%	72.2%	90.0%	5	$3,197	0.01
Existing	Single Family	Heat Pump	Duct Insulation Upgrade	10,991	3.0%	63.7%	50.0%	20	$477	0.00
Existing	Single Family	Heat Pump	Cool Roof	10,991	1.1%	85.5%	80.0%	20	$127	0.00
Existing	Single Family	Heat Pump	Check Me Duct Sealing	10,991	5.0%	72.2%	45.0%	20	$732	0.00
Existing	Single Family	Heat Pump	Advanced Cold-Climate Heat Pump	10,991	24.5%	98.0%	29.0%	15	$791	0.00
New	Single Family	Heat Pump	ASHP - High Efficiency	8,792	8.0%	NA	NA	15	$1,373	0.00
Existing	Single Family	Heat Pump	ASHP - Premium Efficiency	11,560	5.0%	NA	NA	15	$6,114	0.01
New	Single Family	Lighting	LED Interior Lighting	2,351	79.1%	88.8%	65.0%	12	$40274	0.08
New	Single Family	Lighting	CFL Torchieries	2,351	4.2%	84.1%	50.0%	5	$2,019	0.02
New	Single Family	Lighting	CFL Lamps	2,351	63.6%	72.2%	80.0%	6	$44431	0.38
New	Single Family	Lighting	CFL Fixtures	2,351	7.5%	84.1%	80.0%	16	$11157	0.06
Existing	Single Family	Lighting	LED Interior Lighting	2,116	79.1%	88.8%	65.0%	12	$74547	0.15
Existing	Single Family	Lighting	CFL Torchieries	2,116	4.2%	84.1%	50.0%	5	$4,264	0.05
Existing	Single Family	Lighting	CFL Lamps	2,116	63.6%	72.2%	80.0%	6	128012	0.96
Existing	Single Family	Lighting	CFL Fixtures	2,116	7.5%	84.1%	80.0%	16	$25619	0.15
New	Single Family	Plug Load	Power Supply Transformer/Converter	5,137	0.3%	80.8%	80.0%	7	$5	0.01
New	Single Family	Plug Load	Efficient DVD systems	5,137	0.1%	42.5%	95.0%	7	$3	0.00
New	Single Family	Plug Load	1-Watt Standby Power	5,137	4.0%	71.2%	21.0%	7	$351	0.00
Existing	Single Family	Plug Load	Power Supply Transformer/Converter	5,137	0.3%	80.8%	80.0%	7	$12	0.02
Existing	Single Family	Plug Load	Efficient DVD systems	5,137	0.1%	42.5%	95.0%	7	$8	0.00
Existing	Single Family	Plug Load	1-Watt Standby Power	5,137	4.0%	71.2%	21.0%	7	$860	0.00
New	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	496	14.7%	65.0%	100.0%	18	$13958	0.01
New	Single Family	Refrigerator	1 kWh/day Refrigerator	496	30.1%	90.3%	90.0%	18	$6,541	0.01

Construction Vintage	Customer Segment	End Use	Measure Name	Baseline kWh (UEC or EUI)	Savings as % of End Use	% Installations		Measure Life	Measure Cost	2027 Savings (aMW)
						Incom-plete	Techn. Feasible			
Existing	Single Family	Refrigerator	Removal of Secondary Refrigerator	506	100.0%	90.3%	7.0%	10	$5,555	0.05
Existing	Single Family	Refrigerator	Refrigerator, ENERGY STAR or better	506	14.7%	65.0%	100.0%	18	$38668	0.03
Existing	Single Family	Refrigerator	1 kWh/day Refrigerator	506	30.1%	90.3%	90.0%	18	$18120	0.02
New	Single Family	Room AC	Cool Roof	350	12.0%	85.5%	80.0%	20	$359	0.00
Existing	Single Family	Room AC	Cool Roof	362	12.0%	85.5%	80.0%	20	$1,187	0.00
New	Single Family	Room Heat	Windows, ENERGY STAR or better	9,816	5.0%	46.9%	95.0%	20	$3,193	0.01
New	Single Family	Room Heat	Whole house air sealing	9,816	16.0%	63.7%	80.0%	10	$22979	0.03
New	Single Family	Room Heat	Insulation-Ceiling Above Code	9,816	2.0%	76.8%	80.0%	30	$4,768	0.00
Existing	Single Family	Room Heat	Windows, ENERGY STAR or better	12,997	21.0%	46.9%	75.0%	20	$32577	0.09
Existing	Single Family	Room Heat	Whole house air sealing	12,997	28.0%	63.7%	80.0%	10	$56594	0.23
Existing	Single Family	Room Heat	Insulation-Ceiling To Code	12,997	10.0%	76.8%	80.0%	30	$30185	0.08
Existing	Single Family	Room Heat	Ductless Heat Pump	12,997	32.0%	98.0%	40.0%	15	$45480	0.23
Existing	Single Family	Room Heat	Below Grade Wall Insulation	12,997	4.0%	72.2%	60.0%	20	$11537	0.01
New	Single Family	Water Heat	Water Heater Temperature Setback	2,850	3.0%	42.5%	95.0%	5	$1,405	0.00
New	Single Family	Water Heat	High Efficiency Water Heater	2,850	2.2%	80.8%	100.0%	10	$3,564	0.00
New	Single Family	Water Heat	Heat Trap	2,850	10.0%	63.7%	70.0%	15	$3,517	0.02
New	Single Family	Water Heat	ENERGY STAR Dishwasher	2,850	5.7%	82.0%	71.0%	13	$1,801	0.01
New	Single Family	Water Heat	ENERGY STAR Clothes Washer - Premium Efficiency	2,850	17.6%	62.0%	92.0%	14	$7,293	0.01
New	Single Family	Water Heat	Drain Water Heat Recovery (GFX)	2,850	20.0%	98.0%	45.0%	15	$22968	0.03
Existing	Single Family	Water Heat	Water Heater Temperature Setback	2,852	3.0%	42.5%	95.0%	5	$3,686	0.01
Existing	Single Family	Water Heat	Low-Flow Showerheads	2,852	12.5%	27.7%	95.0%	10	$1,941	0.04
Existing	Single Family	Water Heat	Heat Trap	2,852	10.0%	76.5%	95.0%	15	$15860	0.08
Existing	Single Family	Water Heat	Faucet Aerators	2,852	2.5%	10.6%	95.0%	9	$400	0.00
Existing	Single Family	Water Heat	ENERGY STAR Dishwasher	2,852	5.7%	82.0%	71.0%	13	$4,646	0.04
Existing	Single Family	Water Heat	ENERGY STAR Clothes Washer - Premium Efficiency	2,852	17.6%	62.0%	92.0%	14	$14749	0.02

Appendix C.4. Technical Resources: Energy Efficiency Resources, Class 2 DSM Decrement Analysis

This document was provided to Quantec courtesy of PacifiCorp for the purpose of conducting the Class 2 DSM Decrement Analysis.

CLASS 2 DSM DECREMENT ANALYSIS

This section presents the results of the Class 2 demand-side management decrement analysis. For this analysis, the preferred portfolio, RA14, was used to calculate the decrement value of various types of Class 2 programs following the methodology described in Chapter 6. PacifiCorp will use these decrement values when evaluating the cost-effectiveness of potential new programs between IRP cycles. Note that for the next IRP, the company intends to model Class 2 DSM programs as options in the CEM.

Modeling Results

Tables 7.47 and 7.48 shows the nominal results of the 12 decrement cases for each year of the 20-year study period. Although no resources were deferred or eliminated from the portfolio due to the addition of Class 2 decrements, there is value in having to produce less generation to meet a smaller load. Consistent with the results for the 2004 IRP, the residential air conditioning decrements produce the highest value for both the east and west locations. The commercial lighting, residential lighting, and system load shapes provide the lowest avoided costs. Much of their end use shapes reduce loads during a greater percentage of off-peak hours than the other shapes and during all seasons, not just the summer.

Table 7.47 – Annual Nominal Avoided Costs for Decrements, 2010-2017

Decrement Name	Actual Load Factor	Decrement Values (Nominal $/MWh)							
		2010	2011	2012	2013	2014	2015	2016	2017
EAST									
Residential Cooling	7%	113.38	108.78	87.59	102.59	93.54	103.99	109.84	125.48
Residential Lighting	60%	68.98	71.73	59.68	62.57	59.64	64.99	70.69	79.62
Residential Whole House	46%	70.15	72.66	59.42	62.88	60.20	65.45	70.96	80.75
Commercial Cooling	16%	84.24	85.30	69.27	71.34	67.94	73.62	80.28	92.47
Commercial Lighting	49%	68.54	71.97	58.73	61.46	58.68	63.41	69.75	78.65
System Load Shape	65%	65.18	68.16	56.32	59.07	56.47	61.24	67.18	75.95
WEST									
Residential Cooling	20%	53.78	51.87	46.99	48.02	53.67	61.06	64.64	71.75
Residential Heating	28%	39.61	51.06	46.11	41.06	46.09	49.83	58.15	62.73
Residential Lighting	60%	44.34	48.56	43.70	42.10	47.45	52.78	58.20	64.16
Commercial Cooling	16%	51.66	51.53	46.13	45.39	50.85	56.96	61.81	68.73
Commercial Lighting	49%	43.70	49.34	44.49	42.02	47.47	53.32	59.31	64.67
System Load Shape	67%	43.30	47.26	42.03	40.37	45.83	50.94	56.26	61.72

Table 7.48 – Annual Nominal Avoided Costs for Decrements, 2018-2026

	Decrement Values (Nominal $/MWh)								
Decrement Name	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
EAST									
Residential Cooling	159.57	126.86	134.61	143.92	156.62.	162.45	179.23	163.99	169.83
Residential Lighting	89.48	79.87	84.65	94.16	101.92	107.82	114.58	109.87	114.15
Residential Whole House	92.15	80.99	86.70	96.72	104.36	109.46	115.60	110.67	115.30
Commercial Cooling	112.19	94.43	101.17	112.70	120.17	127.26	134.85	125.33	130.80
Commercial Lighting	88.24	79.76	84.34	93.77	102.27	107.34	112.81	108.90	113.99
System Load Shape	85.11	76.64	81.36	91.08	98.25	103.65	109.32	106.14	110.51
WEST									
Residential Cooling	82.31	84.03	81.81	84.23	88.84	92.96	92.68	101.82	106.02
Residential Heating	64.95	74.27	73.25	75.52	77.45	83.09	83.53	87.11	90.81
Residential Lighting	69.12	75.11	74.60	77.29	80.09	83.49	84.27	90.13	92.83
Commercial Cooling	79.65	81.63	79.24	82.88	85.36	89.09	89.94	99.11	102.64
Commercial Lighting	69.44	76.45	75.28	78.62	81.44	85.47	86.40	91.81	94.13
System Load Shape	66.44	73.25	72.82	75.55	77.92	81.97	82.64	87.95	90.18

Figures 7.35 and 7.36 show the decrement costs for each end use along with the average annual forward market price for that location: Palo Verde (PV) for the east and Mid-Columbia (Mid-C) for the west.

Figure 7.35 – East Decrement Price Trends

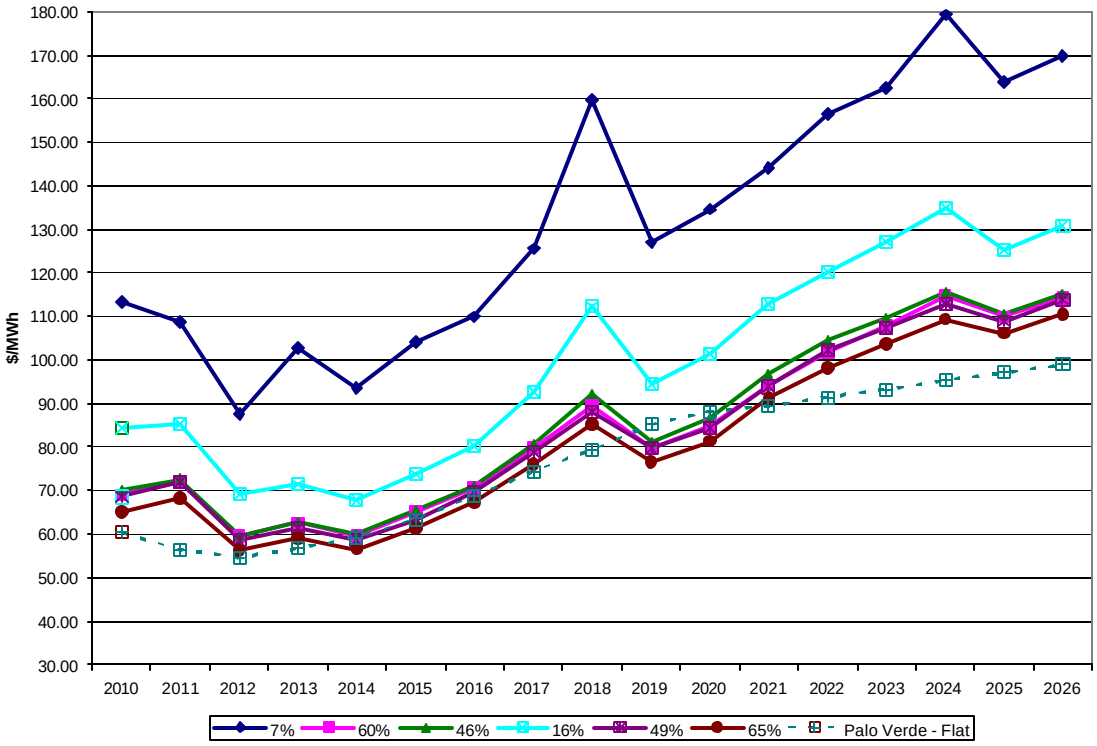
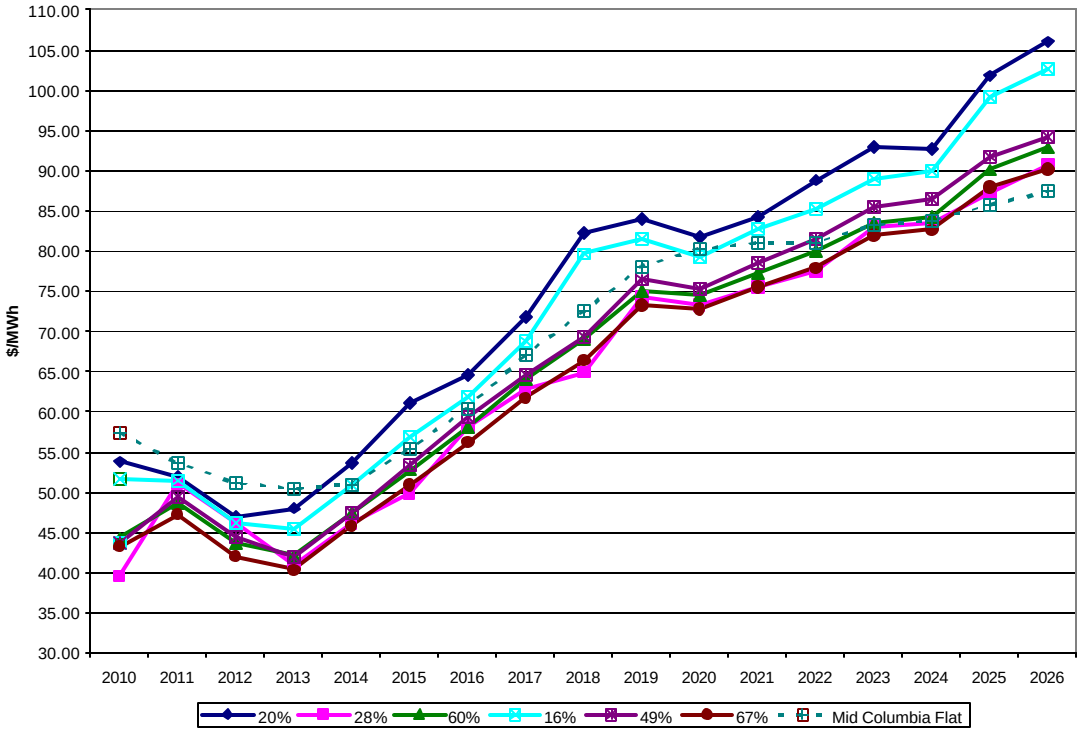


Figure 7.36 – West Decrement Price Trends



Appendix D. Technical Supplements: Class 4 Resources

Descriptions and References for Reviewed Programs

Non-Targeted Campaign – Demand Reduction

Opinion Dynamics Corporation (2006). "Process Evaluation of the 2004/2005 Flex Your Power Now! State-wide Marketing Campaign." Final Integrated Report. July 24, 2006. Available on calmac.org.

- *Summary:* The evaluation report concludes that Californians have had a hard time distinguishing between the Flex Your Power Now! alerts and the more general awareness Flex Your Power Now campaign (described below). Approximately 12% of state residents surveyed recalled seeing or hearing Flex Your Power Now! messages, but this level of recognition is less than that reported for similar national campaigns. Most survey respondents were not aware that the "Flex Your Power Now!" message was time-sensitive.

Non-Targeted Campaign – Conservation and Voluntary Efficiency

Bender, Sylvia, et al. **(2002)**. "Using Mass Media to Influence Energy Consumption Behavior: California's 2001 Flex Your Power Campaign as a Case Study." Paper presented at ACEEE National Conference.

- *Summary*: Uses a frame-work of four factors to evaluate the effectiveness of any media campaigns (targeting the right audience,) The paper concludes that while consumer awareness may be impacted by a media campaign, this does not necessarily lead to changes in consumer behavior.

McGuire, W. (2001). "Overview of the Flex Your Power Campaign." ACEEE National Conference on Energy Efficiency and Reliability: Lessons Learned in 2001.

- This presentation was not available from the ACEEE website nor from the Flex Your Power program office. Author McGuire provided summary information in electronic mail correspondence dated February 20, 2007.

Power Forward

Hunter, Carol (2001). *Power Forward.* Presentation at the ACEEE National Conference on Energy Efficiency and Reliability, Berkeley, CA. October.

- *Summary*: Power point slides shown at the October 2001 conference. Provides a very general description of the program and the direct costs incurred in 2001.

Other Campaigns

Auch, Lynn and Mike McDonald (1994). "Conservation Advertising Campaigns and Advertising Effectiveness Research: The Right Combination to Solidify the Conservation Ethic." ACEEE presentation 1994. (Puget Sound Power & Light 3 year campaign, '91 to '93).

- *Summary:* Puget Sound Power & Light partnered with a local research firm to assess the effectiveness of its marketing campaign. The findings show that between June 1992 and June 1993, more customers were reporting the adoption of energy efficiency measures, including the use of CFLs, and low-flow showerheads.

Henderson, B. (2001). "Lessons Learned in 2001." Panel presentation at the ACEEE National Conference.

- *Summary:* Very brief presentation provided. Henderson provides a listing of energy savings realized by NYSERDA in 2001. By category, he indicates that energy efficiency programs resulted in 63 MW of savings, peak load management resulted in 195 MW, voluntary appeals/public awareness 6 MW, and distributed generation approximately 1 MW.

Hungerford, David, et al. **(2002)**. "Conservation Understanding and Behavior Among Low-Income Consumers." 2002 ACEEE Summer Study on Energy Efficiency in Buildings.

- *Summary:* Report on the CPUC Electric Education Trust Community Outreach Program, and its program to engage community-based organizations to inform hard-to-reach populations about energy conservation. Effective organizations typically had previous experience in an area, used culturally appropriate materials, and included many one-on one interactions in the outreach.

Keane, Gerry and Kenneth Tiedemann (1996). "Advertising, Customer Awareness and Energy Conserving Behaviour." (BC Hydro Power Smart communications initiative)

- *Summary:* Keane and Tideman are BC Hydro staff. They report on increasing consumer awareness over a two year period of time (1990 to 1992), reported changes in energy efficient behaviors, and resulting energy savings. The estimated energy savings are significant – approximately 20 GWh per year, they report. The cost to operate these programs is described only generally as "millions of dollars."

Kushler, Martin, et al. (2002). "Using Energy Efficiency to Help Address Electric System Reliability: An Initial Examination of the 2001 Experience." Paper presented at the ACEEE National Conference.

- *Summary*: This paper reviews 22 different programs defined as "energy efficiency programs that were specifically designed…to address electric system reliability concerns." It concludes that energy efficiency programs acted as "an important resource to address short-term reliability concerns in the summer of 2001." While programs aimed solely at reliability may be outside the scope of our Class 4 definition, there is some overlap in Kushler's definition. Kushler's paper includes Flex Your Power and Power Forward, for example.

Of the 263 MW in estimated savings in New York, Kushler cites Henderson as attributing only 6 MW to voluntary appeals and public awareness. (See Henderson reference above.)

Peters, Jane, et al. (1998). "Changing Consumer Attitudes to Energy Efficiency: Midterm Results from an Advertising Campaign." Paper presented at the ACEEE National Conference. (Wisconsin Electric 1997 Energy Conservation Campaign)

- *Summary:* Peters and team discuss the theory of Planned Behavior in this report; that is, they examine the impact of outreach campaigns on behavior intention and the process by which this may (or may not) in turn lead to behavior changes. They conclude that the Wisconsin Electric campaign has had a positive impact on consumer intentions to utilize more efficient showerheads and water heaters.

Education and Conservation

Equipose Consulting Inc. (2006). "Pacific Gas & Electric's 2004/2005 Local School Resources Program and Energenius Program Evaluation." Available through CALMAC website.

- *Summary:* The report generally characterizes the Energenius program as successful, but states that more resources need to be attributed to evaluation work. The program included the Summer Energy Institute, in which participants learn about energy efficiency. Self-reports from the participants indicate that they had adopted at least one practice that they learned at the course.

Gregory, Judith (1992). "Ohio Home Weatherization Assistance Program Client Education Pilot Program: Consumer Education In Ohio Pilot Program." Columbus, OH: State of Ohio, Office of Energy Efficiency (prepared by the Center for Neighborhood Development, Cleveland State University).

Lawrence Berkeley National Laboratory and Xenergy (2004). "Evaluation of the Compressed Air Challenge training Program." Evaluation completed for the US Department of Energy.

- *Summary:* The Compressed Air Challenge (CAC) training program was designed to provide assistance to plant personnel and compressed air vendors. The training was provided by the US Department of Energy over 2002-2003 and evaluated in 2004. The study found that 76% of the system end-users had made significant capital and/or operating improvements to the compressed air systems since attending the training. Of these, 2/3 reported that the change was made as a direct result of attending the training. The average rate of savings achieved as a result of these implemented measures was 148,562 kWh (or 7.5% of the pre-project system energy.)

Mountain Economic Consulting and Associates (2006). "The Impact of Real-Time Feedback on Residential Electricity Consumption: The Hydro One Pilot."

- *Summary:* This evaluation examines the impact of a pilot program undertaken by Hydro One between 2004 and 2006. The program included a sample of more than 400 participants and control customers over a 2.5-year period of time, and across a variety of

geographical regions within the province. The study found that the aggregate reduction in electricity consumption (kWh) was 6.5%. Households with non-electric heating showed energy savings of 8.2%.

Quantec, LLC (2007). M. Sami Khawaja and Jamie Drakos. "Low Income Bill Assistance Program: Adult Energy Education Pilot Component, Year 2."

- *Summary:* This pilot program provided energy education to income-eligible households in the State of Washington. Participant families attended a workshop on energy saving measures and received a range of energy efficiency measures. Based upon participation surveys, Quantec was able to separate the energy savings impact of the educational activities from that of the efficiency measures. 1,436 households participated in the study. The average initial impact of educational programs was found to be 337 kWh per household. This result diminished over time following the completion of the education program.

Talerico, Tom et al (2003). "Are Education and Training Programs Producing Knowledge and Behavioral Effects in Wisconsin?" Paper presented at the IECEP 2003 conference.

- *Summary:* This paper reviews the impact of Focus on Energy's Education and Training programs for commercial users between 1999 and 2002. More than 80 training programs were offered, and included topics such as the proper use of energy diagnostic tools and implementing Energy Star Home standards. While results varied, the majority of participants at four selected program indicated that they would incorporate one of more energy saving practices into their standards business practice (with response rates ranging from 60% to 86%).

Zebedee & Associates (2006). "Final EM&V Report for the Green Action Program." Prepared for the San Diego Regional Energy Office. CALMAC study SDR0005.01.

- *Summary:* The Zebedee report offers a mixed review of the program, stating that it has "been highly successful in meeting its program goals in terms of number of program participants. However, there are concerns about potential design flaws and free-ridership." In the end, the report recommends that the CPUC consider replacing the program.

Appendix E.1. Technical Supplements: Supplemental Resources CHP

Dairy/Swine

Table E.1. California Dairy/Swine Number of Farms

		Total Farms		No. Cows		No. Swine	
Zip Code	Place Name	Milk cow	Hogs and pigs	500-999	1000+	2000-4999	5000+
95531	Crescent City	8	7	0.96	5.76	1.33	4.62
95538	Fort Dick	*		0	0	0	0
95543	Gasquet			0	0	0	0
95548	Klamath			0	0	0	0
95567	Smith River	6		0.72	4.32	0	0
96014	Callahan		*	0	0	0	0
96015	Canby	*		0	0	0	0
96017	Castella			0	0	0	0
96023	Dorris	5	*	0.6	3.6	0	0
96025	Dunsmuir			0	0	0	0
96027	Etna	*	*	0	0	0	0
96032	Fort Jones	*	5	0	0	0.95	3.3
96034	Gazelle			0	0	0	0
96037	Greenview		*	0	0	0	0
96038	Grenada	*		0	0	0	0
96039	Happy Camp			0	0	0	0
96044	Hornbrook			0	0	0	0
96050	Klamath River	*		0	0	0	0
96051	Lakehead			0	0	0	0
96057	Mccloud			0	0	0	0
96058	Macdoel		*	0	0	0	0
96064	Montague	*	*	0	0	0	0
96067	Mount Shasta	*		0	0	0	0
96085	Scott Bar			0	0	0	0
96086	Seiad Valley			0	0	0	0
96094	Weed		*	0	0	0	0
96097	Yreka	*	5	0	0	0.95	3.3
96101	Alturas	*	*	0	0	0	0
96104	Cedarville	*		0	0	0	0
96134	Tulelake		*	0	0	0	0
Total:				2.3	13.7	3.2	11.2

% of farms of with herd size in range from: Farms, Land in Farms, and Livestock 2/07 USDA

Table E.2. Idaho Dairy/Swine Number of Farms

		Total Farms		No. Cows		No. Swine	
Zip Code	Place Name	Milk cow	Hogs and pigs	500-999	1000+	2000-4999	5000+
83213	Arco 1			0	0	0	0
83214	Arimo 1	*	10	0	0	1.9	6.6
83217	Bancroft 1	6	6	0.84	3.42	1.14	3.96
83218	Basalt 1			0	0	0	0
83220	Bern 1			0	0	0	0
83221	Blackfoot 1	36	14	5.04	20.52	2.66	9.24
83223	Bloomington 1	*		0	0	0	0
83228	Clifton 1	13		1.82	7.41	0	0
83232	Dayton 1	*	*	0	0	0	0
83233	Dingle 1			0	0	0	0
83234	Downey 1	*	7	0	0	1.33	4.62
83236	Firth 1	10	20	1.4	5.7	3.8	13.2
83237	Franklin 1	*		0	0	0	0
83238	Geneva 1	*		0	0	0	0
83239	Georgetown 1	5	6	0.7	2.85	1.14	3.96
83241	Grace 1	5	5	0.7	2.85	0.95	3.3
83243	Holbrook 1		*	0	0	0	0
83244	Howe 1	8	6	1.12	4.56	1.14	3.96
83246	Lava Hot Springs 1		*	0	0	0	0
83250	Mccammon 1	*	13	0	0	2.47	8.58
83252	Malad City 1	12	17	1.68	6.84	3.23	11.22
83254	Montpelier 1	11	*	1.54	6.27	0	0
83261	Paris 1	*	*	0	0	0	0
83263	Preston 1	42	28	5.88	23.94	5.32	18.48
83272	Saint Charles 1			0	0	0	0
83274	Shelley 1	9	*	1.26	5.13	0	0
83276	Soda Springs 1		*	0	0	0	0
83281	Swanlake 1	*		0	0	0	0
83283	Thatcher 1			0	0	0	0
83286	Weston 1	20	*	2.8	11.4	0	0
83287	Fish Haven 1			0	0	0	0
83401	Idaho Falls 1	9	16	1.26	5.13	3.04	10.56
83402	Idaho Falls 2	*	10	0	0	1.9	6.6
83403	Idaho Falls 3			0	0	0	0
83404	Idaho Falls 4		7	0	0	1.33	4.62
83405	Idaho Falls 5			0	0	0	0
83406	Idaho Falls 6			0	0	0	0
83420	Ashton 1	*		0	0	0	0
83421	Chester 1	*		0	0	0	0
83423	Dubois 1			0	0	0	0
83424	Felt 1			0	0	0	0
83425	Hamer 1	*		0	0	0	0
83427	Iona 1			0	0	0	0
83431	Lewisville 1	*		0	0	0	0
83434	Menan 1	6		0.84	3.42	0	0
83435	Monteview 1	*	6	0	0	1.14	3.96
83436	Newdale 1		*	0	0	0	0
83438	Parker 1		6	0	0	1.14	3.96
83440	Rexburg 1	10	6	1.4	5.7	1.14	3.96
83442	Rigby 1	20	*	2.8	11.4	0	0
83443	Ririe 1			0	0	0	0
83444	Roberts 1	*	*	0	0	0	0
83445	Saint Anthony 1	9	20	1.26	5.13	3.8	13.2
83448	Sugar City 1	*		0	0	0	0
83450	Terreton 1	*	*	0	0	0	0
83451	Teton 1			0	0	0	0
83452	Tetonia 1	5		0.7	2.85	0	0
83454	Ucon 1			0	0	0	0
83464	Leadore 1		*	0	0	0	0
83610	Cambridge 1	*	*	0	0	0	0
Total:				33.0	134.5	38.6	134.0

* Data withheld for categories with one to four farms. Farm counts for these zip codes are included in the 'Sta

Source: http://www.nass.usda.gov/Census_of_Agriculture/index.asp

% of farms of with herd size in range from: Farms, Land in Farms, and Livestock 2/07 USDA

Table E.3. Oregon Dairy/Swine Number of Farms

Zip Code	Place Name	Total Farms	No. Swine	
		Hogs and pigs	2000-4999	5000+
97016	Clatskanie	9	1.7	5.9
97029	Grass Valley		0.0	0.0
97031	Hood River	8	1.5	5.3
97033	Kent	*	0.0	0.0
97039	Moro	*	0.0	0.0
97040	Mosier	*	0.0	0.0
97050	Rufus		0.0	0.0
97058	The Dalles	10	1.9	6.6
97060	Troutdale		0.0	0.0
97065	Wasco	*	0.0	0.0
97102	Arch Cape	*	0.0	0.0
97103	Astoria	11	2.1	7.3
97138	Seaside		0.0	0.0
97146	Warrenton	*	0.0	0.0
97201	Portland 1		0.0	0.0
97202	Portland 2		0.0	0.0
97203	Portland 3		0.0	0.0
97204	Portland 4		0.0	0.0
97205	Portland 5		0.0	0.0
97206	Portland 6		0.0	0.0
97208	Portland 8		0.0	0.0
97209	Portland 9		0.0	0.0
97210	Portland 10		0.0	0.0
97211	Portland 11		0.0	0.0
97212	Portland 12		0.0	0.0
97213	Portland 13		0.0	0.0
97214	Portland 14		0.0	0.0
97215	Portland 15		0.0	0.0
97216	Portland 16		0.0	0.0
97217	Portland 17		0.0	0.0
97218	Portland 18		0.0	0.0
97219	Portland 19		0.0	0.0
97220	Portland 20		0.0	0.0
97221	Portland 21		0.0	0.0
97230	Portland 29		0.0	0.0
97231	Portland 30	*	0.0	0.0
97232	Portland 31		0.0	0.0
97233	Portland 32		0.0	0.0
97236	Portland 33		0.0	0.0
97239	Portland 35		0.0	0.0
97242	Portland 37		0.0	0.0
97266	Portland 45		0.0	0.0
97283	Portland 54		0.0	0.0
97286	Portland 55		0.0	0.0
97293	Portland 59		0.0	0.0
97294	Portland 60		0.0	0.0

Zip Code	Place Name	Total Farms	No. Swine	
		Hogs and pigs	2000-4999	5000+
97301	Salem 1	11	2.1	7.3
97302	Salem 2	*	0.0	0.0
97303	Salem 3	*	0.0	0.0
97304	Salem 4	5	1.0	3.3
97305	Salem 5	7	1.3	4.6
97306	Salem 6	6	1.1	4.0
97307	Keizer		0.0	0.0
97308	Salem 7		0.0	0.0
97309	Salem 8		0.0	0.0
97321	Albany 1	*	0.0	0.0
97322	Albany 2	6	1.1	4.0
97325	Aumsville	*	0.0	0.0
97327	Brownsville	*	0.0	0.0
97329	Cascadia		0.0	0.0
97330	Corvallis 1	8	1.5	5.3
97331	Corvallis 2		0.0	0.0
97333	Corvallis 3	7	1.3	4.6
97335	Crabtree		0.0	0.0
97336	Crawfordsville		0.0	0.0
97338	Dallas	14	2.7	9.2
97339	Corvallis 4		0.0	0.0
97344	Falls City		0.0	0.0
97345	Foster		0.0	0.0
97346	Gates		0.0	0.0
97347	Grand Ronde	*	0.0	0.0
97348	Halsey	5	1.0	3.3
97351	Independence	*	0.0	0.0
97352	Jefferson	*	0.0	0.0
97355	Lebanon	21	4.0	13.9
97358	Lyons	*	0.0	0.0
97360	Mill City		0.0	0.0
97361	Monmouth	*	0.0	0.0
97367	Lincoln City	*	0.0	0.0
97368	Otis	*	0.0	0.0
97370	Philomath	15	2.9	9.9
97371	Rickreall		0.0	0.0
97372	Rose Lodge		0.0	0.0
97374	Scio	14	2.7	9.2
97377	Shedd	*	0.0	0.0
97383	Stayton	6	1.1	4.0
97384	Mehama		0.0	0.0
97385	Sublimity	*	0.0	0.0
97386	Sweet Home	*	0.0	0.0
97388	Gleneden Beach		0.0	0.0
97389	Tangent	*	0.0	0.0
97392	Turner	7	1.3	4.6

Zip Code	Place Name	Total Farms	No. Swine	
		Hogs and pigs	2000-4999	5000+
97401	Eugene 1		0.0	0.0
97402	Eugene 2	8	1.5	5.3
97403	Eugene 3		0.0	0.0
97404	Eugene 4		0.0	0.0
97405	Eugene 5	*	0.0	0.0
97408	Eugene 6	*	0.0	0.0
97410	Azalea		0.0	0.0
97411	Bandon	*	0.0	0.0
97414	Broadbent	*	0.0	0.0
97417	Canyonville		0.0	0.0
97420	Coos Bay	5	1.0	3.3
97423	Coquille	*	0.0	0.0
97424	Cottage Grove	9	1.7	5.9
97426	Creswell	9	1.7	5.9
97428	Curtin		0.0	0.0
97429	Days Creek	*	0.0	0.0
97432	Dillard	*	0.0	0.0
97442	Glendale	*	0.0	0.0
97443	Glide	5	1.0	3.3
97446	Harrisburg	*	0.0	0.0
97447	Idleyld Park		0.0	0.0
97448	Junction City	10	1.9	6.6
97456	Monroe	6	1.1	4.0
97457	Myrtle Creek	*	0.0	0.0
97458	Myrtle Point	6	1.1	4.0
97459	North Bend		0.0	0.0
97462	Oakland	6	1.1	4.0
97466	Powers		0.0	0.0
97469	Riddle	*	0.0	0.0
97470	Roseburg	31	5.9	20.5
97479	Sutherlin	*	0.0	0.0
97484	Tiller		0.0	0.0
97486	Umpqua	*	0.0	0.0
97495	Winchester		0.0	0.0
97496	Winston	*	0.0	0.0
97497	Wolf Creek		0.0	0.0
97501	Medford 1	14	2.7	9.2
97502	Central Point	13	2.5	8.6
97503	White City	6	1.1	4.0
97504	Medford 2	5	1.0	3.3
97520	Ashland	14	2.7	9.2
97522	Butte Falls		0.0	0.0
97523	Cave Junction	6	1.1	4.0
97524	Eagle Point	25	4.8	16.5
97525	Gold Hill	*	0.0	0.0
97526	Grants Pass 1	*	0.0	0.0
97527	Grants Pass 2	14	2.7	9.2
97528	Grants Pass 3		0.0	0.0

Zip Code	Place Name	Total Farms	No. Swine	
		Hogs and pigs	2000-4999	5000+
97530	Jacksonville	*	0.0	0.0
97531	Kerby		0.0	0.0
97532	Merlin	*	0.0	0.0
97533	Murphy		0.0	0.0
97534	O Brien		0.0	0.0
97535	Phoenix		0.0	0.0
97536	Prospect	*	0.0	0.0
97537	Rogue River	6	1.1	4.0
97538	Selma		0.0	0.0
97539	Shady Cove	*	0.0	0.0
97540	Talent	*	0.0	0.0
97541	Trail		0.0	0.0
97543	Wilderville	*	0.0	0.0
97544	Williams	*	0.0	0.0
97601	Klamath Falls 1	*	0.0	0.0
97602	Klamath Falls 2		0.0	0.0
97603	Klamath Falls 3	10	1.9	6.6
97621	Beatty		0.0	0.0
97622	Bly	*	0.0	0.0
97623	Bonanza	9	1.7	5.9
97624	Chiloquin	5	1.0	3.3
97625	Dairy	*	0.0	0.0
97626	Fort Klamath	*	0.0	0.0
97627	Keno		0.0	0.0
97630	Lakeview	*	0.0	0.0
97632	Malin	*	0.0	0.0
97633	Merrill	9	1.7	5.9
97634	Midland	*	0.0	0.0
97635	New Pine Creek		0.0	0.0
97639	Sprague River		0.0	0.0
97701	Bend 1	25	4.8	16.5
97702	Bend 2	*	0.0	0.0
97707	Bend 3		0.0	0.0
97708	Bend 4	*	0.0	0.0
97709	Bend 5		0.0	0.0
97734	Culver	*	0.0	0.0
97741	Madras	6	1.1	4.0
97754	Prineville	23	4.4	15.2
97756	Redmond	27	5.1	17.8
97760	Terrebonne	*	0.0	0.0
97761	Warm Springs		0.0	0.0
97801	Pendleton	6	1.1	4.0
97810	Adams	*	0.0	0.0
97812	Arlington	*	0.0	0.0
97813	Athena	*	0.0	0.0
97818	Boardman	*	0.0	0.0
97826	Echo	*	0.0	0.0
97828	Enterprise	6	1.1	4.0

Zip Code	Place Name	Total Farms Hogs and pigs	No. Swine 2000-4999	5000+
97835	Helix		0.0	0.0
97838	Hermiston	16	3.0	10.6
97842	Imnaha		0.0	0.0
97846	Joseph	*	0.0	0.0
97857	Lostine	*	0.0	0.0
97862	Milton Freewater	12	2.3	7.9
97868	Pilot Rock	*	0.0	0.0
97875	Stanfield	6	1.1	4.0
97882	Umatilla		0.0	0.0
97885	Wallowa	5	1.0	3.3
97886	Weston		0.0	0.0
Total			101.3	351.8

* Data withheld for categories with one to four farms. Farm counts for these zip codes are included in the "state total' category.

Source: http://www.nass.usda.gov/Census_of_Agriculture/index.asp

% of farms of with herd size in range from: Farms, Land in Farms, and Livestock 2/07 USDA

Table E.4. Number of Oregon Dairy Farms

Farm		City	County	# animals
TMCF	(Six Mile Dairy)	Boardman	Morrow	21,819
TMCF	Colombia	Boardman	Morrow	17,499
Williams	Dairy	Milton-Freewater	Umatilla	6,250
Rickreall	Dairy	Rickreall	Polk	3,221
Platt's	Oak Hill	Independence	Polk	2,888
Bonanza	View	Bonanza	Klamath	1,900
Holland's	Dairy	Klamath Falls	Klamath	1,660
Mallorie's	Dairy	Silverton	Jefferson	1,600
Dejong,	Tom or Nellie	Klamath Falls	Klamath	1,560
Volbeda	Dairy	Albany	Linn	1,531
Danish	Dairy	Coquille	Coos	1,208
Langell	Valley	Bonanza	Klamath	1,193
Konyn	Dairy	Eugene	Lane	1,190
Lochmead	Farms	Junction City	Lane	1,109
Dejager	Dairy	Jefferson	Marion	1,050
Noble	Dairy	Grants Pass	Josephine	1,016

Source: "Sizing and Characterizing the Market for Oregon Biopower Projects" for Energy Trust, by CH2MHill, 2005

Table E.5. Utah Dairy/Swine Number of Farms

		Total Farms		No. Cows		No. Swine	
Zip Code	Place Name	Milk cow	Hogs and pigs	500-999	1000+	2000-4999	5000+
84003	American Fork 1	5	*	1.2	1.25	0	0
84004	Alpine 1	6		1.44	1.5	0	0
84010	Bountiful 1			0	0	0	0
84013	Cedar Valley 1			0	0	0	0
84014	Centerville 1			0	0	0	0
84015	Clearfield 1		*	0	0	0	0
84016	Clearfield 2			0	0	0	0
84017	Coalville 1	15	*	3.6	3.75	0	0
84018	Croydon 1			0	0	0	0
84020	Draper 1	*		0	0	0	0
84024	Echo 1			0	0	0	0
84025	Farmington 1		*	0	0	0	0
84028	Garden City 1			0	0	0	0
84029	Grantsville 1	*	11	0	0	2.09	7.26
84032	Heber City 1	6	8	1.44	1.5	1.52	5.28
84033	Henefer 1		*	0	0	0	0
84034	Ibapah 1	*	*	0	0	0	0
84036	Kamas 1	*	*	0	0	0	0
84037	Kaysville 1	*	*	0	0	0	0
84038	Laketown 1	*	*	0	0	0	0
84040	Layton 1			0	0	0	0
84041	Layton 2	*	*	0	0	0	0
84042	Lindon 1	*	*	0	0	0	0
84043	Lehi 1		15	0	0	2.85	9.9
84044	Magna 1	6	*	1.44	1.5	0	0
84047	Midvale 1			0	0	0	0
84049	Midway 1	*		0	0	0	0
84050	Morgan 1	9	11	2.16	2.25	2.09	7.26
84054	North Salt Lake 1			0	0	0	0
84055	Oakley 1	*		0	0	0	0
84057	Orem 1			0	0	0	0
84058	Orem 2	*		0	0	0	0
84059	Orem 3			0	0	0	0
84060	Park City 1			0	0	0	0
84061	Peoa 1	*		0	0	0	0
84062	Pleasant Grove 1	5	*	1.2	1.25	0	0
84064	Randolph 1		*	0	0	0	0
84065	Riverton 1	5	7	1.2	1.25	1.33	4.62
84067	Roy 1		6	0	0	1.14	3.96
84069	Rush Valley 1	*	*	0	0	0	0
84070	Sandy 1			0	0	0	0
84071	Stockton 1			0	0	0	0
84074	Tooele 1	*	8	0	0	1.52	5.28
84075	Syracuse 1	*		0	0	0	0
84078	Vernal 1	19	26	4.56	4.75	4.94	17.16
84079	Vernal 2			0	0	0	0
84080	Vernon 1			0	0	0	0
84082	Wallsburg 1	7	*	1.68	1.75	0	0
84084	West Jordan 1			0	0	0	0

		Total Farms		No. Cows		No. Swine	
Zip Code	Place Name	Milk cow	Hogs and pigs	500-999	1000+	2000-4999	5000+
84086	Woodruff 1			0	0	0	0
84087	Woods Cross 1	*		0	0	0	0
84088	West Jordan 2		*	0	0	0	0
84089	Clearfield 3			0	0	0	0
84092	Sandy 4			0	0	0	0
84093	Sandy 5		*	0	0	0	0
84094	Sandy 6			0	0	0	0
84095	South Jordan 1	7	*	1.68	1.75	0	0
84097	Orem 4	*		0	0	0	0
84098	Park City 3	*	*	0	0	0	0
84101	Salt Lake City 1			0	0	0	0
84102	Salt Lake City 2			0	0	0	0
84103	Salt Lake City 3			0	0	0	0
84104	Salt Lake City 4			0	0	0	0
84105	Salt Lake City 5			0	0	0	0
84106	Salt Lake City 6			0	0	0	0
84107	Salt Lake City 7	*		0	0	0	0
84108	Salt Lake City 8			0	0	0	0
84109	Salt Lake City 9			0	0	0	0
84110	Salt Lake City 10			0	0	0	0
84111	Salt Lake City 11			0	0	0	0
84115	Salt Lake City 15			0	0	0	0
84116	Salt Lake City 16			0	0	0	0
84117	Salt Lake City 17			0	0	0	0
84118	Salt Lake City 18			0	0	0	0
84119	Salt Lake City 19		*	0	0	0	0
84120	Salt Lake City 20		*	0	0	0	0
84121	Salt Lake City 21			0	0	0	0
84123	Salt Lake City 23	*		0	0	0	0
84124	Salt Lake City 24			0	0	0	0
84127	Salt Lake City 27			0	0	0	0
84128	Salt Lake City 28			0	0	0	0
84133	Salt Lake City 32			0	0	0	0
84147	Salt Lake City 41			0	0	0	0
84158	Salt Lake City 48			0	0	0	0
84165	Salt Lake City 49			0	0	0	0
84302	Brigham City 1	6	6	1.44	1.5	1.14	3.96
84304	Cache Junction 1			0	0	0	0
84305	Clarkston 1	*	*	0	0	0	0
84306	Collinston 1			0	0	0	0
84307	Corinne 1	5	*	1.2	1.25	0	0
84308	Cornish 1	8		1.92	2	0	0
84309	Deweyville 1	6		1.44	1.5	0	0
84310	Eden 1	*	*	0	0	0	0
84311	Fielding 1	7		1.68	1.75	0	0
84312	Garland 1	9	*	2.16	2.25	0	0
84314	Honeyville 1	*	*	0	0	0	0
84315	Hooper 1	*	*	0	0	0	0
84316	Howell 1	*	*	0	0	0	0
84317	Huntsville 1		*	0	0	0	0

		Total Farms		No. Cows		No. Swine	
Zip Code	Place Name	Milk cow	Hogs and pigs	500-999	1000+	2000-4999	5000+
84318	Hyde Park 1	*		0	0	0	0
84319	Hyrum 1	16		3.84	4	0	0
84320	Lewiston 1	24	*	5.76	6	0	0
84321	Logan 1	14	10	3.36	3.5	1.9	6.6
84322	Logan 2	*	*	0	0	0	0
84323	Logan 3			0	0	0	0
84324	Mantua 1		*	0	0	0	0
84325	Mendon 1	*	*	0	0	0	0
84326	Millville 1	*		0	0	0	0
84327	Newton 1	6		1.44	1.5	0	0
84328	Paradise 1	5		1.2	1.25	0	0
84330	Plymouth 1			0	0	0	0
84331	Portage 1			0	0	0	0
84332	Providence 1	*		0	0	0	0
84333	Richmond 1	5		1.2	1.25	0	0
84334	Riverside 1	*	*	0	0	0	0
84335	Smithfield 1	34	*	8.16	8.5	0	0
84336	Snowville 1	*	*	0	0	0	0
84337	Tremonton 1	16	21	3.84	4	3.99	13.86
84338	Trenton 1	7	*	1.68	1.75	0	0
84339	Wellsville 1	20	*	4.8	5	0	0
84340	Willard 1	*		0	0	0	0
84341	Logan 4	*	*	0	0	0	0
84401	Ogden 3	10	8	2.4	2.5	1.52	5.28
84402	Ogden 4			0	0	0	0
84403	Ogden 5			0	0	0	0
84404	Ogden 6	21	5	5.04	5.25	0.95	3.3
84405	Ogden 7		*	0	0	0	0
84409	Ogden 10			0	0	0	0
84412	Ogden 11			0	0	0	0
84414	Ogden 12	*		0	0	0	0
84501	Price 1	*	5	0	0	0.95	3.3
84511	Blanding 1	*	*	0	0	0	0
84512	Bluff 1			0	0	0	0
84513	Castle Dale 1	*	*	0	0	0	0
84516	Clawson 1			0	0	0	0
84518	Cleveland 1	*	*	0	0	0	0
84520	East Carbon 1			0	0	0	0
84521	Elmo 1	*	*	0	0	0	0
84522	Emery 1	*		0	0	0	0
84523	Ferron 1	7	*	1.68	1.75	0	0
84525	Green River 1	*	*	0	0	0	0
84526	Helper 1		*	0	0	0	0
84528	Huntington 1		7	0	0	1.33	4.62
84529	Kenilworth 1			0	0	0	0
84530	La Sal 1			0	0	0	0
84531	Mexican Hat 1			0	0	0	0
84532	Moab 1		*	0	0	0	0
84533	Lake Powell 1			0	0	0	0
84534	Montezuma Creek 1			0	0	0	0

		Total Farms		No. Cows		No. Swine	
Zip Code	Place Name	Milk cow	Hogs and pigs	500-999	1000+	2000-4999	5000+
84535	Monticello 1	7	*	1.68	1.75	0	0
84537	Orangeville 1			0	0	0	0
84539	Sunnyside 1			0	0	0	0
84542	Wellington 1			0	0	0	0
84601	Provo 1	*	*	0	0	0	0
84602	Provo 2			0	0	0	0
84603	Provo 3			0	0	0	0
84604	Provo 4			0	0	0	0
84605	Provo 5			0	0	0	0
84606	Provo 6			0	0	0	0
84620	Aurora 1		*	0	0	0	0
84621	Axtell 1			0	0	0	0
84622	Centerfield 1	*	*	0	0	0	0
84623	Chester 1	*		0	0	0	0
84624	Delta 1	22	15	5.28	5.5	2.85	9.9
84626	Elberta 1	*		0	0	0	0
84627	Ephraim 1		*	0	0	0	0
84628	Eureka 1			0	0	0	0
84629	Fairview 1	5	6	1.2	1.25	1.14	3.96
84630	Fayette 1	*	*	0	0	0	0
84632	Fountain Green 1			0	0	0	0
84633	Goshen 1	*		0	0	0	0
84634	Gunnison 1	8	5	1.92	2	0.95	3.3
84635	Hinckley 1	12	*	2.88	3	0	0
84636	Holden 1	*	*	0	0	0	0
84638	Leamington 1			0	0	0	0
84639	Levan 1	*	*	0	0	0	0
84640	Lynndyl 1			0	0	0	0
84642	Manti 1	5	*	1.2	1.25	0	0
84643	Mayfield 1	*	7	0	0	1.33	4.62
84645	Mona 1			0	0	0	0
84646	Moroni 1			0	0	0	0
84647	Mount Pleasant 1	*	5	0	0	0.95	3.3
84648	Nephi 1	*	*	0	0	0	0
84649	Oak City 1	*	*	0	0	0	0
84651	Payson 1	9	11	2.16	2.25	2.09	7.26
84652	Redmond 1	*	6	0	0	1.14	3.96
84653	Salem 1	*	*	0	0	0	0
84654	Salina 1	*	*	0	0	0	0
84655	Santaquin 1	11	10	2.64	2.75	1.9	6.6
84656	Scipio 1	*		0	0	0	0
84657	Sigurd 1	10		2.4	2.5	0	0
84660	Spanish Fork 1	7	18	1.68	1.75	3.42	11.88
84662	Spring City 1		*	0	0	0	0
84663	Springville 1	*	*	0	0	0	0
84664	Mapleton 1	7	6	1.68	1.75	1.14	3.96
84665	Sterling 1	*		0	0	0	0
84667	Wales 1		*	0	0	0	0
84701	Richfield 1	7	20	1.68	1.75	3.8	13.2
84711	Annabella 1		*	0	0	0	0

		Total Farms		No. Cows		No. Swine	
Zip Code	Place Name	Milk cow	Hogs and pigs	500-999	1000+	2000-4999	5000+
84713	Beaver 1	10	*	2.4	2.5	0	0
84720	Cedar City 1	*	5	0	0	0.95	3.3
84721	Cedar City 2		6	0	0	1.14	3.96
84722	Central 1			0	0	0	0
84723	Circleville 1	6		1.44	1.5	0	0
84724	Elsinore 1		*	0	0	0	0
84725	Enterprise 1	*		0	0	0	0
84730	Glenwood 1		*	0	0	0	0
84731	Greenville 1	*		0	0	0	0
84733	Gunlock 1			0	0	0	0
84737	Hurricane 1	9	10	2.16	2.25	1.9	6.6
84738	Ivins 1		*	0	0	0	0
84739	Joseph 1	*		0	0	0	0
84740	Junction 1			0	0	0	0
84742	Kanarraville 1			0	0	0	0
84743	Kingston 1			0	0	0	0
84745	La Verkin 1			0	0	0	0
84746	Leeds 1			0	0	0	0
84750	Marysvale 1	*		0	0	0	0
84751	Milford 1		5	0	0	0.95	3.3
84752	Minersville 1	6	6	1.44	1.5	1.14	3.96
84754	Monroe 1	5	6	1.2	1.25	1.14	3.96
84757	New Harmony 1			0	0	0	0
84759	Panguitch 1	*		0	0	0	0
84760	Paragonah 1		*	0	0	0	0
84761	Parowan 1	*	18	0	0	3.42	11.88
84763	Rockville 1	*		0	0	0	0
84765	Santa Clara 1	*		0	0	0	0
84766	Sevier 1	*		0	0	0	0
84767	Springdale 1			0	0	0	0
84770	Saint George 1	*	*	0	0	0	0
84772	Summit 1			0	0	0	0
84774	Toquerville 1			0	0	0	0
84779	Virgin 1			0	0	0	0
84780	Washington 1		*	0	0	0	0
84782	Veyo 1			0	0	0	0
84783	Dammeron Valley 1			0	0	0	0
Total:				110.9	115.5	60.6	210.5

* Data withheld for categories with one to four farms. Farm counts for these zip codes are included in the 'State Total' category.

Source: http://www.nass.usda.gov/Census_of_Agriculture/index.asp

% of farms of with herd size in range from: Farms, Land in Farms, and Livestock 2/07 USDA

Table E.6. Washington Dairy/Swine Number of Farms

		Total Farms		No. Cows		No. Swine	
Zip Code	Place Name	Milk cow	Hogs and pigs	500-999	1000+	2000-4999	5000+
98362	Port Angeles	*	6	0	0	1.14	3.96
98603	Ariel			0	0	0	0
98672	White Salmon			0	0	0	0
98901	Yakima 1			0	0	0	0
98902	Yakima 2	*	*	0	0	0	0
98903	Yakima 3	*	6	0	0	1.14	3.96
98904	Yakima 4			0	0	0	0
98907	Yakima 5	*		0	0	0	0
98908	Yakima 6	*	7	0	0	1.33	4.62
98909	Yakima 7	*		0	0	0	0
98920	Brownstown			0	0	0	0
98921	Buena			0	0	0	0
98923	Cowiche	*		0	0	0	0
98930	Grandview	10	9	1.6	4.4	1.71	5.94
98932	Granger	6		0.96	2.64	0	0
98933	Harrah			0	0	0	0
98935	Mabton	7	8	1.12	3.08	1.52	5.28
98936	Moxee	7		1.12	3.08	0	0
98937	Naches	*	*	0	0	0	0
98938	Outlook	5	*	0.8	2.2	0	0
98939	Parker			0	0	0	0
98942	Selah	7	*	1.12	3.08	0	0
98944	Sunnyside	30	6	4.8	13.2	1.14	3.96
98947	Tieton		*	0	0	0	0
98948	Toppenish	5	7	0.8	2.2	1.33	4.62
98951	Wapato	6	6	0.96	2.64	1.14	3.96
98952	White Swan	*		0	0	0	0
98953	Zillah	6	*	0.96	2.64	0	0
99301	Pasco	7	14	1.12	3.08	2.66	9.24
99323	Burbank	*	*	0	0	0	0
99324	College Place			0	0	0	0
99328	Dayton	*	6	0	0	1.14	3.96
99329	Dixie			0	0	0	0
99347	Pomeroy		*	0	0	0	0
99348	Prescott		*	0	0	0	0
99350	Prosser	12	5	1.92	5.28	0.95	3.3
99361	Waitsburg		*	0	0	0	0
99362	Walla Walla	9	*	1.44	3.96	0	0
99363	Wallula			0	0	0	0
Total:				18.7	51.5	15.2	52.8

* Data withheld for categories with one to four farms. Farm counts for these zip codes are included in the 'State Total' category.

Source: http://www.nass.usda.gov/Census_of_Agriculture/index.asp

% of farms of with herd size in range from: Farms, Land in Farms, and Livestock 2/07 USDA

Table E.7. Wyoming Dairy/Swine Number of Farms

		Total Farms		No. Cows		No. Swine	
Zip Code	Place Name	Milk cow	Hogs and pigs	500-999	1000+	2000-4999	5000+
82070	Laramie 1	7	6	1.61	2.87	1.14	3.96
82071	Laramie 2			0	0	0	0
82072	Laramie 3	*	*	0	0	0	0
82073	Laramie 4		*	0	0	0	0
82213	Glendo 1	*		0	0	0	0
82301	Rawlins 1	*		0	0	0	0
82310	Jeffrey City 1			0	0	0	0
82322	Bairoil 1			0	0	0	0
82334	Sinclair 1			0	0	0	0
82336	Wamsutter 1			0	0	0	0
82401	Worland 1	*	*	0	0	0	0
82412	Byron 1			0	0	0	0
82414	Cody 1	5	*	1.15	2.05	0	0
82420	Cowley 1		6	0	0	1.14	3.96
82421	Deaver 1			0	0	0	0
82423	Frannie 1		*	0	0	0	0
82426	Greybull 1		*	0	0	0	0
82430	Kirby 1			0	0	0	0
82431	Lovell 1	5	*	1.15	2.05	0	0
82432	Manderson 1			0	0	0	0
82433	Meeteetse 1		*	0	0	0	0
82435	Powell 1	6	9	1.38	2.46	1.71	5.94
82440	Ralston 1			0	0	0	0
82443	Thermopolis 1	*	*	0	0	0	0
82450	Wapiti 1			0	0	0	0
82501	Riverton 1	12	14	2.76	4.92	2.66	9.24
82515	Hudson 1			0	0	0	0
82520	Lander 1	6	*	1.38	2.46	0	0
82601	Casper 1		*	0	0	0	0
82602	Casper 2			0	0	0	0
82604	Casper 3	*	14	0	0	2.66	9.24
82605	Casper 4			0	0	0	0
82609	Casper 5			0	0	0	0
82620	Alcova 1	*		0	0	0	0
82633	Douglas 1	5	*	1.15	2.05	0	0
82635	Edgerton 1			0	0	0	0
82636	Evansville 1			0	0	0	0
82637	Glenrock 1	5	6	1.15	2.05	1.14	3.96
82640	Linch 1			0	0	0	0
82643	Midwest 1			0	0	0	0
82644	Mills 1	*	5	0	0	0.95	3.3
82649	Shoshoni 1	*	*	0	0	0	0
82834	Buffalo 1	*	7	0	0	1.33	4.62
82901	Rock Springs 1		*	0	0	0	0
82902	Rock Springs 2			0	0	0	0
82930	Evanston 1	*	*	0	0	0	0
82931	Evanston 2			0	0	0	0
82935	Green River 1	*		0	0	0	0
82943	Reliance 1			0	0	0	0
Total:				11.7	20.9	12.7	44.2

* Data withheld for categories with one to four farms. Farm counts for these zip codes are included in the 'State Total' category.

Source: http://www.nass.usda.gov/Census_of_Agriculture/index.asp

% of farms of with herd size in range from: Farms, Land in Farms, and Livestock 2/07 USDA

Energy Insights Data

Table E.8. Percent of Establishments that are CHP Eligible (30 kW-99kW)

Segment	CA	ID	OR	UT	WA	WY
Offices	0%	0%	0%	0%	0%	0%
Restaurants	0%	0%	0%	0%	0%	0%
Retail	8%	12%	0%	16%	0%	12%
Grocery	0%	0%	0%	0%	0%	0%
Warehouse	43%	43%	0%	42%	0%	42%
Schools	0%	48%	41%	44%	46%	41%
Health	13%	20%	8%	18%	8%	24%
Lodging	0%	0%	47%	0%	49%	0%
Other Commercial	21%	21%	16%	21%	16%	23%
Mining	22%	51%	0%	49%	0%	45%
Chemicals	22%	0%	46%	0%	46%	0%
Petroleum Refining	9%	17%	50%	42%	9%	39%
Food	49%	46%	48%	47%	47%	40%
Stone, Clay, Glass	51%	47%	44%	47%	47%	50%
Primary Metals	100%	49%	0%	47%	0%	49%
Industrial Machinery	0%	0%	0%	0%	0%	0%
Electronic Equipment	0%	0%	0%	0%	0%	0%
Transportation Equipment	0%	0%	0%	0%	0%	0%
Lumber	44%	39%	46%	45%	45%	42%
Paper	100%	56%	48%	51%	43%	100%
Other Industrial	0%	0%	0%	0%	0%	0%
Total	**12%**	**15%**	**10%**	**14%**	**11%**	**17%**

Table E.9. Percent of Establishments that are CHP Eligible (100 kW-199 kW)

Segment	CA	ID	OR	UT	WA	WY
Offices	100%	100%	100%	100%	100%	100%
Restaurants	0%	100%	0%	100%	0%	100%
Retail	88%	94%	94%	99%	91%	98%
Grocery	100%	100%	100%	100%	100%	100%
Warehouse	100%	100%	94%	91%	55%	99%
Schools	100%	100%	100%	100%	100%	100%
Health	100%	100%	100%	100%	100%	100%
Lodging	100%	100%	100%	100%	100%	100%
Other Commercial	100%	100%	100%	100%	100%	100%
Mining	100%	100%	0%	100%	0%	100%
Chemicals	100%	100%	100%	100%	100%	100%
Petroleum Refining	100%	100%	100%	100%	100%	100%
Food	100%	100%	100%	100%	100%	100%
Stone, Clay, Glass	100%	100%	100%	100%	100%	100%
Primary Metals	100%	100%	0%	100%	0%	100%
Industrial Machinery	100%	0%	100%	0%	100%	0%
Electronic Equipment	100%	0%	0%	0%	0%	0%
Transportation Equipment	100%	100%	100%	100%	100%	100%
Lumber	100%	100%	100%	100%	100%	100%
Paper	100%	100%	100%	100%	100%	100%
Other Industrial	71%	45%	41%	21%	72%	17%
Total	**91%**	**93%**	**86%**	**92%**	**89%**	**94%**

Table E.10. Percent of Establishments that are CHP Eligible (200 kW-499 kW)

Segment	CA	ID	OR	UT	WA	WY
Offices	100%	100%	100%	100%	100%	100%
Restaurants	100%	100%	100%	100%	100%	100%
Retail	95%	96%	98%	99%	95%	99%
Grocery	100%	100%	100%	100%	100%	100%
Warehouse	100%	100%	92%	93%	57%	99%
Schools	100%	100%	100%	100%	100%	100%
Health	100%	100%	100%	100%	100%	100%
Lodging	100%	100%	100%	100%	100%	100%
Other Commercial	100%	100%	100%	100%	100%	100%
Mining	100%	100%	0%	100%	0%	100%
Chemicals	100%	100%	100%	100%	100%	100%
Petroleum Refining	100%	100%	100%	100%	100%	100%
Food	100%	100%	100%	100%	100%	100%
Stone, Clay, Glass	100%	100%	100%	100%	100%	100%
Primary Metals	100%	100%	0%	100%	0%	100%
Industrial Machinery	100%	100%	100%	100%	100%	100%
Electronic Equipment	100%	100%	100%	100%	100%	100%
Transportation Equipment	100%	100%	100%	100%	100%	100%
Lumber	100%	100%	100%	100%	100%	100%
Paper	100%	100%	100%	100%	100%	100%
Other Industrial	95%	82%	87%	83%	97%	75%
Total	**99%**	**99%**	**99%**	**99%**	**99%**	**100%**

Table E.11. Percent of Establishments that are CHP Eligible (> 500 kW

Segment	CA	ID	OR	UT	WA	WY
Offices	100%	100%	100%	100%	100%	100%
Restaurants	100%	100%	100%	100%	100%	100%
Retail	100%	100%	100%	100%	100%	100%
Grocery	100%	100%	100%	100%	100%	100%
Warehouse	100%	100%	100%	100%	100%	100%
Schools	100%	100%	100%	100%	100%	100%
Health	100%	100%	100%	100%	100%	100%
Lodging	100%	100%	100%	100%	100%	100%
Other Commercial	100%	100%	100%	100%	100%	100%
Mining	100%	100%	100%	100%	100%	100%
Chemicals	100%	100%	100%	100%	100%	100%
Petroleum Refining	100%	100%	100%	100%	100%	100%
Food	100%	100%	100%	100%	100%	100%
Stone, Clay, Glass	100%	100%	100%	100%	100%	100%
Primary Metals	100%	100%	100%	100%	100%	100%
Industrial Machinery	100%	100%	100%	100%	100%	100%
Electronic Equipment	100%	100%	100%	100%	100%	100%
Transportation Equipment	100%	100%	100%	100%	100%	100%
Lumber	100%	100%	100%	100%	100%	100%
Paper	100%	100%	100%	100%	100%	100%
Other Industrial	100%	100%	100%	100%	100%	100%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Existing CHP Generators

Table E.12. Idaho Existing CHP Generators

State	City	Organization Name	Facility Name	Application	SIC	NAICS	Op Year	Prime Mover	Capacity (kw)	Prim. Fuel
ID	Conda	Nu-West Industries	Sulfuric Acid Plant	Chemicals	2891	325520	1992	CT	2,800	OTR

Table E.13. Oregon Existing CHP Generators

State	City	Organization Name	Facility Name	Application	SIC	NAICS	Op Year	Prime Mover	Capacity (kw)	Prim. Fuel
OR	Klamath Falls	Curtis Livestock Ranch	Curtis Livestock Ranch	Agriculture	200	112111	.	ERENG	500	NG
OR	Eugene	University Of Oregon	University Of Oregon	Colleges/Univ.	8221	61131	1950	B/ST	4,000	NG
OR	Albany	Wah Chang	Wah Chang	Primary Metals	3341	331314	2001	ERENG	14,000	NG
OR	Albany	Willamette Industries, Inc./ Weyerhaeuser	Albany Paper Mill	Pulp and Paper	2621	322121	1995	CC	96,000	NG
OR	Clatskanie	Georgia-Pacific Corp.	Wauna Paper Mill	Pulp and Paper	2621	322121	1996	B/ST	36,000	WOOD
OR	Klamath Falls	Weyerhaeuser Co.	Weyerhaeuser Co.	Pulp and Paper	2661	322215	1990	B/ST	7,500	OTR
OR	Medford	SierraPine Medite	Sierra Pine Medite	Pulp and Paper	2631	32213	2001	CT	6,000	NG
OR	West Linn	West Linn Paper Co.	West Linn Paper Co.	Pulp and Paper	2600	322	.	B/ST	0	NG
OR	Salem	Covanta Marion Inc	Marion	Solid Waste Facilities	4953	562212	1986	B/ST	13,100	WAST
OR	Medford	Medford Wastewater Plant	City of Medford WWTP	Wastewater Treatment	4952	22132	.	ERENG	700	BIOMASS
OR		Crater Lake Lumber Co.	Crater Lake Lumber Co.	Wood Products	2421	321113	1989	B/ST	2,500	WOOD
OR	Eugene	Lane Plywood, Inc.	Lane Plywood, Inc.	Wood Products	2436	321212	1983	B/ST	460	WOOD
OR	Medford	Boise Cascade Corp.	Boise Cascade Medford Operations	Wood Products	2421	321113	1961	B/ST	8,500	WOOD
OR	Prineville	Pine Products Corp.	Pine Products Corporation	Wood Products	2421	321113	1988	B/ST	5,000	WOOD
OR	Riddle	Johnson Lumber Co.	Co-Gen II	Wood Products	2421	321113	1987	B/ST	7,500	WOOD
OR	Roseburg	Roseburg Forest Products Co.	Dillard Complex	Wood Products	2421	321113	1955	B/ST	40,000	WOOD
OR	Warm Springs	Warm Springs Forest Products	Warm Springs Forest Products	Wood Products	2436	321212	1990	B/ST	6,000	WOOD
OR	White City	D R Johnson Lumber Co.	Burrill Resources	Wood Products	2421	321113	1990	B/ST	1,500	NG
OR	Corvallis	Coffin Butte LF	Pacific Northwest Generating Cooperative	LFG	4953	562212	1995	ERENG	2400	WAST
OR	Eugene	Short Mountain LF	Emerald People's Utility District	LFG	4953	562212	1992	ERENG	1600	WAST
OR	Eugene	Short Mountain LF	Emerald People's Utility District	LFG	4953	562212	1993	ERENG	1600	WAST

Table E.14. Utah Existing CHP Generators

State	City	Organization Name	Facility Name	SIC	NAICS	OpYear	Prime Mover	Capacity (kW)	Prim. Fuel
UT	Layton	Inkley's Photo Lab	Inkley's Photo Lab			1987	RENG	120	NG
UT	West Weber	Wadeland Dairy				2004	RENG	150	BIOMASS
UT	Tremonton	La-Z-Boy Chair Company	La-Z-Boy Chair Company	2512		1986	B/ST	290	WOOD
UT	Salt Lake City	Holy Cross Hospital	Holy Cross Hospital			1988	RENG	460	NG
UT	Salt Lake City	Salt Lake City Water Reclamation Plant	Salt Lake City Water Reclamation Plant			1985	RENG	460	OBG
UT	Salt Lake City	Mountain Fuel Supply	Mountain Fuel Supply			1993	RENG	1,150	NG
UT	Ogden	Central Weber Wastewater Treatment Plant	Central Weber Wastewater Treatment Plant			2000	RENG	1,246	OBG
UT	Syracuse	North Davis County Sewer Improvement District	North Davis County Sewer Improvement District			1998	RENG	1,400	OBG
UT	Layton	Wasatch Energy Syste	Davis County Landfill	4939	22	1986	B/ST	1,600	MSW
UT	Salt Lake City	Primary Childrens Medical Center	Primary Childrens Medical Center	8069	622	1988	IC	1,800	NG
UT	Snowbird	Snowbird, Ltd./ Lone Peak Partners	Snowbird Ski Resort	7011		1986	RENG	1,950	NG
UT	Logan	Utah State University	Utah State University Cogen and Chiller Plant			2003	CT	5,000	NG
UT	Salt Lake City	Central Valley Water Reclamation Facility	Central Valley Water Reclamation Facility			1988	RENG	5,970	OBG
UT	Salt Lake City	Tesoro Refining and Marketing Corp.	Tesoro Salt Lake Refinery			2002	GT	30,000	NG/OG

Table E.15. Washington Existing CHP Generators

State	City	Organization Name	Facility Name	Application	SIC	NAICS	Op Year	Prime Mover	Capacity (kw)	Prim. Fuel
WA	Outlook	George DeRuyter & Sons Dairy	George DeRuyter & Sons Dairy	Agriculture	241	11212	2006	ERENG	1,060	BIOMASS

Table E.16. Wyoming Existing CHP Generators

State	City	Organization Name	Facility Name	Op Year	SIC	NAICS	Capacity (kW)	Prime Mover	Prim. Fuel
WY	Green River	General Chemical Cor	General Chemical	1968	2810	325188	30,000	ST	SUB
WY		Howell Petroleum Corp	Elk Basin Gasoline Plant/Winkleman Dome	1948	211		4,300	B/ST	NG
WY	Rock Springs	Simplot	Simplot	1986	1475	325311	11,500	ST	NG
WY	Sinclair	Sinclair Oil Corp	Sinclair Oil Refinery	1925, 1954	2911	32411	3,200	ST	DFO

Glossary of Abbreviations Given in Existing CHP Generator Tables

Prime Mover

Code	Prime Mover Description
B/ST	Boiler/Steam Turbine
CA	Combined Cycle Steam Part
CC	Combined Cycle - Total Unit
CE	Compressed Air Energy Storage
CS	Combined Cycle Single Shaft (combustion turbine and steam turbine share a single generator)
CT	Combined Cycle Combustion Turbine Part
FC	Fuel Cell
GT	Combustion (Gas) Turbine (includes jet engine design)
HY	Hydraulic Turbine (includes turbines associated with delivery of water by pipeline)
IC	Internal Combustion Engine (diesel, piston)
MT	Microturbine
OTR	Other
PS	Hydraulic Turbine – Reversible (pumped storage)
PV	Photovoltaic
RENG	Reciprocating Engine
ST	Steam Turbine, including nuclear, geothermal and solar steam (does not include combined cycle)
WT	Wind Turbine
OT	Other
NA	Unknown at this time (use only for plants/generators in planning stage)

Energy Source

Code	Energy Source Description
AB	Agriculture Crop Byproducts/Straw/Energy Crops
BFG	Blast Furnace Gas
BIOMASS	Biomass
BIT	(Anthracite Coal, Bituminous Coal)
BLQ	Black Liquor
BMTH	Bio-Methane
COAL	Coal
DFO	Distillate Fuel Oil (includes all Diesel and No. 1, No. 2, and No. 4 Fuel Oils)
GEO	Geothermal
JF	Jet Fuel
KER	Kerosene
LFG	Landfill Gas
LIG	Lignite Coal
MSW	Municipal Solid Waste
NG	Natural Gas
NUC	Nuclear (Uranium, Plutonium, Thorium)
OBG	Other Biomass Gases (Digester Gas, Methane, and other biomass gases)
OBL	Other Biomass Liquid (Ethanol, Fish Oil, Liquid Acetonitrile Waste, Medical Waste, Tall Oil, Waste Alcohol, and other Biomass not specified)
OBS	Other Biomass Solid (Animal Manure and Waste, Solid Byproducts, and other solid biomass not specified)
O-ES, OG	Other
OG	Other Gas (Butane, Coal Processes, Coke-Oven, Refinery, and other processes)
OIL	Oil
PC	Petroleum Coke
PG	Propane
PUR	Purchased Steam
RFO	Residual Fuel Oil (includes No. 5 and No. 6 Fuel Oils and Bunker C Fuel Oil)
SC	Coal-based Synfuel and include briquettes, pellets, or extrusions, which are formed by binding materials and processes that recycle material
SLW	Sludge Waste
SUB	Subbituminous Coal
SUN	Solar (Photovoltaic, Thermal)
TDF	Tires
WAT	Water (Conventional, Pumped Storage)
WC	Waste/Other Coal (Anthracite Culm, Bituminous Gob, Fine Coal, Lignite Waste, Waste Coal)
WDL	Wood Waste Liquids (Red Liquor, Sludge Wood, Spent Sulfite Liquor, and other wood related liquids not
WDS	Wood/Wood Waste Solids (Paper Pellets, Railroad Ties, Utility Poles, Wood Chips, and other wood solids)
W-FL	Waste Fuel
WND	Wind
WO	Oil-Other and Waste Oil (Butane (Liquid), Crude Oil, Liquid Byproducts, Oil Waste, Propane (Liquid), Re-refined
WOOD	Wood
OTH	Other (Batteries, Chemicals, Coke Breeze, Hydrogen, Pitch, Sulfur, Tar Coal, and miscellaneous technologies)
NA	Not Available

Source: EEA, Inc., NWCHP Application Center, Intermountain CHP Application Center, NWPCC

Gas Prices

Table E.17. Gas Price from 0307 Price Foreward Forecast

Year	ID	WY	WA/OR	CA	UT
2007	$5.02	$5.02	$7.48	$7.61	$5.95
2008	$7.19	$7.19	$8.06	$8.18	$7.47
2009	$7.29	$7.29	$7.86	$7.99	$7.58
2010	$7.04	$7.04	$7.45	$7.57	$7.32
2011	$7.04	$7.04	$7.24	$7.36	$7.32
2012	$6.92	$6.92	$7.07	$7.19	$7.19
2013	$6.98	$6.98	$7.17	$7.28	$7.25
2014	$7.17	$7.17	$7.41	$7.50	$7.44
2015	$7.38	$7.38	$7.75	$7.83	$7.65
2016	$7.62	$7.62	$8.01	$8.09	$7.89
2017	$7.87	$7.87	$8.27	$8.35	$8.14
2018	$8.12	$8.12	$8.53	$8.61	$8.39
2019	$8.31	$8.31	$8.72	$8.81	$8.57
2020	$8.66	$8.66	$9.05	$9.13	$8.92
2021	$8.57	$8.57	$8.95	$9.04	$8.83
2022	$8.51	$8.51	$8.90	$8.99	$8.78
2023	$8.49	$8.49	$8.88	$8.96	$8.76
2024	$8.40	$8.40	$8.78	$8.86	$8.67
2025	$8.33	$8.33	$8.71	$8.79	$8.60
2026	$8.25	$8.25	$8.63	$8.71	$8.52
2027	$8.28	$8.28	$8.65	$8.73	$8.54

Table E.18 Gas Price with Adders

Year	ID	WY	WA/OR	CA	UT	AVG
2007	$5.54	$5.44	$8.06	$7.71	$5.95	$6.54
2008	$7.77	$7.65	$8.66	$8.29	$7.47	$7.97
2009	$7.88	$7.77	$8.47	$8.09	$7.58	$7.96
2010	$7.64	$7.52	$8.05	$7.68	$7.32	$7.64
2011	$7.64	$7.52	$7.84	$7.47	$7.32	$7.56
2012	$7.53	$7.40	$7.68	$7.30	$7.19	$7.42
2013	$7.59	$7.47	$7.79	$7.39	$7.25	$7.50
2014	$7.80	$7.67	$8.05	$7.62	$7.44	$7.71
2015	$8.02	$7.89	$8.40	$7.94	$7.65	$7.98
2016	$8.27	$8.14	$8.67	$8.20	$7.89	$8.24
2017	$8.54	$8.41	$8.94	$8.47	$8.14	$8.50
2018	$8.80	$8.66	$9.21	$8.73	$8.39	$8.76
2019	$9.00	$8.86	$9.42	$8.93	$8.57	$8.96
2020	$9.36	$9.22	$9.76	$9.26	$8.92	$9.30
2021	$9.28	$9.14	$9.67	$9.17	$8.83	$9.22
2022	$9.23	$9.09	$9.62	$9.11	$8.78	$9.17
2023	$9.22	$9.08	$9.61	$9.09	$8.76	$9.15
2024	$9.13	$8.99	$9.52	$9.00	$8.67	$9.06
2025	$9.07	$8.92	$9.46	$8.93	$8.60	$8.99
2026	$9.00	$8.85	$9.38	$8.85	$8.52	$8.92
2027	$9.03	$8.88	$9.41	$8.87	$8.54	$8.95

Table E.19. Adders

State	Gas Commodity	Losses/taxes % of Commod	Variable $/MMBtu	Reservation $/MMBtu
CA	Malin	0.00%	0	0.1
WA/OR	Stanfield	2.01%	0.0316	0.39547
ID	Opal	2.01%	0.0316	0.39547
WY	Opal	1.72%	0.017	0.317184658
UT	Gadsby	0.00%	0	0

Source: David Engberg of PacifiCorp

Landfill Methane Outreach Program (LMOP) Database

Table E.20. California LMOP

Project ID	Landfill ID	Expansion ID	LMOP Territory ID	Landfill Name	Landfill City	Landfill County	Waste In Place (tons)	Year Landfill Opened	Landfill Closure Year	Landfill Owner Organization	Project Status	Project Start Date	Project Shutdown Date	Project Developer Organization	LFGE Utilization Type (Direct-Use vs Electricity)	LFGE Project Type	MW Capacity	LFG Flow to Project (mmscfd)	Emission Reductions (MMTCO2E)
186	130	0	3	Cedarville LF - East	Cedarville	Modoc	10,000		1993	US BLM	Potential						0.01		
96	40	0	3	Eagleville Disposal Site	Eagleville	Modoc	10,000		1993	US BLM	Potential						0.01		
153	97	0	3	Fort Bidwell LF	Fort Bidwell	Modoc	10,000		1993	Modoc Co. DPW	Potential						0.01		
196	140	0	3	Lake City LF	Lake City	Modoc	10,000		2015	US BLM	Potential						0.01		
211	154	0	3	Cecilville Disposal Site	Cecilville	Siskiyou	10,000		1994	US DOA, US FS	Potential						0.01		
247	190	0	3	Happy Camp Solid Waste Disposal site	Happy Camp	Siskiyou	10,000		1996	Landfill Owner	Potential						0.01		
129	73	0	3	Hotelling Gulch Disposal Site	Forks of Salmon	Siskiyou	10,000		1994	US DOA, US FS	Potential						0.01		
152	96	0	3	Kelly Gulch Solid Waste Disposal Site	Sawyers Bar	Siskiyou	10,000		1994	US DOA, US FS	Potential						0.01		
223	166	0	3	Lava Beds Disposal Site	Tulelake	Siskiyou	10,000		1995	NPS	Potential						0.01		
235	178	0	3	Rogers Creek	Somes Bar	Siskiyou	10,000		1994	US DOA, US FS	Potential						0.01		
242	185	0	3	Weed Solid Waste Disposal Site	Weed	Siskiyou	25,000		1995	Santa Fe Pac. Prop, Inc., Catellis Corp	Potential						0.02		
252	195	0	3	Alturas SLF	Alturas	Modoc	33,872		2028	Modoc Co. DPW	Potential						0.03		
264	207	0	3	McCloud Community Services District LF	McCloud	Siskiyou	50,000		1995	McCloud Community Services District	Potential						0.04		
322	263	0	3	Tulelake SLF	Tulelake	Siskiyou	75,000		2001	City of Tulelake	Potential						0.06		
280	223	0	3	Black Butte Solid Waste Disposal Site	Mount Shasta	Siskiyou	150,000		2003	US DOA, US FS	Potential						0.12		
357	297	0	3	Yreka Solid Waste LF	Yreka	Siskiyou	200,000		2109	City of Yreka	Potential						0.16		
378	318	0	3	Crescent City SLF	Crescent City	Del Norte	806,400			Del Norte County	Potential						0.63		
388	328	0	3	Tennant Solid Waste Disposal Site	Tennant	Siskiyou				US DOA, US FS	Potential						0.50		

Source: http://www.epa.gov/lmop/proj/index.htm

Key:

US BLM: United States Bureau of Land Management

US DOA: United States Department of Agriculture

US FS: United States Forest Service

Modoc Co. DPW: Modoc County Department of Public Works

NPS: United States Department of the Interior - National Park Service

Table E.21. Idaho LMOP

Project ID	Landfill ID	Expansion ID	LMOP Territory	Landfill Name	Landfill City	Landfill County	Waste In Place (tons)	Year Landfill Opened	Landfill Closure Year	Landfill Owner Organization	Project Status	Project Start Date	Project Shutdown Date	Project Developer Organization	LFGE Utilization Type (Direct-Use vs Electricity)	LFGE Project Type	MW Capacity	LFG Flow to Project (mmscfd)	Emission Reductions (MMTCO2E)
180255	2178	0	3	Franklin County Sanitary Landfill	Dayton	Franklin		1968	2007	Franklin County, ID	Candidate						0.50		
180269	2192	0	3	St. Anthonys Landfill	St. Anthony	Fremont		1965		Fremont County	Potential						0.50		
180264	2187	0	3	Montpelier Canyon Landfill	Montpelier	Bear Lake		1973	2042	Bear Lake County	Potential						0.50		
180246	2169	0	3	Bingham County Landfill-Ridge Road	Blackfoot	Bingham		1987	2002	Bingham County	Potential						0.50		
180248	2171	0	3	Bonneville County Landfill	Idaho Falls	Bonneville		1993		Bonneville County	Potential						0.50		
180260	2183	0	3	Jefferson County / Circular Butte	Mud Lake	Jefferson		1995		Jefferson County, ID	Potential						0.50		
180253	2176	0	3	Circular Butte Landfill	Terreton	Jefferson		1996			Potential						0.50		
180250	2173	0	3	Butte County Arco Sanitary Landfill	Arco	Butte			2022	Butte County, ID	Potential						0.50		
180251	2174	0	3	Butte County Howe Landfill	Howe	Butte				Butte County, ID	Potential						0.50		
180245	2168	0	3	Bingham County / Fielding / Goshen Landfill	Shelley	Bingham			2000	Bingham County	Potential						0.50		

Source: http://www.epa.gov/lmop/proj/index.htm

Table E.22. Utah LMOP

Project ID	Landfill ID	Expansion ID	LMOP Territory	Landfill Name	Landfill City	Landfill County	Waste In Place (tons)	Year Landfill Opened	Landfill Closure Year	Landfill Owner Organization	Project Status	Project Start Date	Project Shutdown Date	Project Developer Organization	LFGE Utilization Type (Direct-Use vs Electricity)	LFGE Project Type	MW Capacity
1618	1541	0	3	Davis County Solid Waste Management SSD LF	Layton	Davis	800	1980	1995	Box Elder County	Potential						0.00
1619	1542	0	3	Salt Lake Valley LF	Salt Lake	Salt Lake	1,600	1980	1995	San Juan County	Potential						0.00
1620	1543	0	3	Trans-Jordan LF	South Jordan	Salt Lake	1,600	1980	1995	San Juan County	Potential						0.00
1604	1527	0	3	City of Logan Sanitary Landfill	Logan	Cache	8,100	1970		Snowville Town	Potential						0.01
1616	1539	0	3	South Utah County SSD/Bayview LF		Utah	9,464	1970	1995	San Juan County	Potential						0.01
1643	1566	0	3	Uintah County/Vernal City LF	Vernal	Uintah	18,300	1987	2044	Nephi City	Potential						0.01
1617	1540	0	3	Bountiful City Sanitary LF	Woods Cross	Davis	36,000	1960	1995	Max Dalton	Potential						0.03
1630	1553	0	3	Beaver County LF	Beaver	Beaver	40,688	1981	2030	Rich County	Potential						0.03
1625	1548	0	3	Blanding LF	Blanding	San Juan	44,962	1993	2014	Iron County	Potential						0.04
1627	1550	0	3	San Juan County/Bluff LF	Bluff	San Juan	50,780	1956	1995	Blanding City	Potential						0.04
1598	1521	0	3	Brigham City LF	Brigham	Box Elder	67,650	1986	2034	Millard County	Potential						0.05
1622	1545	0	3	Emery County LF	Castle Dale	Emery	70,200	1993	2024	Sevier County	Potential						0.05
1633	1556	0	3	Iron County/ Armstrong Pit LF	Cedar	Iron	76,300	1960	2004	Grand County	Potential						0.06
1611	1534	0	3	Millard County LF	Delta	Millard	79,205	1965	1995	Green River City	Potential						0.06
2E+05	2074	0	3	ECDC	East Carbon	Carbon	107,648	1968	2014	Beaver City	Potential						0.08
1613	1536	0	3	Sevier County/Sage Flat LF	Glenwood	Sevier	108,396	1989	2066	Sanpete SLF Coop	Potential						0.08
1623	1546	0	3	Green River LF	Green River	Emery	184,600	1970	1995	Box Elder County	Potential						0.14
1628	1551	0	3	San Juan County/Halls Crossing LF	Halls Crossing	San Juan	212,184	1983	2024	Emery County	Potential						0.17
1605	1528	0	3	Rich County LF	Laketown	Rich	262,080	1900	1995	Santaquin City	Potential						0.20
1629	1552	0	3	San Juan County/Mexican Hat LF	Mexican Hat	San Juan	280,000	1956	1995	Carbon County	Potential						0.22
1624	1547	0	3	Grand County LF	Moab	Grand	358,896	1986	2026	Summit County, UT	Potential						0.28
1626	1549	0	3	City of Monticello LF	Monticello	San Juan	616,029	1950	2014	Payson City Corporation	Potential						0.48

Project ID	Landfill ID	Expansion ID	LMOP Territory	Landfill Name	Landfill City	Landfill County	Waste In Place (tons)	Year Landfill Opened	Landfill Closure Year	Landfill Owner Organization	Project Status	Project Start Date	Project Shutdown Date	Project Developer Organization	LFGE Utilization Type (Direct-Use vs Electricity)	LFGE Project Type	MW Capacity
1607	1530	0	3	Nephi LF	Nephi	Juab	693,000	1960	1995	Box Elder County	Potential						0.54
1644	1567	0	3	Weber County LF	Ogden	Weber	1,100,000	1991	2094	South Utah Valley Solid Waste District	Candidate						0.86
1614	1537	0	3	Payson City LF	Payson	Utah	1,131,000	1963	1991	City of Provo	Potential						0.88
1621	1544	0	3	Carbon County LF	Price	Carbon		1992	2059	Allied Waste Services	Potential						0.50
1646	1569	0	3	Provo LF	Provo	Utah			1995	Tooele Army Depot (TEAD)	Potential						0.50
1615	1538	0	3	Santaquin County LF	Santaquin	Utah			1995	Tooele Army Depot (TEAD)	Potential						0.50
1601	1524	0	3	Snowville LF	Snowville	Box Elder		1970			Potential						0.50
1612	1535	0	3	Sanpete SLF Coop	Spring City	Sanpete					Potential						0.50
1638	1561	0	3	Tooele Army Depot LF #1	Tooele	Tooele					Potential						0.50
1639	1562	0	3	Tooele Army Depot LF #2	Tooele	Tooele	1,400,000	1961	2016	City of Logan	Candidate						1.09
1602	1525	0	3	Tremonton LF	Tremonton	Box Elder	3,300,000	1952	2022	Wasatch Energy Systems	Operational	1/10/2005		Ameresco, Inc.	Electricity	Reciprocating Engine	2.57
1637	1560	0	3	Summit County/Three Mile Canyon LF	Wanship	Summit	1,707,965	1964	1993	Landfill Owner	Potential						1.33
1603	1526	0	3	Yost LF		Box Elder	2,171,531	1960	2058	City of Bountiful	Candidate						1.69
1606	1529	0	3	Callao LF		Juab	2,773,000	1950	2008	Uintah County, Vernal City	Candidate						2.16
1609	1532	0	3	Eskdale LF		Millard	3,500,000	1966	1996	Weber County	Potential						2.73
1608	1531	0	3	Partoun LF		Juab	5,600,000	1958	2017	Trans-Jordan Cities, UT	Construction	12/1/2006		Granger Electric/Energy	Direct	Direct Thermal	4.368

Source: http://www.epa.gov/lmop/proj/index.htm

Table E.23. Oregon LMOP

Project ID	Landfill ID	Expansion ID	LMOP Territory	Landfill Name	Landfill City	Landfill County	Waste In Place (tons)	Year Landfill Opened	Landfill Closure Year	Landfill Owner Organization	Project Status	Project Start Date	Project Shutdown Date	Project Developer Organization	LFGE Utilization Type (Direct-Use vs Electricity)	LFGE Project Type	MW	LFG Flow to Project (mmscfd)	Emission Reductions (MMTCO2E)
1316	1241	0	3	Columbia Ridge LF	Arlington	Gilliam	20,000,000	1990	2060	Waste Management, Inc.	Candidate						15.6		
180125	2073	0	3	Dry Creek Landfill	Medford	Jackson	2,000,000	1972	2048	Rogue Waste, Inc.	Candidate						1.56		
1314	1239	0	3	Klamath Falls LF	Klamath Falls	Klamath	1,000,000	1911	2001	Klamath County	Candidate						0.78		
1313	1238	0	3	Knott LF	Bend	Deschutes	700,000	1972	2029	Deschutes County	Candidate						0.546		
1320	1245	0	3	Roseburg LF	Roseburg	Douglas	1,050,000	1935	2025	Douglas County	Candidate						0.819		
1317	1242	0	3	Finley Buttes Regional Landfill	Boardman	Morrow	4,000,000	1990	2060	Waste Connections, Inc.	Candidate						3.12		
1315	1240	0	3	Northern Wasco County LF	The Dalles	Wasco	1,600,000	1972	2075	Waste Connections, Inc.	Candidate						1.248		
1318	1243	0	3	Milton-Freewater LF	Milton-Freewater	Umatilla	125,000	1972	2030	City of Milton-Freewater	Potential						0.098		
1319	1244	0	3	Pendleton LF		Umatilla	500,000	1972	1997	Sanitary Service Company	Potential						0.39		

Source: http://www.epa.gov/lmop/proj/index.htm

Table E.24. Washington LMOP

Project ID	Landfill ID	Expansion ID	LMOP Territory	Landfill Name	Landfill City	Landfill County	State	Waste In Place (tons)	Year Landfill Opened	Landfill Closure Year	Landfill Owner Organization	Project Status	Project Start Date	MW
1687	1608	0	3	Cheyne Road LF	Zillah	Yakima	WA	1,198,976	1968		Yakima County	Candidate		0.94
1707	1628	0	3	Sudbury Road LF	Walla Walla	Walla Walla	WA	1,102,317	1972	2007	City of Walla Walla	Candidate		0.86
1708	1629	0	3	Terrace Heights LF	Yakima	Yakima	WA	3,727,219	1974	2012	Yakima County	Candidate		2.91
1698	1619	0	3	New Waste Inc. LF	Pasco	Franklin	WA				Landfill Owner	Potential		0.50
1728	1649	0	3	Pasco SLF	Pasco	Franklin	WA			1993	Landfill Owner	Potential		0.50
1703	1624	0	3	Richland LF	Prosser	Benton	WA				Landfill Owner	Potential		1.0
1732	1653	0	3	Snipes Mount LF	Yakima	Yakima	WA				Landfill Owner	Potential		0.50
1710	1631	0	3	Yakima Firing Center	Yakima	Yakima	WA				United States Army	Potential		0.50

Source: http://www.epa.gov/lmop/proj/index.htm

Table E.25. Combined Heat & Power Base Case Scenario:Non-Renewable CA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	Com	Ind												
Recip Engine	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.05	0.08	0.12	0.15	0.19	0.22	0.26
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.04	0.08	0.11	0.14	0.17	0.20	0.23
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 328	$ 321	$ 304	$ 296	$ 290	$ 293	$ 302	$ 315	$ 325	$ 336	$ 346
			Lump sum ($)	$ 1,199	$ 5,088	$ 23,047	$ 36,237	$ 72,157	$ 105,909	$ 120,072	$ 135,493	$ 151,407	$ 168,175	$ 185,690
Microturbine	65%	35%												
			MW	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.03
line loss:	9.2%		aMW	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 486	$ 475	$ 451	$ 438	$ 429	$ 434	$ 447	$ 466	$ 482	$ 497	$ 513
			Lump sum ($)	$ 188	$ 882	$ 3,944	$ 6,115	$ 12,029	$ 17,459	$ 19,623	$ 22,007	$ 24,471	$ 27,081	$ 29,816
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02
line loss:	9.2%		aMW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 400	$ 391	$ 370	$ 361	$ 353	$ 357	$ 368	$ 383	$ 396	$ 409	$ 422
			Lump sum ($)	$ 168	$ 872	$ 3,813	$ 5,541	$ 10,615	$ 14,611	$ 15,172	$ 15,842	$ 16,555	$ 17,341	$ 18,347
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02
line loss:	9.2%		aMW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 455	$ 445	$ 422	$ 410	$ 401	$ 406	$ 418	$ 436	$ 451	$ 465	$ 480
			Lump sum ($)	$ 64	$ 343	$ 1,549	$ 2,477	$ 4,931	$ 7,325	$ 8,501	$ 9,789	$ 11,119	$ 12,523	$ 13,992

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost	
Non-Renewable	Com	Ind											Avg Lev Avoided C	$0.08 $/kWh
Recip Engine	65%	35%												
			MW	0.29	0.33	0.36	0.40	0.43	0.45	0.47	0.48	0.50		
line loss:	9.2%		aMW	0.27	0.30	0.33	0.36	0.39	0.41	0.42	0.44	0.45	Capacity Factor	90%
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335		
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827		
			Fuel ($/kW)	$ 354	$ 367	$ 363	$ 361	$ 361	$ 357	$ 354	$ 351	$ 352		
			Lump sum ($)	$ 203,356	$ 223,138	$ 238,468	$ 254,183	$ 256,052	$ 254,319	$ 235,857	$ 242,157	$ 250,303	Levelized Cost	$0.08 $/kWh
Microturbine	65%	35%												
			MW	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.06		
line loss:	9.2%		aMW	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	Capacity Factor	95%
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525		
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000		
			Fuel ($/kW)	$ 524	$ 543	$ 538	$ 535	$ 534	$ 528	$ 524	$ 519	$ 521		
			Lump sum ($)	$ 32,567	$ 35,694	$ 37,996	$ 40,357	$ 40,890	$ 41,202	$ 41,059	$ 43,307	$ 48,807	Levelized Cost	$0.12 $/kWh
Fuel Cell	65%	35%												
			MW	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03		
line loss:	9.2%		aMW	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	Capacity Factor	95%
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132		
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116		
			Fuel ($/kW)	$ 431	$ 447	$ 443	$ 440	$ 439	$ 434	$ 431	$ 427	$ 428		
			Lump sum ($)	$ 19,659	$ 22,703	$ 24,391	$ 28,384	$ 29,933	$ 28,710	$ 26,068	$ 26,006	$ 26,108	Levelized Cost	$0.16 $/kWh
Gas Turbine	65%	35%												
			MW	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03		
line loss:	9.2%		aMW	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	Capacity Factor	95%
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179		
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315		
			Fuel ($/kW)	$ 491	$ 508	$ 504	$ 501	$ 499	$ 494	$ 490	$ 486	$ 487		
			Lump sum ($)	$ 15,469	$ 17,140	$ 18,384	$ 19,659	$ 20,022	$ 20,071	$ 18,980	$ 19,452	$ 20,095	Levelized Cost	$0.09 $/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.26. Combined Heat & Power Base Case Scenario:Renewable CA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Biomass	**Com**	**Ind**													
Industrial	0%	100%													
			MW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.28	0.34	0.40	0.46	0.53
line loss:	6.9%		aMW	0.00	0.00	0.02	0.04	0.08	0.14	0.19	0.25	0.31	0.36	0.42	0.47
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068	$ 2,097
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584	$ 48,488
			Lump sum ($)	$ 1,738	$ 7,190	$ 32,907	$ 48,873	$ 97,608	$ 137,401	$ 142,290	$ 147,323	$ 152,502	$ 157,831	$ 163,315	$ 168,958
Anaerobic Digester	100%	0%													
			MW	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08
line loss:	10.4%		aMW	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.05	0.06
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031	$ 3,013
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567	$ 82,098
			Lump sum ($)	$ 347	$ 1,755	$ 7,879	$ 11,476	$ 22,485	$ 31,062	$ 31,599	$ 32,162	$ 32,750	$ 33,365	$ 34,007	$ 34,677

	% Penetration (by MW)			2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Biomass	**Com**	**Ind**												
Industrial	0%	100%												
			MW	0.59	0.65	0.71	0.77	0.81	0.84	0.87	0.89			
line loss:	6.9%		aMW	0.53	0.59	0.64	0.69	0.73	0.75	0.78	0.80	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344			
			O&M ($/MW)	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367			
			Lump sum ($)	$ 174,763	$ 180,736	$ 186,881	$ 170,586	$ 153,249	$ 111,422	$ 114,806	$ 118,282	Levelized Cost	$0.03	$/kWh
Anaerobic Digester	100%	0%												
			MW	0.09	0.09	0.10	0.11	0.12	0.12	0.13	0.13			
line loss:	10.4%		aMW	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871			
			O&M ($/MW)	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439			
			Lump sum ($)	$ 35,376	$ 36,105	$ 36,864	$ 33,861	$ 31,620	$ 29,613	$ 33,255	$ 43,723	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.27. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7
aMW	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6
Total Cost	$ 3,284	$ 14,033	$ 63,832	$ 96,584	$ 192,244	$ 274,363	$ 293,948	$ 314,959	$ 336,636	$ 359,343
Fuel ($/MN	$ 8.29	$ 8.09	$ 7.68	$ 7.47	$ 7.30	$ 7.39	$ 7.62	$ 7.94	$ 8.20	$ 8.47

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.4	1.5	1.5
aMW	0.7	0.8	0.9	1.0	1.1	1.2	1.2	1.3	1.3	1.4
Total Cost	$ 382,980	$ 406,954	$ 433,236	$ 455,261	$ 477,875	$ 460,441	$ 439,125	$ 376,826	$ 390,149	$ 412,235
Fuel ($/MN	$ 8.73	$ 8.93	$ 9.26	$ 9.17	$ 9.11	$ 9.09	$ 9.00	$ 8.93	$ 8.85	$ 8.87

Table E.28. Combined Heat & Power Base Case Scenario:Non-Renewable ID

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.01	0.03	0.12	0.26	0.53	0.91	1.28	1.66	2.03	2.40	2.78
line loss:	9.2%		aMW	0.00	0.02	0.11	0.24	0.48	0.82	1.15	1.49	1.83	2.16	2.50
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 308	$ 313	$ 303	$ 303	$ 298	$ 301	$ 309	$ 318	$ 328	$ 339	$ 349
			Lump sum ($)	$ 12,699	$ 54,106	$ 245,825	$ 388,408	$ 774,445	$ 1,136,974	$ 1,289,850	$ 1,450,675	$ 1,621,197	$ 1,800,865	$ 1,988,513
Microturbine	65%	35%												
			MW	0.00	0.00	0.02	0.03	0.07	0.11	0.16	0.20	0.25	0.30	0.34
line loss:	9.2%		aMW	0.00	0.00	0.01	0.03	0.06	0.10	0.14	0.18	0.23	0.27	0.31
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 456	$ 463	$ 448	$ 449	$ 442	$ 446	$ 458	$ 471	$ 486	$ 501	$ 516
			Lump sum ($)	$ 1,988	$ 9,381	$ 42,070	$ 65,571	$ 129,173	$ 187,543	$ 210,956	$ 235,715	$ 262,135	$ 290,114	$ 319,435
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.04	0.06	0.09	0.12	0.14	0.17	0.19
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.04	0.06	0.08	0.11	0.13	0.16	0.18
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 375	$ 381	$ 369	$ 369	$ 363	$ 366	$ 376	$ 387	$ 399	$ 412	$ 425
			Lump sum ($)	$ 1,789	$ 9,291	$ 40,681	$ 59,281	$ 113,658	$ 156,504	$ 162,642	$ 169,473	$ 177,140	$ 185,590	$ 196,380
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.04	0.06	0.09	0.11	0.14	0.16	0.19
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.03	0.06	0.08	0.11	0.13	0.16	0.18
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 427	$ 433	$ 419	$ 420	$ 413	$ 417	$ 428	$ 440	$ 454	$ 469	$ 483
			Lump sum ($)	$ 678	$ 3,640	$ 16,513	$ 26,590	$ 53,029	$ 78,804	$ 91,509	$ 104,907	$ 119,160	$ 134,214	$ 149,959

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.08	$/kWh
Recip Engine	65%	35%													
			MW	3.15	3.53	3.90	4.27	4.60	4.86	5.02	5.18	5.34			
line loss:	9.2%		aMW	2.84	3.17	3.51	3.85	4.14	4.38	4.52	4.66	4.81	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 357	$ 371	$ 368	$ 366	$ 366	$ 362	$ 360	$ 357	$ 358			
			Lump sum ($)	$ 2,177,749	$ 2,395,156	$ 2,560,828	$ 2,731,361	$ 2,754,064	$ 2,738,578	$ 2,543,791	$ 2,613,524	$ 2,702,975	Levelized Cost	$0.08	$/kWh
Microturbine	65%	35%													
			MW	0.39	0.43	0.48	0.53	0.57	0.60	0.62	0.64	0.66			
line loss:	9.2%		aMW	0.35	0.39	0.43	0.47	0.51	0.54	0.56	0.58	0.59	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 528	$ 550	$ 545	$ 542	$ 541	$ 536	$ 532	$ 528	$ 530			
			Lump sum ($)	$ 348,928	$ 383,443	$ 408,389	$ 434,094	$ 440,293	$ 444,166	$ 443,052	$ 467,506	$ 526,669	Levelized Cost	$0.11	$/kWh
Fuel Cell	65%	35%													
			MW	0.22	0.25	0.27	0.30	0.32	0.34	0.35	0.36	0.37			
line loss:	9.2%		aMW	0.21	0.23	0.26	0.28	0.30	0.32	0.33	0.34	0.35	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 434	$ 452	$ 448	$ 446	$ 445	$ 441	$ 438	$ 434	$ 436			
			Lump sum ($)	$ 210,438	$ 243,468	$ 261,655	$ 304,510	$ 321,274	$ 308,479	$ 280,469	$ 280,026	$ 281,320	Levelized Cost	$0.16	$/kWh
Gas Turbine	65%	35%													
			MW	0.21	0.24	0.27	0.29	0.31	0.33	0.34	0.35	0.36			
line loss:	9.2%		aMW	0.20	0.23	0.25	0.28	0.30	0.31	0.32	0.33	0.35	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 494	$ 514	$ 510	$ 507	$ 506	$ 502	$ 498	$ 494	$ 496			
			Lump sum ($)	$ 165,790	$ 184,209	$ 197,689	$ 211,558	$ 215,695	$ 216,501	$ 205,068	$ 210,344	$ 217,439	Levelized Cost	$0.08	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.29. Combined Heat & Power Base Case Scenario:Renewable ID

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Biomass	**Com**	**Ind**													
Industrial	0%	100%													
			MW	0.02	0.11	0.51	1.08	2.20	3.75	5.29	6.83	8.38	9.92	11.46	13.01
line loss:	6.9%		aMW	0.02	0.10	0.46	0.97	1.98	3.37	4.76	6.15	7.54	8.93	10.32	11.71
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068	$ 2,097
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584	$ 48,488
			Lump sum ($)	$ 42,872	$ 177,377	$ 811,879	$ 1,205,790	$ 2,408,151	$ 3,389,914	$ 3,510,545	$ 3,634,700	$ 3,762,472	$ 3,893,958	$ 4,029,258	$ 4,168,473
Anaerobic Digester	100%	0%													
			MW	0.00	0.01	0.03	0.06	0.11	0.19	0.28	0.36	0.44	0.52	0.60	0.68
line loss:	10.4%		aMW	0.00	0.00	0.02	0.04	0.09	0.16	0.22	0.28	0.35	0.41	0.48	0.54
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031	$ 3,013
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567	$ 82,098
			Lump sum ($)	$ 3,073	$ 15,530	$ 69,713	$ 101,549	$ 198,956	$ 274,854	$ 279,607	$ 284,583	$ 289,788	$ 295,229	$ 300,911	$ 306,842

	% Penetration (by MW)			2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Biomass	**Com**	**Ind**												
Industrial	0%	100%												
			MW	14.55	16.09	17.64	18.96	20.06	20.72	21.38	22.04			
line loss:	6.9%		aMW	13.09	14.48	15.87	17.06	18.05	18.65	19.24	19.84	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344			
			O&M ($/MW)	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367			
			Lump sum ($)	$ 4,311,708	$ 4,459,070	$ 4,610,670	$ 4,208,653	$ 3,780,909	$ 2,748,959	$ 2,832,456	$ 2,918,228	Levelized Cost	$0.03	$/kWh
Anaerobic Digester	100%	0%												
			MW	0.76	0.84	0.92	0.99	1.04	1.08	1.11	1.15			
line loss:	10.4%		aMW	0.61	0.67	0.73	0.79	0.83	0.86	0.89	0.92	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871			
			O&M ($/MW)	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439			
			Lump sum ($)	$ 313,027	$ 319,473	$ 326,188	$ 299,616	$ 279,787	$ 262,034	$ 294,259	$ 386,880	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.30. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.1	0.7	1.4	2.9	4.9	6.9	9.0	11.0	13.0
aMW	0.0	0.1	0.6	1.3	2.6	4.4	6.2	8.0	9.8	11.7
Total Cost	$ 59,320	$ 250,651	$ 1,143,918	$ 1,722,309	$ 3,434,524	$ 4,880,447	$ 5,171,368	$ 5,474,675	$ 5,792,380	$ 6,123,981
Fuel ($/MMBT	$ 7.77	$ 7.88	$ 7.64	$ 7.64	$ 7.53	$ 7.59	$ 7.80	$ 8.02	$ 8.27	$ 8.54
	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
MW	15.0	17.0	19.1	21.1	23.1	24.9	26.3	27.2	28.0	28.9
aMW	13.5	15.3	17.1	18.9	20.7	22.3	23.6	24.4	25.1	25.9
Total Cost	$ 6,468,304	$ 6,818,465	$ 7,203,657	$ 7,536,562	$ 7,879,219	$ 7,477,418	$ 7,015,116	$ 5,759,158	$ 5,949,854	$ 6,224,756
Fuel ($/MMBT	$ 8.80	$ 9.00	$ 9.36	$ 9.28	$ 9.23	$ 9.22	$ 9.13	$ 9.07	$ 9.00	$ 9.03

Table E.31. Combined Heat & Power Base Case Scenario:Non-Renewable OR

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	Com	Ind												
Recip Engine	65%	35%												
			MW	0.01	0.06	0.29	0.62	1.28	2.17	3.06	3.95	4.85	5.74	6.63
line loss:	9.2%		aMW	0.01	0.06	0.26	0.56	1.15	1.95	2.75	3.56	4.36	5.16	5.97
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 328	$ 321	$ 304	$ 296	$ 290	$ 293	$ 302	$ 315	$ 325	$ 336	$ 346
			Lump sum ($)	$ 30,816	$ 130,766	$ 592,319	$ 931,285	$ 1,854,438	$ 2,721,876	$ 3,085,860	$ 3,482,190	$ 3,891,179	$ 4,322,112	$ 4,772,271
Microturbine	65%	35%												
			MW	0.00	0.01	0.04	0.08	0.16	0.27	0.38	0.49	0.60	0.71	0.82
line loss:	9.2%		aMW	0.00	0.01	0.03	0.07	0.14	0.24	0.34	0.44	0.54	0.64	0.74
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 486	$ 475	$ 451	$ 438	$ 429	$ 434	$ 447	$ 466	$ 482	$ 497	$ 513
			Lump sum ($)	$ 4,831	$ 22,676	$ 101,374	$ 157,166	$ 309,147	$ 448,694	$ 504,317	$ 565,591	$ 628,915	$ 695,977	$ 766,273
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.28	0.34	0.40	0.46
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.08	0.14	0.20	0.26	0.32	0.38	0.44
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 400	$ 391	$ 370	$ 361	$ 353	$ 357	$ 368	$ 383	$ 396	$ 409	$ 422
			Lump sum ($)	$ 4,328	$ 22,413	$ 97,987	$ 142,406	$ 272,797	$ 375,500	$ 389,930	$ 407,149	$ 425,474	$ 445,677	$ 471,517
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.27	0.33	0.39	0.45
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.08	0.14	0.20	0.26	0.31	0.37	0.43
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 455	$ 445	$ 422	$ 410	$ 401	$ 406	$ 418	$ 436	$ 451	$ 465	$ 480
			Lump sum ($)	$ 1,654	$ 8,810	$ 39,799	$ 63,654	$ 126,716	$ 188,262	$ 218,466	$ 251,581	$ 285,749	$ 321,839	$ 359,593

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	Com	Ind											Avg Lev Avoided C	$0.08	$/kWh
Recip Engine	65%	35%													
			MW	7.52	8.42	9.31	10.20	10.97	11.60	11.99	12.37	12.75			
line loss:	9.2%		aMW	6.77	7.57	8.38	9.18	9.87	10.44	10.79	11.13	11.48	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 354	$ 367	$ 363	$ 361	$ 361	$ 357	$ 354	$ 351	$ 352			
			Lump sum ($)	$ 5,226,268	$ 5,734,685	$ 6,128,657	$ 6,532,544	$ 6,580,573	$ 6,536,038	$ 6,061,556	$ 6,223,463	$ 6,432,830	Levelized Cost	$0.08	$/kWh
Microturbine	65%	35%													
			MW	0.93	1.04	1.15	1.26	1.35	1.43	1.48	1.53	1.57			
line loss:	9.2%		aMW	0.83	0.93	1.03	1.13	1.22	1.29	1.33	1.37	1.42	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 524	$ 543	$ 538	$ 535	$ 534	$ 528	$ 524	$ 519	$ 521			
			Lump sum ($)	$ 836,986	$ 917,342	$ 976,506	$ 1,037,172	$ 1,050,885	$ 1,058,889	$ 1,055,210	$ 1,112,996	$ 1,254,352	Levelized Cost	$0.12	$/kWh
Fuel Cell	65%	35%													
			MW	0.52	0.59	0.65	0.71	0.76	0.81	0.83	0.86	0.89			
line loss:	9.2%		aMW	0.50	0.56	0.62	0.67	0.73	0.77	0.79	0.82	0.84	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 431	$ 447	$ 443	$ 440	$ 439	$ 434	$ 431	$ 427	$ 428			
			Lump sum ($)	$ 505,227	$ 583,479	$ 626,851	$ 729,470	$ 769,274	$ 737,850	$ 669,943	$ 668,367	$ 670,974	Levelized Cost	$0.16	$/kWh
Gas Turbine	65%	35%													
			MW	0.51	0.57	0.63	0.69	0.75	0.79	0.81	0.84	0.87			
line loss:	9.2%		aMW	0.49	0.54	0.60	0.66	0.71	0.75	0.77	0.80	0.82	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 491	$ 508	$ 504	$ 501	$ 499	$ 494	$ 490	$ 486	$ 487			
			Lump sum ($)	$ 397,555	$ 440,488	$ 472,480	$ 505,240	$ 514,577	$ 515,834	$ 487,791	$ 499,929	$ 516,445	Levelized Cost	$0.08	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.32. Combined Heat & Power Base Case Scenario:Renewable OR

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	**Com**	**Ind**												
Industrial	0%	100%												
			MW	0.03	0.13	0.60	1.27	2.59	4.40	6.21	8.02	9.83	11.64	13.45
line loss:	6.9%		aMW	0.02	0.12	0.54	1.14	2.33	3.96	5.59	7.22	8.85	10.48	12.11
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 50,412	$ 208,574	$ 954,670	$ 1,417,861	$ 2,831,691	$ 3,986,124	$ 4,127,972	$ 4,273,962	$ 4,424,206	$ 4,578,818	$ 4,737,914
Anaerobic Digester	100%	0%												
			MW	0.00	0.01	0.03	0.06	0.13	0.23	0.32	0.41	0.50	0.60	0.69
line loss:	10.4%		aMW	0.00	0.01	0.02	0.05	0.11	0.18	0.25	0.33	0.40	0.48	0.55
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 3,595	$ 18,167	$ 81,550	$ 118,791	$ 232,737	$ 321,522	$ 327,082	$ 332,902	$ 338,992	$ 345,356	$ 352,003

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost	
Biomass	**Com**	**Ind**												
Industrial	0%	100%												
			MW	15.27	17.08	18.89	20.70	22.25	23.54	24.32	25.10	25.87		
line loss:	6.9%		aMW	13.74	15.37	17.00	18.63	20.03	21.19	21.89	22.59	23.29	Capacity Factor	80%
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344		
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367		
			Lump sum ($)	$ 4,901,614	$ 5,070,041	$ 5,243,321	$ 5,421,583	$ 4,948,861	$ 4,445,885	$ 3,232,439	$ 3,330,621	$ 3,431,479	Levelized Cost	$0.03 $/kWh
Anaerobic Digester	100%	0%												
			MW	0.78	0.87	0.97	1.06	1.14	1.20	1.24	1.28	1.32		
line loss:	10.4%		aMW	0.62	0.70	0.77	0.85	0.91	0.96	1.00	1.03	1.06	Capacity Factor	80%
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871		
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439		
			Lump sum ($)	$ 358,941	$ 366,176	$ 373,717	$ 381,572	$ 350,489	$ 327,292	$ 306,525	$ 344,222	$ 452,569	Levelized Cost	$0.07 $/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.33. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.2	0.9	2.0	4.0	6.8	9.6	12.4	15.2	18.0
aMW	0.0	0.2	0.8	1.8	3.6	6.1	8.6	11.1	13.6	16.1
Total Cost	$ 84,821	$ 357,501	$ 1,628,510	$ 2,467,873	$ 4,918,732	$ 7,029,289	$ 7,540,580	$ 8,088,615	$ 8,653,828	$ 9,245,624
Fuel ($/MW	$ 8.29	$ 8.09	$ 7.68	$ 7.47	$ 7.30	$ 7.39	$ 7.62	$ 7.94	$ 8.20	$ 8.47

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	20.8	23.6	26.4	29.2	32.0	34.4	36.4	37.6	38.8	39.9
aMW	18.6	21.1	23.6	26.1	28.7	30.8	32.6	33.7	34.7	35.8
Total Cost	$ 9,861,409	$ 10,485,922	$ 11,169,875	$ 11,744,536	$ 12,334,405	$ 11,878,506	$ 11,307,688	$ 9,598,911	$ 9,896,616	$ 10,315,102
Fuel ($/MW	$ 8.73	$ 8.93	$ 9.26	$ 9.17	$ 9.11	$ 9.09	$ 9.00	$ 8.93	$ 8.85	$ 8.87

Table E.34. Combined Heat & Power Base Case Scenario:Non-Renewable UT

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.03	0.13	0.59	1.25	2.55	4.33	6.12	7.90	9.69	11.47	13.25
line loss:	9.2%		aMW	0.02	0.11	0.53	1.12	2.29	3.90	5.51	7.11	8.72	10.32	11.93
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 296	$ 300	$ 290	$ 290	$ 285	$ 287	$ 295	$ 303	$ 313	$ 323	$ 332
			Lump sum ($)	$ 60,974	$ 259,560	$ 1,178,991	$ 1,858,751	$ 3,704,651	$ 5,429,653	$ 6,141,103	$ 6,889,631	$ 7,683,259	$ 8,519,233	$ 9,392,033
Microturbine	65%	35%												
			MW	0.00	0.02	0.07	0.15	0.31	0.53	0.75	0.97	1.19	1.41	1.63
line loss:	9.2%		aMW	0.00	0.01	0.07	0.14	0.28	0.48	0.68	0.88	1.07	1.27	1.47
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 439	$ 445	$ 430	$ 430	$ 422	$ 425	$ 436	$ 449	$ 463	$ 478	$ 492
			Lump sum ($)	$ 9,539	$ 44,989	$ 201,696	$ 313,594	$ 617,429	$ 894,661	$ 1,002,856	$ 1,117,312	$ 1,239,479	$ 1,368,839	$ 1,504,369
Fuel Cell	65%	35%												
			MW	0.00	0.01	0.04	0.09	0.18	0.30	0.43	0.55	0.67	0.80	0.92
line loss:	9.2%		aMW	0.00	0.01	0.04	0.08	0.17	0.29	0.40	0.52	0.64	0.76	0.88
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 361	$ 366	$ 353	$ 353	$ 347	$ 350	$ 359	$ 369	$ 381	$ 393	$ 405
			Lump sum ($)	$ 8,605	$ 44,696	$ 195,649	$ 284,691	$ 545,605	$ 750,269	$ 777,675	$ 808,319	$ 842,852	$ 881,011	$ 930,319
Gas Turbine	65%	35%												
			MW	0.00	0.01	0.04	0.08	0.17	0.29	0.42	0.54	0.66	0.78	0.90
line loss:	9.2%		aMW	0.00	0.01	0.04	0.08	0.16	0.28	0.40	0.51	0.63	0.74	0.86
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 410	$ 416	$ 402	$ 402	$ 395	$ 398	$ 408	$ 420	$ 433	$ 447	$ 461
			Lump sum ($)	$ 3,243	$ 17,423	$ 79,016	$ 126,872	$ 252,881	$ 374,977	$ 433,817	$ 495,877	$ 561,904	$ 631,631	$ 704,531

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.08	$/kWh
Recip Engine	65%	35%													
			MW	15.04	16.82	18.61	20.39	21.92	23.20	23.96	24.73	25.49			
line loss:	9.2%		aMW	13.54	15.14	16.75	18.35	19.73	20.88	21.56	22.25	22.94	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 340	$ 354	$ 350	$ 348	$ 347	$ 344	$ 341	$ 338	$ 339			
			Lump sum ($)	$ 10,271,453	$ 11,283,177	$ 12,049,397	$ 12,837,712	$ 12,915,783	$ 12,814,410	$ 11,855,997	$ 12,173,230	$ 12,583,336	Levelized Cost	$0.08	$/kWh
Microturbine	65%	35%													
			MW	1.85	2.07	2.29	2.51	2.70	2.86	2.95	3.05	3.14			
line loss:	9.2%		aMW	1.67	1.87	2.06	2.26	2.43	2.57	2.66	2.74	2.83	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 503	$ 524	$ 519	$ 515	$ 514	$ 509	$ 505	$ 500	$ 501			
			Lump sum ($)	$ 1,640,539	$ 1,800,279	$ 1,914,601	$ 2,032,339	$ 2,056,497	$ 2,070,310	$ 2,061,491	$ 2,175,953	$ 2,457,419	Levelized Cost	$0.11	$/kWh
Fuel Cell	65%	35%													
			MW	1.05	1.17	1.30	1.42	1.53	1.62	1.67	1.72	1.77			
line loss:	9.2%		aMW	0.99	1.11	1.23	1.35	1.45	1.53	1.58	1.64	1.69	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 414	$ 431	$ 426	$ 424	$ 423	$ 418	$ 415	$ 411	$ 412			
			Lump sum ($)	$ 995,301	$ 1,151,486	$ 1,236,420	$ 1,440,226	$ 1,518,423	$ 1,454,445	$ 1,317,741	$ 1,313,982	$ 1,318,416	Levelized Cost	$0.16	$/kWh
Gas Turbine	65%	35%													
			MW	1.02	1.14	1.27	1.39	1.49	1.58	1.63	1.68	1.73			
line loss:	9.2%		aMW	0.97	1.09	1.20	1.32	1.42	1.50	1.55	1.60	1.65	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 471	$ 490	$ 485	$ 482	$ 481	$ 476	$ 472	$ 468	$ 469			
			Lump sum ($)	$ 777,750	$ 863,118	$ 925,038	$ 988,709	$ 1,005,704	$ 1,007,077	$ 950,154	$ 973,799	$ 1,006,009	Levelized Cost	$0.08	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.35. Combined Heat & Power Base Case Scenario:Renewable UT

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.01	0.07	0.32	0.67	1.38	2.34	3.30	4.26	5.23	6.19	7.15
line loss:	6.9%		aMW	0.01	0.06	0.28	0.61	1.24	2.10	2.97	3.84	4.70	5.57	6.44
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 26,818	$ 110,958	$ 507,868	$ 754,278	$ 1,506,411	$ 2,120,550	$ 2,196,011	$ 2,273,675	$ 2,353,603	$ 2,435,853	$ 2,520,490
Anaerobic Digester	100%	0%												
			MW	0.00	0.01	0.04	0.09	0.18	0.31	0.44	0.56	0.69	0.82	0.95
line loss:	10.4%		aMW	0.00	0.01	0.03	0.07	0.15	0.25	0.35	0.45	0.55	0.66	0.76
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 4,961	$ 25,072	$ 112,545	$ 163,940	$ 321,193	$ 443,722	$ 451,395	$ 459,428	$ 467,831	$ 476,615	$ 485,789

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost	
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	8.11	9.08	10.04	11.00	11.83	12.51	12.93	13.34	13.75		
line loss:	6.9%		aMW	7.30	8.17	9.03	9.90	10.64	11.26	11.63	12.00	12.38	Capacity Factor	80%
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344		
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367		
			Lump sum ($)	$ 2,607,575	$ 2,697,176	$ 2,789,358	$ 2,884,190	$ 2,632,710	$ 2,365,136	$ 1,719,602	$ 1,771,834	$ 1,825,488	Levelized Cost	$0.03 $/kWh
Anaerobic Digester	100%	0%												
			MW	1.07	1.20	1.33	1.46	1.57	1.66	1.71	1.77	1.82		
line loss:	10.4%		aMW	0.86	0.96	1.06	1.17	1.25	1.33	1.37	1.41	1.46	Capacity Factor	80%
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871		
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439		
			Lump sum ($)	$ 495,363	$ 505,348	$ 515,755	$ 526,595	$ 483,698	$ 451,685	$ 423,025	$ 475,050	$ 624,576	Levelized Cost	$0.07 $/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.36. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.2	1.0	2.1	4.3	7.3	10.3	13.3	16.3	19.3
aMW	0.0	0.2	0.9	1.9	3.8	6.5	9.2	11.9	14.6	17.3
Total Cost	$ 95,994	$ 413,001	$ 1,878,361	$ 2,903,713	$ 5,784,871	$ 8,368,443	$ 9,221,665	$ 10,117,741	$ 11,065,510	$ 12,062,021
Fuel ($/MM	$ 7.47	$ 7.58	$ 7.32	$ 7.32	$ 7.19	$ 7.25	$ 7.44	$ 7.65	$ 7.89	$ 8.14

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	22.3	25.2	28.2	31.2	34.2	36.8	38.9	40.2	41.5	42.8
aMW	20.0	22.7	25.4	28.0	30.7	33.0	35.0	36.1	37.3	38.4
Total Cost	$ 13,101,299	$ 14,150,355	$ 15,346,783	$ 16,277,254	$ 17,234,645	$ 17,035,089	$ 16,635,282	$ 14,945,594	$ 15,390,564	$ 16,035,892
Fuel ($/MM	$ 8.39	$ 8.57	$ 8.92	$ 8.83	$ 8.78	$ 8.76	$ 8.67	$ 8.60	$ 8.52	$ 8.54

Table E.37. Combined Heat & Power Base Case Scenario:Non-Renewable WA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.00	0.02	0.09	0.20	0.41	0.70	0.99	1.28	1.57	1.85	2.14
line loss:	9.2%		aMW	0.00	0.02	0.09	0.18	0.37	0.63	0.89	1.15	1.41	1.67	1.93
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 343	$ 336	$ 319	$ 311	$ 304	$ 309	$ 319	$ 333	$ 344	$ 355	$ 365
			Lump sum ($)	$ 9,954	$ 42,281	$ 191,529	$ 301,858	$ 601,258	$ 884,298	$ 1,006,492	$ 1,139,468	$ 1,276,120	$ 1,419,976	$ 1,570,187
Microturbine	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.05	0.09	0.12	0.16	0.19	0.23	0.26
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.05	0.08	0.11	0.14	0.17	0.21	0.24
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 508	$ 497	$ 472	$ 460	$ 451	$ 457	$ 472	$ 493	$ 509	$ 525	$ 541
			Lump sum ($)	$ 1,562	$ 7,335	$ 32,794	$ 50,980	$ 100,322	$ 145,952	$ 164,782	$ 185,499	$ 206,803	$ 229,337	$ 252,941
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.01	0.01	0.03	0.05	0.07	0.09	0.11	0.13	0.15
line loss:	9.2%		aMW	0.00	0.00	0.01	0.01	0.03	0.05	0.07	0.08	0.10	0.12	0.14
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 418	$ 409	$ 388	$ 378	$ 371	$ 376	$ 388	$ 405	$ 418	$ 432	$ 445
			Lump sum ($)	$ 1,395	$ 7,223	$ 31,582	$ 45,973	$ 88,099	$ 121,463	$ 126,545	$ 132,557	$ 138,890	$ 145,841	$ 154,617
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.01	0.01	0.03	0.05	0.07	0.09	0.11	0.13	0.15
line loss:	9.2%		aMW	0.00	0.00	0.01	0.01	0.03	0.05	0.06	0.08	0.10	0.12	0.14
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 475	$ 465	$ 442	$ 431	$ 422	$ 428	$ 442	$ 461	$ 476	$ 491	$ 506
			Lump sum ($)	$ 537	$ 2,856	$ 12,904	$ 20,703	$ 41,229	$ 61,414	$ 71,613	$ 82,784	$ 94,257	$ 106,361	$ 119,017

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.08	$/kWh
Recip Engine	65%	35%													
			MW	2.43	2.72	3.01	3.30	3.54	3.75	3.87	4.00	4.12			
line loss:	9.2%		aMW	2.19	2.45	2.71	2.97	3.19	3.38	3.49	3.60	3.71	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 373	$ 387	$ 383	$ 382	$ 381	$ 377	$ 375	$ 372	$ 373			
			Lump sum ($)	$ 1,721,632	$ 1,891,613	$ 2,023,437	$ 2,159,236	$ 2,180,191	$ 2,170,668	$ 2,021,391	$ 2,076,555	$ 2,147,192	Levelized Cost	$0.08	$/kWh
Microturbine	65%	35%													
			MW	0.30	0.34	0.37	0.41	0.44	0.46	0.48	0.49	0.51			
line loss:	9.2%		aMW	0.27	0.30	0.33	0.37	0.39	0.42	0.43	0.44	0.46	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 553	$ 573	$ 568	$ 565	$ 564	$ 559	$ 555	$ 551	$ 552			
			Lump sum ($)	$ 276,680	$ 303,710	$ 323,677	$ 344,271	$ 349,685	$ 353,129	$ 352,519	$ 371,657	$ 417,680	Levelized Cost	$0.12	$/kWh
Fuel Cell	65%	35%													
			MW	0.17	0.19	0.21	0.23	0.25	0.26	0.27	0.28	0.29			
line loss:	9.2%		aMW	0.16	0.18	0.20	0.22	0.23	0.25	0.26	0.26	0.27	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 455	$ 471	$ 467	$ 465	$ 464	$ 460	$ 456	$ 453	$ 454			
			Lump sum ($)	$ 165,921	$ 191,622	$ 206,001	$ 239,477	$ 252,731	$ 243,043	$ 221,496	$ 221,257	$ 222,382	Levelized Cost	$0.16	$/kWh
Gas Turbine	65%	35%													
			MW	0.17	0.18	0.20	0.22	0.24	0.26	0.26	0.27	0.28			
line loss:	9.2%		aMW	0.16	0.18	0.19	0.21	0.23	0.24	0.25	0.26	0.27	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 517	$ 536	$ 531	$ 529	$ 528	$ 523	$ 519	$ 515	$ 517			
			Lump sum ($)	$ 131,740	$ 146,159	$ 156,932	$ 168,027	$ 171,546	$ 172,401	$ 163,688	$ 167,884	$ 173,508	Levelized Cost	$0.09	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.38. Combined Heat & Power Base Case Scenario:Renewable WA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.01	0.03	0.15	0.32	0.65	1.10	1.56	2.01	2.46	2.92	3.37
line loss:	6.9%		aMW	0.01	0.03	0.13	0.29	0.58	0.99	1.40	1.81	2.22	2.63	3.03
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 12,618	$ 52,206	$ 238,955	$ 354,892	$ 708,776	$ 997,732	$ 1,033,236	$ 1,069,778	$ 1,107,384	$ 1,146,084	$ 1,185,906
Anaerobic Digester	100%	0%												
			MW	0.00	0.00	0.01	0.03	0.06	0.10	0.14	0.18	0.23	0.27	0.31
line loss:	10.4%		aMW	0.00	0.00	0.01	0.02	0.05	0.08	0.11	0.15	0.18	0.21	0.25
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 1,599	$ 8,080	$ 36,270	$ 52,833	$ 103,511	$ 142,998	$ 145,471	$ 148,060	$ 150,768	$ 153,599	$ 156,555

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost	
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	3.82	4.28	4.73	5.19	5.57	5.90	6.09	6.29	6.48		
line loss:	6.9%		aMW	3.44	3.85	4.26	4.67	5.02	5.31	5.48	5.66	5.83	Capacity Factor	80%
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344		
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367		
			Lump sum ($)	$ 1,226,880	$ 1,269,038	$ 1,312,410	$ 1,357,029	$ 1,238,706	$ 1,112,811	$ 809,083	$ 833,659	$ 858,903	Levelized Cost	$0.03 $/kWh
Anaerobic Digester	100%	0%												
			MW	0.35	0.39	0.43	0.48	0.51	0.54	0.56	0.58	0.59		
line loss:	10.4%		aMW	0.28	0.31	0.35	0.38	0.41	0.43	0.45	0.46	0.48	Capacity Factor	80%
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871		
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439		
			Lump sum ($)	$ 159,640	$ 162,858	$ 166,212	$ 169,706	$ 155,881	$ 145,564	$ 136,328	$ 153,094	$ 201,282	Levelized Cost	$0.07 $/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.39. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.1	0.3	0.5	1.1	1.9	2.7	3.5	4.3	5.0
aMW	0.0	0.1	0.2	0.5	1.0	1.7	2.4	3.1	3.8	4.5
Total Cost	$ 24,171	#######	$ 466,754	$ 709,583	$ 1,413,544	$ 2,025,028	$ 2,185,199	$ 2,357,305	$ 2,534,272	$ 2,719,659
Fuel ($/MM	$ 8.66	$ 8.47	$ 8.05	$ 7.84	$ 7.68	$ 7.79	$ 8.05	$ 8.40	$ 8.67	$ 8.94
	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
MW	5.8	6.6	7.4	8.2	9.0	9.6	10.2	10.5	10.9	11.2
aMW	5.2	5.9	6.6	7.3	8.0	8.6	9.1	9.4	9.7	10.0
Total Cost	$ 2,912,647	#######	$ 3,323,509	$ 3,502,059	$ 3,685,971	$ 3,574,779	$ 3,429,043	$ 2,966,803	$ 3,063,308	$ 3,207,377
Fuel ($/MM	$ 9.21	$ 9.42	$ 9.76	$ 9.67	$ 9.62	$ 9.61	$ 9.52	$ 9.46	$ 9.38	$ 9.41

Table E.40. Combined Heat & Power Base Case Scenario:Non-Renewable WY

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	Com	Ind												
Recip Engine	65%	35%												
			MW	0.01	0.07	0.31	0.66	1.35	2.30	3.25	4.20	5.14	6.09	7.04
line loss:	9.2%		aMW	0.01	0.06	0.28	0.60	1.22	2.07	2.92	3.78	4.63	5.48	6.33
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 303	$ 308	$ 298	$ 298	$ 293	$ 296	$ 304	$ 313	$ 323	$ 333	$ 343
			Lump sum ($)	$ 32,528	$ 138,550	$ 629,454	$ 993,764	$ 1,981,256	$ 2,907,151	$ 3,294,882	$ 3,702,841	$ 4,135,502	$ 4,591,458	$ 5,067,718
Microturbine	65%	35%												
			MW	0.00	0.01	0.04	0.08	0.17	0.28	0.40	0.52	0.63	0.75	0.87
line loss:	9.2%		aMW	0.00	0.01	0.03	0.07	0.15	0.26	0.36	0.47	0.57	0.68	0.78
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 449	$ 456	$ 441	$ 442	$ 435	$ 438	$ 450	$ 463	$ 478	$ 493	$ 508
			Lump sum ($)	$ 5,091	$ 24,019	$ 107,709	$ 167,728	$ 330,367	$ 479,350	$ 538,597	$ 601,266	$ 668,166	$ 739,033	$ 813,313
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.02	0.05	0.09	0.16	0.23	0.29	0.36	0.42	0.49
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.28	0.34	0.40	0.47
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 369	$ 375	$ 363	$ 363	$ 357	$ 361	$ 370	$ 381	$ 393	$ 406	$ 418
			Lump sum ($)	$ 4,586	$ 23,818	$ 104,275	$ 151,873	$ 291,143	$ 400,719	$ 416,082	$ 433,211	$ 452,468	$ 473,720	$ 500,963
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.02	0.05	0.09	0.16	0.22	0.29	0.35	0.41	0.48
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.27	0.33	0.39	0.45
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 420	$ 427	$ 413	$ 413	$ 407	$ 410	$ 421	$ 433	$ 447	$ 462	$ 476
			Lump sum ($)	$ 1,733	$ 9,313	$ 42,246	$ 67,958	$ 135,510	$ 201,237	$ 233,410	$ 267,343	$ 303,454	$ 341,606	$ 381,513

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	Com	Ind											Avg Lev Avoided C	$0.08	$/kWh
Recip Engine	65%	35%													
			MW	7.98	8.93	9.88	10.83	11.64	12.31	12.72	13.13	13.53			
line loss:	9.2%		aMW	7.19	8.04	8.89	9.74	10.47	11.08	11.45	11.81	12.18	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 351	$ 366	$ 362	$ 360	$ 360	$ 356	$ 354	$ 351	$ 352			
			Lump sum ($)	$ 5,547,936	$ 6,100,125	$ 6,519,828	$ 6,951,859	$ 7,005,113	$ 6,961,099	$ 6,458,350	$ 6,634,343	$ 6,860,744	Levelized Cost	$0.08	$/kWh
Microturbine	65%	35%													
			MW	0.98	1.10	1.22	1.33	1.43	1.52	1.57	1.62	1.67			
line loss:	9.2%		aMW	0.89	0.99	1.10	1.20	1.29	1.37	1.41	1.46	1.50	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 520	$ 541	$ 536	$ 533	$ 533	$ 527	$ 524	$ 519	$ 521			
			Lump sum ($)	$ 888,013	$ 975,542	$ 1,038,565	$ 1,103,510	$ 1,118,502	$ 1,127,661	$ 1,124,272	$ 1,186,484	$ 1,337,727	Levelized Cost	$0.11	$/kWh
Fuel Cell	65%	35%													
			MW	0.56	0.62	0.69	0.75	0.81	0.86	0.89	0.91	0.94			
line loss:	9.2%		aMW	0.53	0.59	0.65	0.72	0.77	0.81	0.84	0.87	0.90	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 428	$ 445	$ 441	$ 439	$ 438	$ 434	$ 431	$ 427	$ 429			
			Lump sum ($)	$ 536,581	$ 620,855	$ 667,063	$ 776,561	$ 819,156	$ 785,960	$ 713,838	$ 712,450	$ 715,506	Levelized Cost	$0.16	$/kWh
Gas Turbine	65%	35%													
			MW	0.54	0.61	0.67	0.74	0.79	0.84	0.86	0.89	0.92			
line loss:	9.2%		aMW	0.52	0.58	0.64	0.70	0.75	0.80	0.82	0.85	0.87	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 487	$ 506	$ 502	$ 499	$ 498	$ 494	$ 490	$ 486	$ 488			
			Lump sum ($)	$ 421,630	$ 468,360	$ 502,439	$ 537,503	$ 547,648	$ 549,313	$ 519,702	$ 532,961	$ 550,872	Levelized Cost	$0.08	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.41. Combined Heat & Power Base Case Scenario:Renewable WY

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	**Com**	**Ind**												
Industrial	0%	100%												
			MW	0.01	0.07	0.33	0.70	1.42	2.42	3.42	4.41	5.41	6.41	7.40
line loss:	6.9%		aMW	0.01	0.06	0.29	0.63	1.28	2.18	3.07	3.97	4.87	5.76	6.66
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 27,734	$ 114,746	$ 525,205	$ 780,026	$ 1,557,833	$ 2,192,936	$ 2,270,972	$ 2,351,288	$ 2,433,944	$ 2,519,002	$ 2,606,528
Anaerobic Digester	100%	0%												
			MW	0.00	0.00	0.00	0.01	0.02	0.04	0.05	0.06	0.08	0.09	0.11
line loss:	10.4%		aMW	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.09
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 573	$ 2,895	$ 12,996	$ 18,931	$ 37,090	$ 51,239	$ 52,125	$ 53,052	$ 54,023	$ 55,037	$ 56,096

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost	
Biomass	**Com**	**Ind**												
Industrial	0%	100%												
			MW	8.40	9.39	10.39	11.39	12.24	12.95	13.38	13.81	14.23		
line loss:	6.9%		aMW	7.56	8.46	9.35	10.25	11.02	11.66	12.04	12.43	12.81	Capacity Factor	80%
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344		
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367		
			Lump sum ($)	$ 2,696,586	$ 2,789,245	$ 2,884,573	$ 2,982,643	$ 2,722,579	$ 2,445,870	$ 1,778,302	$ 1,832,316	$ 1,887,802	Levelized Cost	$0.03 $/kWh
Anaerobic Digester	100%	0%												
			MW	0.12	0.14	0.15	0.17	0.18	0.19	0.20	0.20	0.21		
line loss:	10.4%		aMW	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.16	0.17	Capacity Factor	80%
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871		
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439		
			Lump sum ($)	$ 57,202	$ 58,355	$ 59,557	$ 60,808	$ 55,855	$ 52,158	$ 48,849	$ 54,856	$ 72,123	Levelized Cost	$0.07 $/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.42. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.1	0.7	1.4	2.9	4.9	6.9	9.0	11.0	13.0
aMW	0.0	0.1	0.6	1.3	2.6	4.4	6.2	8.1	9.9	11.7
Total Cost	$ 62,567	$ 265,497	$ 1,209,871	$ 1,860,612	$ 3,711,550	$ 5,352,323	$ 5,851,044	$ 6,374,071	$ 6,926,356	$ 7,506,419
Fuel ($/MW	$ 7.65	$ 7.77	$ 7.52	$ 7.52	$ 7.40	$ 7.47	$ 7.67	$ 7.89	$ 8.14	$ 8.41

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	15.0	17.0	19.1	21.1	23.1	24.9	26.3	27.2	28.0	28.9
aMW	13.5	15.4	17.2	19.0	20.8	22.4	23.7	24.5	25.3	26.0
Total Cost	$ 8,111,050	$ 8,722,423	$ 9,415,023	$ 9,965,201	$ 10,531,477	$ 10,329,732	$ 10,006,863	$ 8,803,541	$ 9,052,730	$ 9,369,706
Fuel ($/MW	$ 8.66	$ 8.86	$ 9.22	$ 9.14	$ 9.09	$ 9.08	$ 8.99	$ 8.92	$ 8.85	$ 8.88

Table E.43. High Avoided Cost Scenario:Non-Renewable CA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.05	0.08	0.12	0.15	0.19	0.22	0.26
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.04	0.08	0.11	0.14	0.17	0.20	0.23
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 328	$ 321	$ 304	$ 296	$ 310	$ 405	$ 493	$ 530	$ 559	$ 567	$ 580
			Lump sum ($)	$ 1,199	$ 5,088	$ 23,047	$ 36,237	$ 73,078	$ 114,615	$ 140,982	$ 165,866	$ 191,894	$ 215,641	$ 241,063
Microturbine	65%	35%												
			MW	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.03
line loss:	9.2%		aMW	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 486	$ 475	$ 451	$ 438	$ 459	$ 600	$ 730	$ 785	$ 828	$ 840	$ 859
			Lump sum ($)	$ 188	$ 882	$ 3,944	$ 6,115	$ 12,197	$ 19,048	$ 23,441	$ 27,552	$ 31,863	$ 35,746	$ 39,925
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02
line loss:	9.2%		aMW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 400	$ 391	$ 370	$ 361	$ 377	$ 494	$ 601	$ 645	$ 681	$ 691	$ 706
			Lump sum ($)	$ 168	$ 872	$ 3,813	$ 5,541	$ 10,693	$ 15,349	$ 16,945	$ 18,417	$ 19,988	$ 21,365	$ 23,041
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02
line loss:	9.2%		aMW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 455	$ 445	$ 422	$ 410	$ 429	$ 562	$ 683	$ 734	$ 775	$ 786	$ 803
			Lump sum ($)	$ 64	$ 343	$ 1,549	$ 2,477	$ 5,017	$ 8,145	$ 10,470	$ 12,650	$ 14,933	$ 16,994	$ 19,208

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.12	$/kWh
Recip Engine	65%	35%													
			MW	0.29	0.33	0.36	0.40	0.43	0.45	0.47	0.48	0.50			
line loss:	9.2%		aMW	0.27	0.30	0.33	0.36	0.39	0.41	0.42	0.44	0.45	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 583	$ 617	$ 611	$ 608	$ 603	$ 599	$ 593	$ 588	$ 590			
			Lump sum ($)	$ 264,796	$ 298,311	$ 320,664	$ 344,110	$ 351,212	$ 354,957	$ 338,466	$ 347,096	$ 358,766	Levelized Cost	$0.09	$/kWh
Microturbine	65%	35%													
			MW	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.06			
line loss:	9.2%		aMW	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 863	$ 913	$ 904	$ 900	$ 893	$ 887	$ 879	$ 871	$ 873			
			Lump sum ($)	$ 43,784	$ 49,417	$ 53,002	$ 56,773	$ 58,262	$ 59,574	$ 59,790	$ 62,464	$ 68,608	Levelized Cost	$0.14	$/kWh
Fuel Cell	65%	35%													
			MW	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03			
line loss:	9.2%		aMW	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 709	$ 751	$ 744	$ 740	$ 735	$ 730	$ 723	$ 716	$ 718			
			Lump sum ($)	$ 24,867	$ 29,076	$ 31,359	$ 36,007	$ 38,000	$ 37,241	$ 34,766	$ 34,902	$ 35,302	Levelized Cost	$0.18	$/kWh
Gas Turbine	65%	35%													
			MW	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03			
line loss:	9.2%		aMW	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 807	$ 855	$ 846	$ 842	$ 836	$ 830	$ 822	$ 815	$ 817			
			Lump sum ($)	$ 21,257	$ 24,221	$ 26,127	$ 28,130	$ 28,986	$ 29,551	$ 28,646	$ 29,338	$ 30,312	Levelized Cost	$0.08	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.44. High Avoided Cost Scenario:Renewable CA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.28	0.34	0.40	0.46
line loss:	6.9%		aMW	0.00	0.00	0.02	0.04	0.08	0.14	0.19	0.25	0.31	0.36	0.42
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 1,738	$ 7,190	$ 32,907	$ 48,873	$ 97,608	$ 137,401	$ 142,290	$ 147,323	$ 152,502	$ 157,831	$ 163,315
Anaerobic Digester	100%	0%												
			MW	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.07
line loss:	10.4%		aMW	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.05
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 347	$ 1,755	$ 7,879	$ 11,476	$ 22,485	$ 31,062	$ 31,599	$ 32,162	$ 32,750	$ 33,365	$ 34,007

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost	
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.53	0.59	0.65	0.71	0.77	0.81	0.84	0.87	0.89		
line loss:	6.9%		aMW	0.47	0.53	0.59	0.64	0.69	0.73	0.75	0.78	0.80	Capacity Factor	80%
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344		
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367		
			Lump sum ($)	$ 168,958	$ 174,763	$ 180,736	$ 186,881	$ 170,586	$ 153,249	$ 111,422	$ 114,806	$ 118,282	Levelized Cost	$0.03 $/kWh
Anaerobic Digester	100%	0%												
			MW	0.08	0.09	0.09	0.10	0.11	0.12	0.12	0.13	0.13		
line loss:	10.4%		aMW	0.06	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	Capacity Factor	80%
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871		
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439		
			Lump sum ($)	$ 34,677	$ 35,376	$ 36,105	$ 36,864	$ 33,861	$ 31,620	$ 29,613	$ 33,255	$ 43,723	Levelized Cost	$0.07 $/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.45. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7
aMW	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6
Total Cost	$ 3,348	$ 14,375	$ 65,381	$ 99,060	$ 198,182	$ 291,214	$ 325,329	$ 357,982	$ 392,056	$ 423,804
Fuel ($/MM	$ 8.29	$ 8.09	$ 7.68	$ 7.47	$ 7.81	$ 10.23	$ 12.44	$ 13.37	$ 14.10	$ 14.31

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.5	1.6
aMW	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.3	1.3	1.4
Total Cost	$ 457,561	$ 489,651	$ 532,629	$ 563,585	$ 595,931	$ 584,587	$ 569,314	$ 508,080	$ 524,425	$ 551,010
Fuel ($/MM	$ 14.63	$ 14.70	$ 15.56	$ 15.40	$ 15.34	$ 15.22	$ 15.12	$ 14.97	$ 14.84	$ 14.87

Table E.46. High Avoided Cost Scenario:Non-Renewable ID

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	Com	Ind												
Recip Engine	65%	35%												
			MW	0.01	0.03	0.12	0.26	0.53	0.91	1.28	1.66	2.03	2.40	2.78
line loss:	9.2%		aMW	0.00	0.02	0.11	0.24	0.48	0.82	1.15	1.49	1.83	2.16	2.50
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 308	$ 313	$ 303	$ 303	$ 319	$ 416	$ 505	$ 535	$ 564	$ 572	$ 584
			Lump sum ($)	$ 12,699	$ 54,106	$ 245,825	$ 388,408	$ 784,572	$ 1,232,410	$ 1,518,273	$ 1,777,926	$ 2,057,047	$ 2,311,535	$ 2,583,954
Microturbine	65%	35%												
			MW	0.00	0.00	0.02	0.03	0.07	0.11	0.16	0.20	0.25	0.30	0.34
line loss:	9.2%		aMW	0.00	0.00	0.01	0.03	0.06	0.10	0.14	0.18	0.23	0.27	0.31
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 456	$ 463	$ 448	$ 449	$ 473	$ 617	$ 747	$ 792	$ 835	$ 847	$ 865
			Lump sum ($)	$ 1,988	$ 9,381	$ 42,070	$ 65,571	$ 131,022	$ 204,966	$ 252,657	$ 295,457	$ 341,703	$ 383,340	$ 428,137
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.04	0.06	0.09	0.12	0.14	0.17	0.19
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.04	0.06	0.08	0.11	0.13	0.16	0.18
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 375	$ 381	$ 369	$ 369	$ 389	$ 507	$ 615	$ 651	$ 687	$ 696	$ 711
			Lump sum ($)	$ 1,789	$ 9,291	$ 40,681	$ 59,281	$ 114,516	$ 164,595	$ 182,006	$ 197,215	$ 214,089	$ 228,881	$ 246,858
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.04	0.06	0.09	0.11	0.14	0.16	0.19
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.03	0.06	0.08	0.11	0.13	0.16	0.18
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 427	$ 433	$ 419	$ 420	$ 442	$ 577	$ 699	$ 741	$ 781	$ 792	$ 810
			Lump sum ($)	$ 678	$ 3,640	$ 16,513	$ 26,590	$ 53,983	$ 87,794	$ 113,027	$ 135,734	$ 160,217	$ 182,319	$ 206,049

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	Com	Ind											Avg Lev Avoided C	$0.13	$/kWh
Recip Engine	65%	35%													
			MW	3.15	3.53	3.90	4.27	4.60	4.86	5.02	5.18	5.34			
line loss:	9.2%		aMW	2.84	3.17	3.51	3.85	4.14	4.38	4.52	4.66	4.81	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 587	$ 624	$ 618	$ 616	$ 612	$ 609	$ 603	$ 598	$ 600			
			Lump sum ($)	$ 2,838,201	$ 3,206,700	$ 3,448,721	$ 3,703,714	$ 3,783,963	$ 3,829,136	$ 3,656,844	$ 3,753,134	$ 3,881,887	Levelized Cost	$0.09	$/kWh
Microturbine	65%	35%													
			MW	0.39	0.43	0.48	0.53	0.57	0.60	0.62	0.64	0.66			
line loss:	9.2%		aMW	0.35	0.39	0.43	0.47	0.51	0.54	0.56	0.58	0.59	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 869	$ 924	$ 915	$ 912	$ 906	$ 901	$ 893	$ 886	$ 889			
			Lump sum ($)	$ 469,498	$ 531,596	$ 570,480	$ 611,604	$ 628,308	$ 643,256	$ 646,248	$ 675,551	$ 741,888	Levelized Cost	$0.14	$/kWh
Fuel Cell	65%	35%													
			MW	0.22	0.25	0.27	0.30	0.32	0.34	0.35	0.36	0.37			
line loss:	9.2%		aMW	0.21	0.23	0.26	0.28	0.30	0.32	0.33	0.34	0.35	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 715	$ 760	$ 752	$ 750	$ 745	$ 741	$ 734	$ 729	$ 731			
			Lump sum ($)	$ 266,427	$ 312,265	$ 336,924	$ 386,939	$ 408,582	$ 400,929	$ 374,826	$ 376,634	$ 381,260	Levelized Cost	$0.18	$/kWh
Gas Turbine	65%	35%													
			MW	0.21	0.24	0.27	0.29	0.31	0.33	0.34	0.35	0.36			
line loss:	9.2%		aMW	0.20	0.23	0.25	0.28	0.30	0.31	0.32	0.33	0.35	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 813	$ 865	$ 856	$ 853	$ 848	$ 843	$ 836	$ 829	$ 832			
			Lump sum ($)	$ 228,004	$ 260,657	$ 281,329	$ 303,154	$ 312,712	$ 319,232	$ 309,918	$ 317,695	$ 328,493	Levelized Cost	$0.08	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.47. High Avoided Scenario:Renewable ID

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	**Com**	**Ind**												
Industrial	0%	100%												
			MW	0.02	0.11	0.51	1.08	2.20	3.75	5.29	6.83	8.38	9.92	11.46
line loss:	6.9%		aMW	0.02	0.10	0.46	0.97	1.98	3.37	4.76	6.15	7.54	8.93	10.32
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 42,872	$ 177,377	$ 811,879	$ 1,205,790	$ 2,408,151	$ 3,389,914	$ 3,510,545	$ 3,634,700	$ 3,762,472	$ 3,893,958	$ 4,029,258
Anaerobic Digester	100%	0%												
			MW	0.00	0.01	0.03	0.06	0.11	0.19	0.28	0.36	0.44	0.52	0.60
line loss:	10.4%		aMW	0.00	0.00	0.02	0.04	0.09	0.16	0.22	0.28	0.35	0.41	0.48
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 3,073	$ 15,530	$ 69,713	$ 101,549	$ 198,956	$ 274,854	$ 279,607	$ 284,583	$ 289,788	$ 295,229	$ 300,911

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Biomass	**Com**	**Ind**													
Industrial	0%	100%													
			MW	13.01	14.55	16.09	17.64	18.96	20.06	20.72	21.38	22.04			
line loss:	6.9%		aMW	11.71	13.09	14.48	15.87	17.06	18.05	18.65	19.24	19.84	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344			
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367			
			Lump sum ($)	$ 4,168,473	$ 4,311,708	$ 4,459,070	$ 4,610,670	$ 4,208,653	$ 3,780,909	$ 2,748,959	$ 2,832,456	$ 2,918,228	Levelized Cost	$0.03	$/kWh
Anaerobic Digester	100%	0%													
			MW	0.68	0.76	0.84	0.92	0.99	1.04	1.08	1.11	1.15			
line loss:	10.4%		aMW	0.54	0.61	0.67	0.73	0.79	0.83	0.86	0.89	0.92	Capacity Factor	80%	
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871			
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439			
			Lump sum ($)	$ 306,842	$ 313,027	$ 319,473	$ 326,188	$ 299,616	$ 279,787	$ 262,034	$ 294,259	$ 386,880	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.48. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.1	0.7	1.4	2.9	4.9	6.9	9.0	11.0	13.0
aMW	0.0	0.1	0.6	1.3	2.6	4.4	6.2	8.0	9.8	11.7
Total Cost	$ 59,320	$ 250,651	$ 1,143,918	$ 1,722,309	$ 3,445,605	$ 4,984,872	$ 5,421,309	$ 5,832,753	$ 6,269,287	$ 6,682,755
Fuel ($/MW	$ 7.77	$ 7.88	$ 7.64	$ 7.64	$ 8.05	$ 10.51	$ 12.73	$ 13.50	$ 14.22	$ 14.43

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	15.0	17.0	19.1	21.1	23.1	24.9	26.3	27.2	28.0	28.9
aMW	13.5	15.3	17.1	18.9	20.7	22.3	23.6	24.4	25.1	25.9
Total Cost	$ 7,119,836	$ 7,541,131	$ 8,091,649	$ 8,508,094	$ 8,943,168	$ 8,604,334	$ 8,208,405	$ 6,977,061	$ 7,196,816	$ 7,514,722
Fuel ($/MW	$ 14.74	$ 14.80	$ 15.74	$ 15.59	$ 15.54	$ 15.43	$ 15.35	$ 15.21	$ 15.09	$ 15.15

Table E.49. High Avoided Cost Scenario:Non-Renewable OR

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.01	0.06	0.29	0.62	1.28	2.17	3.06	3.95	4.85	5.74	6.63
line loss:	9.2%		aMW	0.01	0.06	0.26	0.56	1.15	1.95	2.75	3.56	4.36	5.16	5.97
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 343	$ 336	$ 319	$ 311	$ 326	$ 427	$ 521	$ 560	$ 591	$ 599	$ 612
			Lump sum ($)	$ 30,988	$ 131,630	$ 596,273	$ 939,754	$ 1,896,735	$ 2,988,712	$ 3,700,981	$ 4,372,562	$ 5,072,125	$ 5,708,593	$ 6,389,822
Microturbine	65%	35%												
			MW	0.00	0.01	0.04	0.08	0.16	0.27	0.38	0.49	0.60	0.71	0.82
line loss:	9.2%		aMW	0.00	0.01	0.03	0.07	0.14	0.24	0.34	0.44	0.54	0.64	0.74
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 508	$ 497	$ 472	$ 460	$ 482	$ 632	$ 771	$ 830	$ 875	$ 887	$ 906
			Lump sum ($)	$ 4,862	$ 22,834	$ 102,096	$ 158,712	$ 316,869	$ 497,407	$ 616,612	$ 728,135	$ 844,506	$ 949,089	$ 1,061,569
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.28	0.34	0.40	0.46
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.08	0.14	0.20	0.26	0.32	0.38	0.44
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 418	$ 409	$ 388	$ 378	$ 396	$ 520	$ 634	$ 682	$ 719	$ 729	$ 745
			Lump sum ($)	$ 4,342	$ 22,487	$ 98,323	$ 143,124	$ 276,382	$ 398,121	$ 442,076	$ 482,629	$ 525,586	$ 563,213	$ 608,642
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.27	0.33	0.39	0.45
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.08	0.14	0.20	0.26	0.31	0.37	0.43
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 475	$ 465	$ 442	$ 431	$ 451	$ 592	$ 722	$ 776	$ 818	$ 830	$ 848
			Lump sum ($)	$ 1,670	$ 8,891	$ 40,172	$ 64,452	$ 130,700	$ 213,398	$ 276,411	$ 335,455	$ 396,994	$ 452,446	$ 511,967

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.12	$/kWh
Recip Engine	65%	35%													
			MW	7.52	8.42	9.31	10.20	10.97	11.60	11.99	12.37	12.75			
line loss:	9.2%		aMW	6.77	7.57	8.38	9.18	9.87	10.44	10.79	11.13	11.48	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 615	$ 651	$ 644	$ 642	$ 638	$ 634	$ 629	$ 624	$ 626			
			Lump sum ($)	$ 7,025,084	$ 7,926,132	$ 8,528,010	$ 9,162,850	$ 9,372,435	$ 9,495,122	$ 9,086,893	$ 9,325,173	$ 9,642,779	Levelized Cost	$0.10	$/kWh
Microturbine	65%	35%													
			MW	0.93	1.04	1.15	1.26	1.35	1.43	1.48	1.53	1.57			
line loss:	9.2%		aMW	0.83	0.93	1.03	1.13	1.22	1.29	1.33	1.37	1.42	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 910	$ 963	$ 954	$ 951	$ 944	$ 939	$ 931	$ 924	$ 926			
			Lump sum ($)	$ 1,165,373	$ 1,317,407	$ 1,414,525	$ 1,517,354	$ 1,560,560	$ 1,599,092	$ 1,607,507	$ 1,679,235	$ 1,840,351	Levelized Cost	$0.14	$/kWh
Fuel Cell	65%	35%													
			MW	0.52	0.59	0.65	0.71	0.76	0.81	0.83	0.86	0.89			
line loss:	9.2%		aMW	0.50	0.56	0.62	0.67	0.73	0.77	0.79	0.82	0.84	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 748	$ 792	$ 784	$ 782	$ 777	$ 772	$ 765	$ 759	$ 762			
			Lump sum ($)	$ 657,718	$ 769,255	$ 830,252	$ 952,449	$ 1,005,949	$ 988,702	$ 926,411	$ 931,309	$ 943,091	Levelized Cost	$0.18	$/kWh
Gas Turbine	65%	35%													
			MW	0.51	0.57	0.63	0.69	0.75	0.79	0.81	0.84	0.87			
line loss:	9.2%		aMW	0.49	0.54	0.60	0.66	0.71	0.75	0.77	0.80	0.82	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 851	$ 901	$ 893	$ 890	$ 884	$ 879	$ 871	$ 864	$ 867			
			Lump sum ($)	$ 567,005	$ 646,923	$ 698,500	$ 753,016	$ 777,572	$ 794,581	$ 772,779	$ 792,111	$ 818,824	Levelized Cost	$0.08	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.50. High Avoided Cost Scenario:Renewable OR

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.03	0.13	0.60	1.27	2.59	4.40	6.21	8.02	9.83	11.64	13.45
line loss:	6.9%		aMW	0.02	0.12	0.54	1.14	2.33	3.96	5.59	7.22	8.85	10.48	12.11
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 50,412	$ 208,574	$ 954,670	$ 1,417,861	$ 2,831,691	$ 3,986,124	$ 4,127,972	$ 4,273,962	$ 4,424,206	$ 4,578,818	$ 4,737,914
Anaerobic Digester	100%	0%												
			MW	0.00	0.01	0.03	0.06	0.13	0.23	0.32	0.41	0.50	0.60	0.69
line loss:	10.4%		aMW	0.00	0.01	0.02	0.05	0.11	0.18	0.25	0.33	0.40	0.48	0.55
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 3,595	$ 18,167	$ 81,550	$ 118,791	$ 232,737	$ 321,522	$ 327,082	$ 332,902	$ 338,992	$ 345,356	$ 352,003

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost	
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	15.27	17.08	18.89	20.70	22.25	23.54	24.32	25.10	25.87		
line loss:	6.9%		aMW	13.74	15.37	17.00	18.63	20.03	21.19	21.89	22.59	23.29	Capacity Factor	80%
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344		
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367		
			Lump sum ($)	$ 4,901,614	$ 5,070,041	$ 5,243,321	$ 5,421,583	$ 4,948,861	$ 4,445,885	$ 3,232,439	$ 3,330,621	$ 3,431,479	Levelized Cost	$0.03 $/kWh
Anaerobic Digester	100%	0%												
			MW	0.78	0.87	0.97	1.06	1.14	1.20	1.24	1.28	1.32		
line loss:	10.4%		aMW	0.62	0.70	0.77	0.85	0.91	0.96	1.00	1.03	1.06	Capacity Factor	80%
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871		
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439		
			Lump sum ($)	$ 358,941	$ 366,176	$ 373,717	$ 381,572	$ 350,489	$ 327,292	$ 306,525	$ 344,222	$ 452,569	Levelized Cost	$0.07 $/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.51. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.2	0.9	2.0	4.1	6.9	9.8	12.7	15.5	18.4
aMW	0.0	0.2	0.8	1.8	3.7	6.2	8.8	11.4	13.9	16.5
Total Cost	$ 86,664	$ 367,257	$ 1,672,636	$ 2,540,794	$ 5,091,729	$ 7,509,523	$ 8,432,111	$ 9,314,442	$ 10,231,769	$ 11,084,551
Fuel ($/MM	$ 8.66	$ 8.47	$ 8.05	$ 7.84	$ 8.21	$ 10.77	$ 13.14	$ 14.13	$ 14.90	$ 15.11

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	21.2	24.1	26.9	29.8	32.7	35.1	37.1	38.4	39.6	40.8
aMW	19.1	21.6	24.2	26.8	29.3	31.5	33.3	34.4	35.5	36.6
Total Cost	$ 11,990,926	$ 12,851,742	$14,008,244	$ 14,842,390	$ 15,717,728	$ 15,447,940	$ 15,061,354	$ 13,397,027	$ 13,790,436	$ 14,343,874
Fuel ($/MM	$ 15.43	$ 15.50	$ 16.41	$ 16.25	$ 16.20	$ 16.09	$ 16.00	$ 15.86	$ 15.73	$ 15.78

Table E.52. High Avoided Cost Scenario:Non-Renewable UT

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	Com	Ind												
Recip Engine	65%	35%												
			MW	0.03	0.13	0.59	1.25	2.55	4.33	6.12	7.90	9.69	11.47	13.25
line loss:	9.2%		aMW	0.02	0.11	0.53	1.12	2.29	3.90	5.51	7.11	8.72	10.32	11.93
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 296	$ 300	$ 290	$ 290	$ 305	$ 398	$ 482	$ 510	$ 538	$ 545	$ 557
			Lump sum ($)	$ 60,974	$ 259,560	$ 1,178,991	$ 1,858,751	$ 3,751,349	$ 5,869,102	$ 7,191,997	$ 8,394,653	$ 9,687,442	$ 10,867,225	$ 12,129,484
Microturbine	65%	35%												
			MW	0.00	0.02	0.07	0.15	0.31	0.53	0.75	0.97	1.19	1.41	1.63
line loss:	9.2%		aMW	0.00	0.01	0.07	0.14	0.28	0.48	0.68	0.88	1.07	1.27	1.47
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 439	$ 445	$ 430	$ 430	$ 452	$ 589	$ 713	$ 755	$ 796	$ 807	$ 825
			Lump sum ($)	$ 9,539	$ 44,989	$ 201,696	$ 313,594	$ 625,954	$ 974,885	$ 1,194,705	$ 1,392,065	$ 1,605,357	$ 1,797,482	$ 2,004,110
Fuel Cell	65%	35%												
			MW	0.00	0.01	0.04	0.09	0.18	0.30	0.43	0.55	0.67	0.80	0.92
line loss:	9.2%		aMW	0.00	0.01	0.04	0.08	0.17	0.29	0.40	0.52	0.64	0.76	0.88
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 361	$ 366	$ 353	$ 353	$ 371	$ 484	$ 586	$ 621	$ 655	$ 664	$ 678
			Lump sum ($)	$ 8,605	$ 44,696	$ 195,649	$ 284,691	$ 549,564	$ 787,522	$ 866,763	$ 935,905	$ 1,012,753	$ 1,080,058	$ 1,162,382
Gas Turbine	65%	35%												
			MW	0.00	0.01	0.04	0.08	0.17	0.29	0.42	0.54	0.66	0.78	0.90
line loss:	9.2%		aMW	0.00	0.01	0.04	0.08	0.16	0.28	0.40	0.51	0.63	0.74	0.86
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 410	$ 416	$ 402	$ 402	$ 423	$ 551	$ 667	$ 707	$ 745	$ 755	$ 772
			Lump sum ($)	$ 3,243	$ 17,423	$ 79,016	$ 126,872	$ 257,279	$ 416,373	$ 532,812	$ 637,650	$ 750,699	$ 852,813	$ 962,400

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	Com	Ind											Avg Lev Avoided C	$0.13	$/kWh
Recip Engine	65%	35%													
			MW	15.04	16.82	18.61	20.39	21.92	23.20	23.96	24.73	25.49			
line loss:	9.2%		aMW	13.54	15.14	16.75	18.35	19.73	20.88	21.56	22.25	22.94	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 559	$ 595	$ 588	$ 586	$ 581	$ 577	$ 572	$ 566	$ 568			
			Lump sum ($)	$ 13,306,872	$ 15,013,886	$ 16,126,373	$ 17,297,788	$ 17,635,353	$ 17,805,856	$ 16,944,518	$ 17,376,898	$ 17,962,110	Levelized Cost	$0.09	$/kWh
Microturbine	65%	35%													
			MW	1.85	2.07	2.29	2.51	2.70	2.86	2.95	3.05	3.14			
line loss:	9.2%		aMW	1.67	1.87	2.06	2.26	2.43	2.57	2.66	2.74	2.83	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 828	$ 881	$ 871	$ 867	$ 861	$ 855	$ 846	$ 839	$ 841			
			Lump sum ($)	$ 2,194,677	$ 2,481,347	$ 2,658,882	$ 2,846,558	$ 2,918,088	$ 2,981,535	$ 2,990,437	$ 3,125,920	$ 3,439,353	Levelized Cost	$0.13	$/kWh
Fuel Cell	65%	35%													
			MW	1.05	1.17	1.30	1.42	1.53	1.62	1.67	1.72	1.77			
line loss:	9.2%		aMW	0.99	1.11	1.23	1.35	1.45	1.53	1.58	1.64	1.69	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 681	$ 724	$ 716	$ 713	$ 708	$ 703	$ 696	$ 690	$ 692			
			Lump sum ($)	$ 1,252,623	$ 1,467,750	$ 1,582,038	$ 1,818,321	$ 1,918,516	$ 1,877,586	$ 1,749,112	$ 1,755,114	$ 1,774,392	Levelized Cost	$0.18	$/kWh
Gas Turbine	65%	35%													
			MW	1.02	1.14	1.27	1.39	1.49	1.58	1.63	1.68	1.73			
line loss:	9.2%		aMW	0.97	1.09	1.20	1.32	1.42	1.50	1.55	1.60	1.65	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 775	$ 824	$ 815	$ 812	$ 805	$ 800	$ 792	$ 785	$ 787			
			Lump sum ($)	$ 1,063,687	$ 1,214,552	$ 1,309,091	$ 1,408,850	$ 1,450,289	$ 1,477,273	$ 1,429,495	$ 1,463,986	$ 1,512,691	Levelized Cost	$0.08	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.53. High Avoided Cost Scenario:Renewable UT

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	**Com**	**Ind**												
Industrial	0%	100%												
			MW	0.01	0.07	0.32	0.67	1.38	2.34	3.30	4.26	5.23	6.19	7.15
line loss:	6.9%		aMW	0.01	0.06	0.28	0.61	1.24	2.10	2.97	3.84	4.70	5.57	6.44
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 26,818	$ 110,958	$ 507,868	$ 754,278	$ 1,506,411	$ 2,120,550	$ 2,196,011	$ 2,273,675	$ 2,353,603	$ 2,435,853	$ 2,520,490
Anaerobic Digester	100%	0%												
			MW	0.00	0.01	0.04	0.09	0.18	0.31	0.44	0.56	0.69	0.82	0.95
line loss:	10.4%		aMW	0.00	0.01	0.03	0.07	0.15	0.25	0.35	0.45	0.55	0.66	0.76
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 4,961	$ 25,072	$ 112,545	$ 163,940	$ 321,193	$ 443,722	$ 451,395	$ 459,428	$ 467,831	$ 476,615	$ 485,789

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Biomass	**Com**	**Ind**													
Industrial	0%	100%													
			MW	8.11	9.08	10.04	11.00	11.83	12.51	12.93	13.34	13.75			
line loss:	6.9%		aMW	7.30	8.17	9.03	9.90	10.64	11.26	11.63	12.00	12.38	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344			
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367			
			Lump sum ($)	$ 2,607,575	$ 2,697,176	$ 2,789,358	$ 2,884,190	$ 2,632,710	$ 2,365,136	$ 1,719,602	$ 1,771,834	$ 1,825,488	Levelized Cost	$0.03	$/kWh
Anaerobic Digester	100%	0%													
			MW	1.07	1.20	1.33	1.46	1.57	1.66	1.71	1.77	1.82			
line loss:	10.4%		aMW	0.86	0.96	1.06	1.17	1.25	1.33	1.37	1.41	1.46	Capacity Factor	80%	
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871			
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439			
			Lump sum ($)	$ 495,363	$ 505,348	$ 515,755	$ 526,595	$ 483,698	$ 451,685	$ 423,025	$ 475,050	$ 624,576	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.54. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.2	1.0	2.1	4.3	7.3	10.3	13.3	16.3	19.3
aMW	0.0	0.2	0.9	1.9	3.8	6.5	9.2	11.9	14.6	17.3
Total Cost	$ 95,994	$ 413,001	$ 1,878,361	$ 2,903,713	$ 5,835,967	$ 8,849,288	$ 10,371,554	$ 11,764,537	$ 13,258,488	$ 14,631,195
Fuel ($/MN	$ 7.47	$ 7.58	$ 7.32	$ 7.32	$ 7.70	$ 10.03	$ 12.15	$ 12.87	$ 13.56	$ 13.75

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	22.3	25.2	28.2	31.2	34.2	36.8	38.9	40.2	41.5	42.8
aMW	20.0	22.7	25.4	28.0	30.7	33.0	35.0	36.1	37.3	38.4
Total Cost	$ 16,096,618	$ 17,471,712	$ 19,428,926	$ 20,738,283	$ 22,114,863	$ 22,199,245	$ 22,096,924	$ 20,513,455	$ 21,084,420	$ 21,921,348
Fuel ($/MN	$ 14.05	$ 14.11	$ 15.00	$ 14.84	$ 14.78	$ 14.66	$ 14.57	$ 14.42	$ 14.29	$ 14.33

Table E.55. High Avoided Cost Scenario:Non-Renewable WA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	Com	Ind												
Recip Engine	65%	35%												
			MW	0.00	0.02	0.09	0.20	0.41	0.70	0.99	1.28	1.57	1.85	2.14
line loss:	9.2%		aMW	0.00	0.02	0.09	0.18	0.37	0.63	0.89	1.15	1.41	1.67	1.93
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 343	$ 336	$ 319	$ 311	$ 326	$ 427	$ 521	$ 560	$ 591	$ 599	$ 612
			Lump sum ($)	$ 9,954	$ 42,281	$ 191,529	$ 301,858	$ 609,250	$ 960,004	$ 1,188,791	$ 1,404,510	$ 1,629,216	$ 1,833,656	$ 2,052,474
Microturbine	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.05	0.09	0.12	0.16	0.19	0.23	0.26
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.05	0.08	0.11	0.14	0.17	0.21	0.24
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 508	$ 497	$ 472	$ 460	$ 482	$ 632	$ 771	$ 830	$ 875	$ 887	$ 906
			Lump sum ($)	$ 1,562	$ 7,335	$ 32,794	$ 50,980	$ 101,781	$ 159,772	$ 198,062	$ 233,884	$ 271,263	$ 304,857	$ 340,986
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.01	0.01	0.03	0.05	0.07	0.09	0.11	0.13	0.15
line loss:	9.2%		aMW	0.00	0.00	0.01	0.01	0.03	0.05	0.07	0.08	0.10	0.12	0.14
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 418	$ 409	$ 388	$ 378	$ 396	$ 520	$ 634	$ 682	$ 719	$ 729	$ 745
			Lump sum ($)	$ 1,395	$ 7,223	$ 31,582	$ 45,973	$ 88,777	$ 127,880	$ 141,999	$ 155,025	$ 168,823	$ 180,910	$ 195,502
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.01	0.01	0.03	0.05	0.07	0.09	0.11	0.13	0.15
line loss:	9.2%		aMW	0.00	0.00	0.01	0.01	0.03	0.05	0.06	0.08	0.10	0.12	0.14
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 475	$ 465	$ 442	$ 431	$ 451	$ 592	$ 722	$ 776	$ 818	$ 830	$ 848
			Lump sum ($)	$ 537	$ 2,856	$ 12,904	$ 20,703	$ 41,982	$ 68,545	$ 88,786	$ 107,751	$ 127,518	$ 145,330	$ 164,449

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	Com	Ind											Avg Lev Avoided C	$0.10	$/kWh
Recip Engine	65%	35%													
			MW	2.43	2.72	3.01	3.30	3.54	3.75	3.87	4.00	4.12			
line loss:	9.2%		aMW	2.19	2.45	2.71	2.97	3.19	3.38	3.49	3.60	3.71	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 615	$ 651	$ 644	$ 642	$ 638	$ 634	$ 629	$ 624	$ 626			
			Lump sum ($)	$ 2,256,526	$ 2,545,951	$ 2,739,280	$ 2,943,197	$ 3,010,518	$ 3,049,926	$ 2,918,799	$ 2,995,337	$ 3,097,355	Levelized Cost	$0.10	$/kWh
Microturbine	65%	35%													
			MW	0.30	0.34	0.37	0.41	0.44	0.46	0.48	0.49	0.51			
line loss:	9.2%		aMW	0.27	0.30	0.33	0.37	0.39	0.42	0.43	0.44	0.46	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 910	$ 963	$ 954	$ 951	$ 944	$ 939	$ 931	$ 924	$ 926			
			Lump sum ($)	$ 374,329	$ 423,164	$ 454,359	$ 487,389	$ 501,267	$ 513,644	$ 516,347	$ 539,387	$ 591,139	Levelized Cost	$0.14	$/kWh
Fuel Cell	65%	35%													
			MW	0.17	0.19	0.21	0.23	0.25	0.26	0.27	0.28	0.29			
line loss:	9.2%		aMW	0.16	0.18	0.20	0.22	0.23	0.25	0.26	0.26	0.27	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 748	$ 792	$ 784	$ 782	$ 777	$ 772	$ 765	$ 759	$ 762			
			Lump sum ($)	$ 211,265	$ 247,092	$ 266,685	$ 305,936	$ 323,121	$ 317,581	$ 297,572	$ 299,146	$ 302,930	Levelized Cost	$0.18	$/kWh
Gas Turbine	65%	35%													
			MW	0.17	0.18	0.20	0.22	0.24	0.26	0.26	0.27	0.28			
line loss:	9.2%		aMW	0.16	0.18	0.19	0.21	0.23	0.24	0.25	0.26	0.27	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 851	$ 901	$ 893	$ 890	$ 884	$ 879	$ 871	$ 864	$ 867			
			Lump sum ($)	$ 182,127	$ 207,798	$ 224,365	$ 241,876	$ 249,764	$ 255,227	$ 248,224	$ 254,434	$ 263,014	Levelized Cost	$0.08	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.56. High Avoided Cost Scenario:Renewable WA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.01	0.03	0.15	0.32	0.65	1.10	1.56	2.01	2.46	2.92	3.37
line loss:	6.9%		aMW	0.01	0.03	0.13	0.29	0.58	0.99	1.40	1.81	2.22	2.63	3.03
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 12,618	$ 52,206	$ 238,955	$ 354,892	$ 708,776	$ 997,732	$ 1,033,236	$ 1,069,778	$ 1,107,384	$ 1,146,084	$ 1,185,906
Anaerobic Digester	100%	0%												
			MW	0.00	0.00	0.01	0.03	0.06	0.10	0.14	0.18	0.23	0.27	0.31
line loss:	10.4%		aMW	0.00	0.00	0.01	0.02	0.05	0.08	0.11	0.15	0.18	0.21	0.25
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 1,599	$ 8,080	$ 36,270	$ 52,833	$ 103,511	$ 142,998	$ 145,471	$ 148,060	$ 150,768	$ 153,599	$ 156,555

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Biomass	Com	Ind													
Industrial	0%	100%													
			MW	3.82	4.28	4.73	5.19	5.57	5.90	6.09	6.29	6.48			
line loss:	6.9%		aMW	3.44	3.85	4.26	4.67	5.02	5.31	5.48	5.66	5.83	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344			
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367			
			Lump sum ($)	$ 1,226,880	$ 1,269,038	$ 1,312,410	$ 1,357,029	$ 1,238,706	$ 1,112,811	$ 809,083	$ 833,659	$ 858,903	Levelized Cost	$0.03	$/kWh
Anaerobic Digester	100%	0%													
			MW	0.35	0.39	0.43	0.48	0.51	0.54	0.56	0.58	0.59			
line loss:	10.4%		aMW	0.28	0.31	0.35	0.38	0.41	0.43	0.45	0.46	0.48	Capacity Factor	80%	
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871			
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439			
			Lump sum ($)	$ 159,640	$ 162,858	$ 166,212	$ 169,706	$ 155,881	$ 145,564	$ 136,328	$ 153,094	$ 201,282	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.57. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.1	0.3	0.6	1.1	2.0	2.8	3.6	4.4	5.2
aMW	0.0	0.1	0.2	0.5	1.0	1.7	2.5	3.2	3.9	4.6
Total Cost	$ 24,707	$ 105,421	$ 479,648	$ 730,265	$ 1,463,475	$ 2,169,203	$ 2,456,176	$ 2,729,956	$ 3,014,708	$ 3,278,453
Fuel ($/MM	$ 8.66	$ 8.47	$ 8.05	$ 7.84	$ 8.21	$ 10.77	$ 13.14	$ 14.13	$ 14.90	$ 15.11

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	6.0	6.8	7.6	8.4	9.2	9.9	10.4	10.8	11.1	11.5
aMW	5.3	6.1	6.8	7.5	8.2	8.8	9.4	9.7	10.0	10.3
Total Cost	$ 3,559,129	$ 3,824,880	$ 4,185,311	$ 4,441,890	$ 4,711,387	$ 4,654,408	$ 4,563,031	$ 4,111,911	$ 4,235,973	$ 4,419,976
Fuel ($/MM	$ 15.43	$ 15.50	$ 16.41	$ 16.25	$ 16.20	$ 16.09	$ 16.00	$ 15.86	$ 15.73	$ 15.78

Table E.58. High Avoided Cost Scenario:Non-Renewable WY

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.01	0.07	0.31	0.66	1.35	2.30	3.25	4.20	5.14	6.09	7.04
line loss:	9.2%		aMW	0.01	0.06	0.28	0.60	1.22	2.07	2.92	3.78	4.63	5.48	6.33
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 303	$ 308	$ 298	$ 298	$ 314	$ 410	$ 497	$ 526	$ 555	$ 563	$ 575
			Lump sum ($)	$ 32,528	$ 138,550	$ 629,454	$ 993,764	$ 2,006,822	$ 3,148,054	$ 3,871,556	$ 4,529,143	$ 5,236,233	$ 5,881,403	$ 6,572,068
Microturbine	65%	35%												
			MW	0.00	0.01	0.04	0.08	0.17	0.28	0.40	0.52	0.63	0.75	0.87
line loss:	9.2%		aMW	0.00	0.01	0.03	0.07	0.15	0.26	0.36	0.47	0.57	0.68	0.78
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 449	$ 456	$ 441	$ 442	$ 465	$ 607	$ 735	$ 779	$ 822	$ 834	$ 852
			Lump sum ($)	$ 5,091	$ 24,019	$ 107,709	$ 167,728	$ 335,034	$ 523,329	$ 643,873	$ 752,113	$ 869,113	$ 974,522	$ 1,087,943
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.02	0.05	0.09	0.16	0.23	0.29	0.36	0.42	0.49
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.28	0.34	0.40	0.47
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 369	$ 375	$ 363	$ 363	$ 382	$ 499	$ 605	$ 641	$ 676	$ 685	$ 700
			Lump sum ($)	$ 4,586	$ 23,818	$ 104,275	$ 151,873	$ 293,311	$ 421,141	$ 464,969	$ 503,259	$ 545,781	$ 583,073	$ 628,491
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.02	0.05	0.09	0.16	0.22	0.29	0.35	0.41	0.48
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.27	0.33	0.39	0.45
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 420	$ 427	$ 413	$ 413	$ 435	$ 568	$ 688	$ 729	$ 769	$ 780	$ 797
			Lump sum ($)	$ 1,733	$ 9,313	$ 42,246	$ 67,958	$ 137,918	$ 223,930	$ 287,733	$ 345,181	$ 407,144	$ 463,119	$ 523,223

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.13	$/kWh
Recip Engine	65%	35%													
			MW	7.98	8.93	9.88	10.83	11.64	12.31	12.72	13.13	13.53			
line loss:	9.2%		aMW	7.19	8.04	8.89	9.74	10.47	11.08	11.45	11.81	12.18	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 578	$ 615	$ 609	$ 606	$ 602	$ 599	$ 593	$ 588	$ 590			
			Lump sum ($)	$ 7,216,675	$ 8,151,254	$ 8,763,249	$ 9,408,052	$ 9,606,130	$ 9,714,431	$ 9,267,662	$ 9,509,806	$ 9,834,933	Levelized Cost	$0.09	$/kWh
Microturbine	65%	35%													
			MW	0.98	1.10	1.22	1.33	1.43	1.52	1.57	1.62	1.67			
line loss:	9.2%		aMW	0.89	0.99	1.10	1.20	1.29	1.37	1.41	1.46	1.50	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 856	$ 910	$ 901	$ 898	$ 892	$ 887	$ 878	$ 871	$ 874			
			Lump sum ($)	$ 1,192,654	$ 1,349,990	$ 1,448,117	$ 1,551,906	$ 1,593,336	$ 1,630,302	$ 1,637,132	$ 1,711,421	$ 1,880,687	Levelized Cost	$0.14	$/kWh
Fuel Cell	65%	35%													
			MW	0.56	0.62	0.69	0.75	0.81	0.86	0.89	0.91	0.94			
line loss:	9.2%		aMW	0.53	0.59	0.65	0.72	0.77	0.81	0.84	0.87	0.90	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 704	$ 748	$ 741	$ 738	$ 733	$ 729	$ 722	$ 716	$ 719			
			Lump sum ($)	$ 678,046	$ 794,736	$ 857,245	$ 984,781	$ 1,039,653	$ 1,019,369	$ 951,992	$ 956,212	$ 967,637	Levelized Cost	$0.18	$/kWh
Gas Turbine	65%	35%													
			MW	0.54	0.61	0.67	0.74	0.79	0.84	0.86	0.89	0.92			
line loss:	9.2%		aMW	0.52	0.58	0.64	0.70	0.75	0.80	0.82	0.85	0.87	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 801	$ 852	$ 843	$ 840	$ 834	$ 830	$ 822	$ 815	$ 818			
			Lump sum ($)	$ 578,826	$ 661,577	$ 713,770	$ 768,878	$ 792,665	$ 808,678	$ 784,340	$ 803,831	$ 831,041	Levelized Cost	$0.08	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.59. High Avoided Cost Scenario:Renewable WY

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.01	0.07	0.33	0.70	1.42	2.42	3.42	4.41	5.41	6.41	7.40
line loss:	6.9%		aMW	0.01	0.06	0.29	0.63	1.28	2.18	3.07	3.97	4.87	5.76	6.66
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 27,734	$ 114,746	$ 525,205	$ 780,026	$ 1,557,833	$ 2,192,936	$ 2,270,972	$ 2,351,288	$ 2,433,944	$ 2,519,002	$ 2,606,528
Anaerobic Digester	100%	0%												
			MW	0.00	0.00	0.00	0.01	0.02	0.04	0.05	0.06	0.08	0.09	0.11
line loss:	10.4%		aMW	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.09
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 573	$ 2,895	$ 12,996	$ 18,931	$ 37,090	$ 51,239	$ 52,125	$ 53,052	$ 54,023	$ 55,037	$ 56,096

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Biomass	Com	Ind													
Industrial	0%	100%													
			MW	8.40	9.39	10.39	11.39	12.24	12.95	13.38	13.81	14.23			
line loss:	6.9%		aMW	7.56	8.46	9.35	10.25	11.02	11.66	12.04	12.43	12.81	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344			
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367			
			Lump sum ($)	$ 2,696,586	$ 2,789,245	$ 2,884,573	$ 2,982,643	$ 2,722,579	$ 2,445,870	$ 1,778,302	$ 1,832,316	$ 1,887,802	Levelized Cost	$0.03	$/kWh
Anaerobic Digester	100%	0%													
			MW	0.12	0.14	0.15	0.17	0.18	0.19	0.20	0.20	0.21			
line loss:	10.4%		aMW	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.16	0.17	Capacity Factor	80%	
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871			
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439			
			Lump sum ($)	$ 57,202	$ 58,355	$ 59,557	$ 60,808	$ 55,855	$ 52,158	$ 48,849	$ 54,856	$ 72,123	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.60. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.1	0.7	1.4	2.9	4.9	6.9	9.0	11.0	13.0
aMW	0.0	0.1	0.6	1.3	2.6	4.4	6.2	8.1	9.9	11.7
Total Cost	$ 62,567	$ 265,497	$ 1,209,871	$ 1,860,612	$ 3,739,525	$ 5,615,919	$ 6,482,042	$ 7,278,211	$ 8,130,776	$ 8,917,878
Fuel ($/MM	$ 7.65	$ 7.77	$ 7.52	$ 7.52	$ 7.92	$ 10.33	$ 12.53	$ 13.28	$ 14.00	$ 14.20

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	15.0	17.0	19.1	21.1	23.1	24.9	26.3	27.2	28.0	28.9
aMW	13.5	15.4	17.2	19.0	20.8	22.4	23.7	24.5	25.3	26.0
Total Cost	$ 9,757,110	$ 10,548,357	$11,659,369	$ 12,419,952	$ 13,219,046	$ 13,175,766	$ 13,019,560	$ 11,877,491	$ 12,199,063	$ 12,624,065
Fuel ($/MM	$ 14.51	$ 14.58	$ 15.50	$ 15.35	$ 15.30	$ 15.19	$ 15.10	$ 14.96	$ 14.84	$ 14.89

Table E.61. Low Avoided Cost Scenario:Non-Renewable CA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	Com	Ind												
Recip Engine	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.05	0.08	0.12	0.15	0.19	0.22	0.26
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.04	0.08	0.11	0.14	0.17	0.20	0.23
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 328	$ 321	$ 304	$ 296	$ 274	$ 217	$ 179	$ 192	$ 203	$ 206	$ 209
			Lump sum ($)	$ 1,199	$ 5,088	$ 23,047	$ 36,237	$ 71,463	$ 100,006	$ 106,668	$ 118,182	$ 130,289	$ 141,605	$ 153,207
Microturbine	65%	35%												
			MW	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.03	0.03
line loss:	9.2%		aMW	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 486	$ 475	$ 451	$ 438	$ 406	$ 321	$ 266	$ 285	$ 301	$ 305	$ 310
			Lump sum ($)	$ 188	$ 882	$ 3,944	$ 6,115	$ 11,902	$ 16,381	$ 17,176	$ 18,847	$ 20,616	$ 22,230	$ 23,886
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02
line loss:	9.2%		aMW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 400	$ 391	$ 370	$ 361	$ 334	$ 264	$ 218	$ 234	$ 247	$ 251	$ 255
			Lump sum ($)	$ 168	$ 872	$ 3,813	$ 5,541	$ 10,556	$ 14,110	$ 14,036	$ 14,375	$ 14,765	$ 15,089	$ 15,593
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02
line loss:	9.2%		aMW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 455	$ 445	$ 422	$ 410	$ 380	$ 300	$ 249	$ 267	$ 282	$ 286	$ 290
			Lump sum ($)	$ 64	$ 343	$ 1,549	$ 2,477	$ 4,865	$ 6,769	$ 7,238	$ 8,158	$ 9,129	$ 10,020	$ 10,932

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	Com	Ind											Avg Lev Avoided C	$0.06	$/kWh
Recip Engine	65%	35%													
			MW	0.29	0.33	0.36	0.40	0.43	0.45	0.47	0.48	0.50			
line loss:	9.2%		aMW	0.27	0.30	0.33	0.36	0.39	0.41	0.42	0.44	0.45	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 217	$ 214	$ 212	$ 212	$ 213	$ 211	$ 209	$ 207	$ 208			
			Lump sum ($)	$ 166,490	$ 177,126	$ 188,125	$ 199,886	$ 198,118	$ 193,990	$ 173,970	$ 178,865	$ 184,886	Levelized Cost	$0.07	$/kWh
Microturbine	65%	35%													
			MW	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.06			
line loss:	9.2%		aMW	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 321	$ 317	$ 314	$ 314	$ 315	$ 313	$ 310	$ 307	$ 308			
			Lump sum ($)	$ 25,837	$ 27,294	$ 28,806	$ 30,444	$ 30,314	$ 30,188	$ 29,761	$ 31,753	$ 36,865	Levelized Cost	$0.10	$/kWh
Fuel Cell	65%	35%													
			MW	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03			
line loss:	9.2%		aMW	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 264	$ 260	$ 258	$ 258	$ 259	$ 257	$ 255	$ 253	$ 253			
			Lump sum ($)	$ 16,533	$ 18,803	$ 20,123	$ 23,781	$ 25,021	$ 23,596	$ 20,821	$ 20,641	$ 20,562	Levelized Cost	$0.15	$/kWh
Gas Turbine	65%	35%													
			MW	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03			
line loss:	9.2%		aMW	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 301	$ 296	$ 294	$ 294	$ 295	$ 293	$ 290	$ 287	$ 288			
			Lump sum ($)	$ 11,996	$ 12,805	$ 13,642	$ 14,544	$ 14,565	$ 14,388	$ 13,150	$ 13,490	$ 13,933	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.62. Low Avoided Cost Scenario:Renewable CA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.28	0.34	0.40	0.46
line loss:	6.9%		aMW	0.00	0.00	0.02	0.04	0.08	0.14	0.19	0.25	0.31	0.36	0.42
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 1,738	$ 7,190	$ 32,907	$ 48,873	$ 97,608	$ 137,401	$ 142,290	$ 147,323	$ 152,502	$ 157,831	$ 163,315
Anaerobic Digester	100%	0%												
			MW	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.07
line loss:	10.4%		aMW	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.05
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 347	$ 1,755	$ 7,879	$ 11,476	$ 22,485	$ 31,062	$ 31,599	$ 32,162	$ 32,750	$ 33,365	$ 34,007

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost	
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.53	0.59	0.65	0.71	0.77	0.81	0.84	0.87	0.89		
line loss:	6.9%		aMW	0.47	0.53	0.59	0.64	0.69	0.73	0.75	0.78	0.80	Capacity Factor	80%
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344		
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367		
			Lump sum ($)	$ 168,958	$ 174,763	$ 180,736	$ 186,881	$ 170,586	$ 153,249	$ 111,422	$ 114,806	$ 118,282	Levelized Cost	$0.03 $/kWh
Anaerobic Digester	100%	0%												
			MW	0.08	0.09	0.09	0.10	0.11	0.12	0.12	0.13	0.13		
line loss:	10.4%		aMW	0.06	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	Capacity Factor	80%
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871		
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439		
			Lump sum ($)	$ 34,677	$ 35,376	$ 36,105	$ 36,864	$ 33,861	$ 31,620	$ 29,613	$ 33,255	$ 43,723	Levelized Cost	$0.07 $/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.63. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.3	0.4
aMW	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4
Total Cost	$ 1,738	$ 7,190	$ 32,907	$ 48,873	$ 97,608	$ 137,401	$ 142,290	$ 147,323	$ 152,502	$ 157,831
Fuel ($/MW	$ 8.29	$ 8.09	$ 7.68	$ 7.47	$ 6.92	$ 5.47	$ 4.53	$ 4.85	$ 5.13	$ 5.20

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	0.5	0.5	0.6	0.7	0.7	0.8	0.8	0.8	0.9	0.9
aMW	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.8
Total Cost	$ 163,315	$ 168,958	$ 174,763	$ 180,736	$ 186,881	$ 170,586	$ 153,249	$ 111,422	$ 114,806	$ 118,282
Fuel ($/MW	$ 5.27	$ 5.47	$ 5.40	$ 5.35	$ 5.36	$ 5.36	$ 5.33	$ 5.28	$ 5.23	$ 5.25

Table E.64. Low Avoided Cost Scenario:Non-Renewable ID

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.01	0.03	0.12	0.26	0.53	0.91	1.28	1.66	2.03	2.40	2.78
line loss:	9.2%		aMW	0.00	0.02	0.11	0.24	0.48	0.82	1.15	1.49	1.83	2.16	2.50
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 308	$ 313	$ 303	$ 303	$ 283	$ 223	$ 184	$ 194	$ 205	$ 208	$ 211
			Lump sum ($)	$ 12,699	$ 54,106	$ 245,825	$ 388,408	$ 766,819	$ 1,072,262	$ 1,143,434	$ 1,264,159	$ 1,393,861	$ 1,515,012	$ 1,639,205
Microturbine	65%	35%												
			MW	0.00	0.00	0.02	0.03	0.07	0.11	0.16	0.20	0.25	0.30	0.34
line loss:	9.2%		aMW	0.00	0.00	0.01	0.03	0.06	0.10	0.14	0.18	0.23	0.27	0.31
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 456	$ 463	$ 448	$ 449	$ 418	$ 330	$ 272	$ 288	$ 303	$ 308	$ 312
			Lump sum ($)	$ 1,988	$ 9,381	$ 42,070	$ 65,571	$ 127,781	$ 175,730	$ 184,227	$ 201,665	$ 220,634	$ 237,930	$ 255,666
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.04	0.06	0.09	0.12	0.14	0.17	0.19
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.04	0.06	0.08	0.11	0.13	0.16	0.18
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 375	$ 381	$ 369	$ 369	$ 344	$ 271	$ 224	$ 236	$ 250	$ 253	$ 256
			Lump sum ($)	$ 1,789	$ 9,291	$ 40,681	$ 59,281	$ 113,011	$ 151,019	$ 150,230	$ 153,662	$ 157,868	$ 161,357	$ 166,768
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.04	0.06	0.09	0.11	0.14	0.16	0.19
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.03	0.06	0.08	0.11	0.13	0.16	0.18
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 427	$ 433	$ 419	$ 420	$ 392	$ 309	$ 254	$ 269	$ 284	$ 288	$ 292
			Lump sum ($)	$ 678	$ 3,640	$ 16,513	$ 26,590	$ 52,311	$ 72,708	$ 77,717	$ 87,337	$ 97,744	$ 107,287	$ 117,054

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.07	$/kWh
Recip Engine	65%	35%													
			MW	3.15	3.53	3.90	4.27	4.60	4.86	5.02	5.18	5.34			
line loss:	9.2%		aMW	2.84	3.17	3.51	3.85	4.14	4.38	4.52	4.66	4.81	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 219	$ 216	$ 215	$ 215	$ 216	$ 214	$ 213	$ 211	$ 212			
			Lump sum ($)	$ 1,781,465	$ 1,898,422	$ 2,017,025	$ 2,144,258	$ 2,127,051	$ 2,084,819	$ 1,872,465	$ 1,926,186	$ 1,991,933	Levelized Cost	$0.07	$/kWh
Microturbine	65%	35%													
			MW	0.39	0.43	0.48	0.53	0.57	0.60	0.62	0.64	0.66			
line loss:	9.2%		aMW	0.35	0.39	0.43	0.47	0.51	0.54	0.56	0.58	0.59	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 324	$ 320	$ 318	$ 318	$ 319	$ 317	$ 315	$ 312	$ 314			
			Lump sum ($)	$ 276,584	$ 292,761	$ 309,114	$ 326,915	$ 325,827	$ 324,818	$ 320,497	$ 342,028	$ 396,863	Levelized Cost	$0.10	$/kWh
Fuel Cell	65%	35%													
			MW	0.22	0.25	0.27	0.30	0.32	0.34	0.35	0.36	0.37			
line loss:	9.2%		aMW	0.21	0.23	0.26	0.28	0.30	0.32	0.33	0.34	0.35	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 266	$ 263	$ 261	$ 262	$ 263	$ 261	$ 259	$ 257	$ 258			
			Lump sum ($)	$ 176,844	$ 201,358	$ 215,555	$ 254,739	$ 268,121	$ 253,058	$ 223,559	$ 221,758	$ 221,043	Levelized Cost	$0.15	$/kWh
Gas Turbine	65%	35%													
			MW	0.21	0.24	0.27	0.29	0.31	0.33	0.34	0.35	0.36			
line loss:	9.2%		aMW	0.20	0.23	0.25	0.28	0.30	0.31	0.32	0.33	0.35	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 303	$ 300	$ 297	$ 298	$ 299	$ 297	$ 295	$ 292	$ 293			
			Lump sum ($)	$ 128,460	$ 137,417	$ 146,463	$ 156,253	$ 156,630	$ 154,917	$ 141,829	$ 145,596	$ 150,458	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.65. Low Avoided Cost Scenario:Renewable ID

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.02	0.11	0.51	1.08	2.20	3.75	5.29	6.83	8.38	9.92	11.46
line loss:	6.9%		aMW	0.02	0.10	0.46	0.97	1.98	3.37	4.76	6.15	7.54	8.93	10.32
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 42,872	$ 177,377	$ 811,879	$ 1,205,790	$ 2,408,151	$ 3,389,914	$ 3,510,545	$ 3,634,700	$ 3,762,472	$ 3,893,958	$ 4,029,258
Anaerobic Digester	100%	0%												
			MW	0.00	0.01	0.03	0.06	0.11	0.19	0.28	0.36	0.44	0.52	0.60
line loss:	10.4%		aMW	0.00	0.00	0.02	0.04	0.09	0.16	0.22	0.28	0.35	0.41	0.48
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 3,073	$ 15,530	$ 69,713	$ 101,549	$ 198,956	$ 274,854	$ 279,607	$ 284,583	$ 289,788	$ 295,229	$ 300,911

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Biomass	Com	Ind													
Industrial	0%	100%													
			MW	13.01	14.55	16.09	17.64	18.96	20.06	20.72	21.38	22.04			
line loss:	6.9%		aMW	11.71	13.09	14.48	15.87	17.06	18.05	18.65	19.24	19.84	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344			
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367			
			Lump sum ($)	$ 4,168,473	$ 4,311,708	$ 4,459,070	$ 4,610,670	$ 4,208,653	$ 3,780,909	$ 2,748,959	$ 2,832,456	$ 2,918,228	Levelized Cost	$0.03	$/kWh
Anaerobic Digester	100%	0%													
			MW	0.68	0.76	0.84	0.92	0.99	1.04	1.08	1.11	1.15			
line loss:	10.4%		aMW	0.54	0.61	0.67	0.73	0.79	0.83	0.86	0.89	0.92	Capacity Factor	80%	
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871			
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439			
			Lump sum ($)	$ 306,842	$ 313,027	$ 319,473	$ 326,188	$ 299,616	$ 279,787	$ 262,034	$ 294,259	$ 386,880	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.66. Combined Heat & Power Base Case Achievable Potent

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.1	0.5	1.1	2.2	3.7	5.3	6.8	8.4	9.9
aMW	0.0	0.1	0.5	1.0	2.0	3.4	4.8	6.2	7.5	8.9
Total Cost	$ 42,872	$ 177,377	$ 811,879	$ 1,205,790	$ 2,408,151	$ 3,389,914	$ 3,510,545	$ 3,634,700	$ 3,762,472	$ 3,893,958
Fuel ($/MM	$ 7.77	$ 7.88	$ 7.64	$ 7.64	$ 7.13	$ 5.62	$ 4.63	$ 4.90	$ 5.17	$ 5.24

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	11.5	13.0	14.5	16.1	17.6	19.0	20.1	20.7	21.4	22.0
aMW	10.3	11.7	13.1	14.5	15.9	17.1	18.1	18.6	19.2	19.8
Total Cost	$ 4,029,258	$4,168,473	$ 4,311,708	$ 4,459,070	$ 4,610,670	$ 4,208,653	$ 3,780,909	$ 2,748,959	$ 2,832,456	$ 2,918,228
Fuel ($/MM	$ 5.31	$ 5.51	$ 5.46	$ 5.41	$ 5.43	$ 5.44	$ 5.41	$ 5.37	$ 5.32	$ 5.34

Table E.67. Low Avoided Cost Scenario:Non-Renewable OR

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.01	0.06	0.29	0.62	1.28	2.17	3.06	3.95	4.85	5.74	6.63
line loss:	9.2%		aMW	0.01	0.06	0.26	0.56	1.15	1.95	2.75	3.56	4.36	5.16	5.97
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 343	$ 336	$ 319	$ 311	$ 288	$ 228	$ 189	$ 203	$ 215	$ 218	$ 221
			Lump sum ($)	$ 30,988	$ 131,630	$ 596,273	$ 939,754	$ 1,853,118	$ 2,593,209	$ 2,769,656	$ 3,077,139	$ 3,399,484	$ 3,699,807	$ 4,007,533
Microturbine	65%	35%												
			MW	0.00	0.01	0.04	0.08	0.16	0.27	0.38	0.49	0.60	0.71	0.82
line loss:	9.2%		aMW	0.00	0.01	0.03	0.07	0.14	0.24	0.34	0.44	0.54	0.64	0.74
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 508	$ 497	$ 472	$ 460	$ 427	$ 338	$ 281	$ 301	$ 318	$ 322	$ 327
			Lump sum ($)	$ 4,862	$ 22,834	$ 102,096	$ 158,712	$ 308,906	$ 425,205	$ 446,592	$ 491,646	$ 539,153	$ 582,371	$ 626,665
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.28	0.34	0.40	0.46
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.08	0.14	0.20	0.26	0.32	0.38	0.44
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 418	$ 409	$ 388	$ 378	$ 351	$ 278	$ 231	$ 248	$ 261	$ 265	$ 269
			Lump sum ($)	$ 4,342	$ 22,487	$ 98,323	$ 143,124	$ 272,685	$ 364,593	$ 363,124	$ 372,811	$ 383,791	$ 392,922	$ 406,688
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.27	0.33	0.39	0.45
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.08	0.14	0.20	0.26	0.31	0.37	0.43
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 475	$ 465	$ 442	$ 431	$ 400	$ 316	$ 263	$ 282	$ 297	$ 302	$ 306
			Lump sum ($)	$ 1,670	$ 8,891	$ 40,172	$ 64,452	$ 126,592	$ 176,141	$ 188,680	$ 213,425	$ 239,431	$ 263,218	$ 287,554

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.06	$/kWh
Recip Engine	65%	35%													
			MW	7.52	8.42	9.31	10.20	10.97	11.60	11.99	12.37	12.75			
line loss:	9.2%		aMW	6.77	7.57	8.38	9.18	9.87	10.44	10.79	11.13	11.48	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 229	$ 226	$ 224	$ 224	$ 225	$ 223	$ 222	$ 220	$ 221			
			Lump sum ($)	$ 4,360,656	$ 4,642,146	$ 4,934,497	$ 5,248,541	$ 5,213,665	$ 5,116,834	$ 4,607,984	$ 4,739,602	$ 4,900,587	Levelized Cost	$0.07	$/kWh
Microturbine	65%	35%													
			MW	0.93	1.04	1.15	1.26	1.35	1.43	1.48	1.53	1.57			
line loss:	9.2%		aMW	0.83	0.93	1.03	1.13	1.22	1.29	1.33	1.37	1.42	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 339	$ 334	$ 331	$ 332	$ 333	$ 331	$ 328	$ 326	$ 327			
			Lump sum ($)	$ 678,962	$ 717,891	$ 758,504	$ 802,769	$ 801,347	$ 799,803	$ 789,850	$ 842,106	$ 974,630	Levelized Cost	$0.10	$/kWh
Fuel Cell	65%	35%													
			MW	0.52	0.59	0.65	0.71	0.76	0.81	0.83	0.86	0.89			
line loss:	9.2%		aMW	0.50	0.56	0.62	0.67	0.73	0.77	0.79	0.82	0.84	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 279	$ 275	$ 272	$ 273	$ 274	$ 272	$ 270	$ 268	$ 269			
			Lump sum ($)	$ 431,846	$ 490,861	$ 525,618	$ 620,621	$ 653,396	$ 617,540	$ 546,719	$ 542,575	$ 541,080	Levelized Cost	$0.15	$/kWh
Gas Turbine	65%	35%													
			MW	0.51	0.57	0.63	0.69	0.75	0.79	0.81	0.84	0.87			
line loss:	9.2%		aMW	0.49	0.54	0.60	0.66	0.71	0.75	0.77	0.80	0.82	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 317	$ 313	$ 310	$ 311	$ 311	$ 310	$ 307	$ 305	$ 306			
			Lump sum ($)	$ 316,014	$ 337,571	$ 359,989	$ 384,287	$ 385,814	$ 382,145	$ 350,864	$ 360,148	$ 372,107	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.68. Low Avoided Cost Scenario:Renewable OR

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.03	0.13	0.60	1.27	2.59	4.40	6.21	8.02	9.83	11.64	13.45
line loss:	6.9%		aMW	0.02	0.12	0.54	1.14	2.33	3.96	5.59	7.22	8.85	10.48	12.11
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 50,412	$ 208,574	$ 954,670	$ 1,417,861	$ 2,831,691	$ 3,986,124	$ 4,127,972	$ 4,273,962	$ 4,424,206	$ 4,578,818	$ 4,737,914
Anaerobic Digester	100%	0%												
			MW	0.00	0.01	0.03	0.06	0.13	0.23	0.32	0.41	0.50	0.60	0.69
line loss:	10.4%		aMW	0.00	0.01	0.02	0.05	0.11	0.18	0.25	0.33	0.40	0.48	0.55
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 3,595	$ 18,167	$ 81,550	$ 118,791	$ 232,737	$ 321,522	$ 327,082	$ 332,902	$ 338,992	$ 345,356	$ 352,003

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Biomass	Com	Ind													
Industrial	0%	100%													
			MW	15.27	17.08	18.89	20.70	22.25	23.54	24.32	25.10	25.87			
line loss:	6.9%		aMW	13.74	15.37	17.00	18.63	20.03	21.19	21.89	22.59	23.29	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344			
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367			
			Lump sum ($)	$ 4,901,614	$ 5,070,041	$ 5,243,321	$ 5,421,583	$ 4,948,861	$ 4,445,885	$ 3,232,439	$ 3,330,621	$ 3,431,479	Levelized Cost	$0.03	$/kWh
Anaerobic Digester	100%	0%													
			MW	0.78	0.87	0.97	1.06	1.14	1.20	1.24	1.28	1.32			
line loss:	10.4%		aMW	0.62	0.70	0.77	0.85	0.91	0.96	1.00	1.03	1.06	Capacity Factor	80%	
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871			
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439			
			Lump sum ($)	$ 358,941	$ 366,176	$ 373,717	$ 381,572	$ 350,489	$ 327,292	$ 306,525	$ 344,222	$ 452,569	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.69. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.1	0.6	1.3	2.6	4.4	6.2	8.0	9.8	11.6
aMW	0.0	0.1	0.5	1.1	2.3	4.0	5.6	7.2	8.8	10.5
Total Cost	$ 50,412	$ 208,574	$ 954,670	$ 1,417,861	$ 2,831,691	$ 3,986,124	$ 4,127,972	$ 4,273,962	$ 4,424,206	$ 4,578,818
Fuel ($/MM	$ 8.66	$ 8.47	$ 8.05	$ 7.84	$ 7.27	$ 5.76	$ 4.78	$ 5.13	$ 5.42	$ 5.49

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	13.5	15.3	17.1	18.9	20.7	22.3	23.5	24.3	25.1	25.9
aMW	12.1	13.7	15.4	17.0	18.6	20.0	21.2	21.9	22.6	23.3
Total Cost	$ 4,737,914	$ 4,901,614	$ 5,070,041	$ 5,243,321	$ 5,421,583	$ 4,948,861	$ 4,445,885	$ 3,232,439	$ 3,330,621	$ 3,431,479
Fuel ($/MM	$ 5.56	$ 5.77	$ 5.69	$ 5.64	$ 5.66	$ 5.67	$ 5.64	$ 5.59	$ 5.55	$ 5.57

Table E.70. Low Avoided Cost Scenario:Non-Renewable UT

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.03	0.13	0.59	1.25	2.55	4.33	6.12	7.90	9.69	11.47	13.25
line loss:	9.2%		aMW	0.02	0.11	0.53	1.12	2.29	3.90	5.51	7.11	8.72	10.32	11.93
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 296	$ 300	$ 290	$ 290	$ 270	$ 213	$ 175	$ 185	$ 195	$ 198	$ 201
			Lump sum ($)	$ 60,974	$ 259,560	$ 1,178,991	$ 1,858,751	$ 3,669,487	$ 5,131,672	$ 5,467,496	$ 6,031,847	$ 6,637,896	$ 7,204,917	$ 7,786,143
Microturbine	65%	35%												
			MW	0.00	0.02	0.07	0.15	0.31	0.53	0.75	0.97	1.19	1.41	1.63
line loss:	9.2%		aMW	0.00	0.01	0.07	0.14	0.28	0.48	0.68	0.88	1.07	1.27	1.47
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 439	$ 445	$ 430	$ 430	$ 400	$ 315	$ 259	$ 274	$ 289	$ 293	$ 297
			Lump sum ($)	$ 9,539	$ 44,989	$ 201,696	$ 313,594	$ 611,009	$ 840,262	$ 879,884	$ 960,718	$ 1,048,640	$ 1,128,901	$ 1,211,202
Fuel Cell	65%	35%												
			MW	0.00	0.01	0.04	0.09	0.18	0.30	0.43	0.55	0.67	0.80	0.92
line loss:	9.2%		aMW	0.00	0.01	0.04	0.08	0.17	0.29	0.40	0.52	0.64	0.76	0.88
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 361	$ 366	$ 353	$ 353	$ 329	$ 259	$ 213	$ 225	$ 238	$ 241	$ 244
			Lump sum ($)	$ 8,605	$ 44,696	$ 195,649	$ 284,691	$ 542,624	$ 725,008	$ 720,571	$ 735,602	$ 754,233	$ 769,593	$ 794,183
Gas Turbine	65%	35%												
			MW	0.00	0.01	0.04	0.08	0.17	0.29	0.42	0.54	0.66	0.78	0.90
line loss:	9.2%		aMW	0.00	0.01	0.04	0.08	0.16	0.28	0.40	0.51	0.63	0.74	0.86
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 410	$ 416	$ 402	$ 402	$ 374	$ 295	$ 243	$ 257	$ 271	$ 275	$ 278
			Lump sum ($)	$ 3,243	$ 17,423	$ 79,016	$ 126,872	$ 249,568	$ 346,907	$ 370,363	$ 415,073	$ 463,430	$ 507,822	$ 553,256

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.07	$/kWh
Recip Engine	65%	35%													
			MW	15.04	16.82	18.61	20.39	21.92	23.20	23.96	24.73	25.49			
line loss:	9.2%		aMW	13.54	15.14	16.75	18.35	19.73	20.88	21.56	22.25	22.94	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 208	$ 206	$ 204	$ 205	$ 205	$ 203	$ 202	$ 200	$ 200			
			Lump sum ($)	$ 8,450,140	$ 8,999,666	$ 9,552,391	$ 10,144,734	$ 10,042,464	$ 9,822,178	$ 8,786,912	$ 9,034,723	$ 9,339,217	Levelized Cost	$0.07	$/kWh
Microturbine	65%	35%													
			MW	1.85	2.07	2.29	2.51	2.70	2.86	2.95	3.05	3.14			
line loss:	9.2%		aMW	1.67	1.87	2.06	2.26	2.43	2.57	2.66	2.74	2.83	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 308	$ 305	$ 303	$ 303	$ 303	$ 301	$ 299	$ 296	$ 297			
			Lump sum ($)	$ 1,308,046	$ 1,383,408	$ 1,458,754	$ 1,540,716	$ 1,531,952	$ 1,524,057	$ 1,501,208	$ 1,602,996	$ 1,865,182	Levelized Cost	$0.10	$/kWh
Fuel Cell	65%	35%													
			MW	1.05	1.17	1.30	1.42	1.53	1.62	1.67	1.72	1.77			
line loss:	9.2%		aMW	0.99	1.11	1.23	1.35	1.45	1.53	1.58	1.64	1.69	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 254	$ 251	$ 249	$ 249	$ 249	$ 248	$ 245	$ 243	$ 244			
			Lump sum ($)	$ 840,902	$ 957,905	$ 1,024,740	$ 1,211,934	$ 1,274,842	$ 1,200,784	$ 1,057,565	$ 1,047,921	$ 1,043,401	Levelized Cost	$0.15	$/kWh
Gas Turbine	65%	35%													
			MW	1.02	1.14	1.27	1.39	1.49	1.58	1.63	1.68	1.73			
line loss:	9.2%		aMW	0.97	1.09	1.20	1.32	1.42	1.50	1.55	1.60	1.65	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 288	$ 286	$ 283	$ 283	$ 284	$ 282	$ 279	$ 277	$ 278			
			Lump sum ($)	$ 606,181	$ 648,010	$ 689,819	$ 735,030	$ 735,036	$ 725,207	$ 661,045	$ 678,150	$ 700,412	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.71. Low Avoided Cost Scenario:Renewable UT

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	**Com**	**Ind**												
Industrial	0%	100%												
			MW	0.01	0.07	0.32	0.67	1.38	2.34	3.30	4.26	5.23	6.19	7.15
line loss:	6.9%		aMW	0.01	0.06	0.28	0.61	1.24	2.10	2.97	3.84	4.70	5.57	6.44
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 26,818	$ 110,958	$ 507,868	$ 754,278	$ 1,506,411	$ 2,120,550	$ 2,196,011	$ 2,273,675	$ 2,353,603	$ 2,435,853	$ 2,520,490
Anaerobic Digester	100%	0%												
			MW	0.00	0.01	0.04	0.09	0.18	0.31	0.44	0.56	0.69	0.82	0.95
line loss:	10.4%		aMW	0.00	0.01	0.03	0.07	0.15	0.25	0.35	0.45	0.55	0.66	0.76
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 4,961	$ 25,072	$ 112,545	$ 163,940	$ 321,193	$ 443,722	$ 451,395	$ 459,428	$ 467,831	$ 476,615	$ 485,789

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Biomass	**Com**	**Ind**													
Industrial	0%	100%													
			MW	8.11	9.08	10.04	11.00	11.83	12.51	12.93	13.34	13.75			
line loss:	6.9%		aMW	7.30	8.17	9.03	9.90	10.64	11.26	11.63	12.00	12.38	Capacity Factor	80%	
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344			
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367			
			Lump sum ($)	$ 2,607,575	$ 2,697,176	$ 2,789,358	$ 2,884,190	$ 2,632,710	$ 2,365,136	$ 1,719,602	$ 1,771,834	$ 1,825,488	Levelized Cost	$0.03	$/kWh
Anaerobic Digester	100%	0%													
			MW	1.07	1.20	1.33	1.46	1.57	1.66	1.71	1.77	1.82			
line loss:	10.4%		aMW	0.86	0.96	1.06	1.17	1.25	1.33	1.37	1.41	1.46	Capacity Factor	80%	
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871			
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439			
			Lump sum ($)	$ 495,363	$ 505,348	$ 515,755	$ 526,595	$ 483,698	$ 451,685	$ 423,025	$ 475,050	$ 624,576	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.72. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.1	0.3	0.7	1.4	2.3	3.3	4.3	5.2	6.2
aMW	0.0	0.1	0.3	0.6	1.2	2.1	3.0	3.8	4.7	5.6
Total Cost	$ 26,818	$ 110,958	$ 507,868	$ 754,278	$ 1,506,411	$ 2,120,550	$ 2,196,011	$ 2,273,675	$ 2,353,603	$ 2,435,853
Fuel ($/MM	$ 7.47	$ 7.58	$ 7.32	$ 7.32	$ 6.82	$ 5.36	$ 4.42	$ 4.67	$ 4.93	$ 5.00

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	7.2	8.1	9.1	10.0	11.0	11.8	12.5	12.9	13.3	13.8
aMW	6.4	7.3	8.2	9.0	9.9	10.6	11.3	11.6	12.0	12.4
Total Cost	$ 2,520,490	$ 2,607,575	$ 2,697,176	$ 2,789,358	$ 2,884,190	$ 2,632,710	$ 2,365,136	$ 1,719,602	$ 1,771,834	$ 1,825,488
Fuel ($/MM	$ 5.06	$ 5.25	$ 5.20	$ 5.15	$ 5.16	$ 5.17	$ 5.13	$ 5.09	$ 5.04	$ 5.05

Table E.73. Low Avoided Cost Scenario:Non-Renewable WA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.00	0.02	0.09	0.20	0.41	0.70	0.99	1.28	1.57	1.85	2.14
line loss:	9.2%		aMW	0.00	0.02	0.09	0.18	0.37	0.63	0.89	1.15	1.41	1.67	1.93
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 343	$ 336	$ 319	$ 311	$ 288	$ 228	$ 189	$ 203	$ 215	$ 218	$ 221
			Lump sum ($)	$ 9,954	$ 42,281	$ 191,529	$ 301,858	$ 595,240	$ 832,964	$ 889,641	$ 988,407	$ 1,091,947	$ 1,188,414	$ 1,287,259
Microturbine	65%	35%												
			MW	0.00	0.00	0.01	0.02	0.05	0.09	0.12	0.16	0.19	0.23	0.26
line loss:	9.2%		aMW	0.00	0.00	0.01	0.02	0.05	0.08	0.11	0.14	0.17	0.21	0.24
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 508	$ 497	$ 472	$ 460	$ 427	$ 338	$ 281	$ 301	$ 318	$ 322	$ 327
			Lump sum ($)	$ 1,562	$ 7,335	$ 32,794	$ 50,980	$ 99,224	$ 136,580	$ 143,450	$ 157,922	$ 173,181	$ 187,063	$ 201,291
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.01	0.01	0.03	0.05	0.07	0.09	0.11	0.13	0.15
line loss:	9.2%		aMW	0.00	0.00	0.01	0.01	0.03	0.05	0.07	0.08	0.10	0.12	0.14
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 418	$ 409	$ 388	$ 378	$ 351	$ 278	$ 231	$ 248	$ 261	$ 265	$ 269
			Lump sum ($)	$ 1,395	$ 7,223	$ 31,582	$ 45,973	$ 87,589	$ 117,111	$ 116,639	$ 119,751	$ 123,277	$ 126,210	$ 130,632
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.01	0.01	0.03	0.05	0.07	0.09	0.11	0.13	0.15
line loss:	9.2%		aMW	0.00	0.00	0.01	0.01	0.03	0.05	0.06	0.08	0.10	0.12	0.14
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 475	$ 465	$ 442	$ 431	$ 400	$ 316	$ 263	$ 282	$ 297	$ 302	$ 306
			Lump sum ($)	$ 537	$ 2,856	$ 12,904	$ 20,703	$ 40,662	$ 56,578	$ 60,606	$ 68,554	$ 76,908	$ 84,548	$ 92,365

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.06	$/kWh
Recip Engine	65%	35%													
			MW	2.43	2.72	3.01	3.30	3.54	3.75	3.87	4.00	4.12			
line loss:	9.2%		aMW	2.19	2.45	2.71	2.97	3.19	3.38	3.49	3.60	3.71	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 229	$ 226	$ 224	$ 224	$ 225	$ 223	$ 222	$ 220	$ 221			
			Lump sum ($)	$ 1,400,685	$ 1,491,103	$ 1,585,009	$ 1,685,883	$ 1,674,680	$ 1,643,577	$ 1,480,130	$ 1,522,407	$ 1,574,117	Levelized Cost	$0.07	$/kWh
Microturbine	65%	35%													
			MW	0.30	0.34	0.37	0.41	0.44	0.46	0.48	0.49	0.51			
line loss:	9.2%		aMW	0.27	0.30	0.33	0.37	0.39	0.42	0.43	0.44	0.46	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 339	$ 334	$ 331	$ 332	$ 333	$ 331	$ 328	$ 326	$ 327			
			Lump sum ($)	$ 218,089	$ 230,594	$ 243,639	$ 257,857	$ 257,400	$ 256,905	$ 253,707	$ 270,493	$ 313,061	Levelized Cost	$0.10	$/kWh
Fuel Cell	65%	35%													
			MW	0.17	0.19	0.21	0.23	0.25	0.26	0.27	0.28	0.29			
line loss:	9.2%		aMW	0.16	0.18	0.20	0.22	0.23	0.25	0.26	0.26	0.27	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 279	$ 275	$ 272	$ 273	$ 274	$ 272	$ 270	$ 268	$ 269			
			Lump sum ($)	$ 138,713	$ 157,669	$ 168,834	$ 199,349	$ 209,877	$ 198,360	$ 175,612	$ 174,281	$ 173,800	Levelized Cost	$0.15	$/kWh
Gas Turbine	65%	35%													
			MW	0.17	0.18	0.20	0.22	0.24	0.26	0.26	0.27	0.28			
line loss:	9.2%		aMW	0.16	0.18	0.19	0.21	0.23	0.24	0.25	0.26	0.27	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 317	$ 313	$ 310	$ 311	$ 311	$ 310	$ 307	$ 305	$ 306			
			Lump sum ($)	$ 101,507	$ 108,431	$ 115,632	$ 123,437	$ 123,927	$ 122,749	$ 112,701	$ 115,683	$ 119,524	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.74. Low Avoided Cost Scenario:Renewable WA

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.01	0.03	0.15	0.32	0.65	1.10	1.56	2.01	2.46	2.92	3.37
line loss:	6.9%		aMW	0.01	0.03	0.13	0.29	0.58	0.99	1.40	1.81	2.22	2.63	3.03
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 12,618	$ 52,206	$ 238,955	$ 354,892	$ 708,776	$ 997,732	$ 1,033,236	$ 1,069,778	$ 1,107,384	$ 1,146,084	$ 1,185,906
Anaerobic Digester	100%	0%												
			MW	0.00	0.00	0.01	0.03	0.06	0.10	0.14	0.18	0.23	0.27	0.31
line loss:	10.4%		aMW	0.00	0.00	0.01	0.02	0.05	0.08	0.11	0.15	0.18	0.21	0.25
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 1,599	$ 8,080	$ 36,270	$ 52,833	$ 103,511	$ 142,998	$ 145,471	$ 148,060	$ 150,768	$ 153,599	$ 156,555

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost	
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	3.82	4.28	4.73	5.19	5.57	5.90	6.09	6.29	6.48		
line loss:	6.9%		aMW	3.44	3.85	4.26	4.67	5.02	5.31	5.48	5.66	5.83	Capacity Factor	80%
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344		
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367		
			Lump sum ($)	$ 1,226,880	$ 1,269,038	$ 1,312,410	$ 1,357,029	$ 1,238,706	$ 1,112,811	$ 809,083	$ 833,659	$ 858,903	Levelized Cost	$0.03 $/kWh
Anaerobic Digester	100%	0%												
			MW	0.35	0.39	0.43	0.48	0.51	0.54	0.56	0.58	0.59		
line loss:	10.4%		aMW	0.28	0.31	0.35	0.38	0.41	0.43	0.45	0.46	0.48	Capacity Factor	80%
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871		
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439		
			Lump sum ($)	$ 159,640	$ 162,858	$ 166,212	$ 169,706	$ 155,881	$ 145,564	$ 136,328	$ 153,094	$ 201,282	Levelized Cost	$0.07 $/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.75. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.0	0.1	0.3	0.6	1.1	1.6	2.0	2.5	2.9
aMW	0.0	0.0	0.1	0.3	0.6	1.0	1.4	1.8	2.2	2.6
Total Cost	$ 12,618	$ 52,206	$ 238,955	$ 354,892	$ 708,776	$ 997,732	$ 1,033,236	$ 1,069,778	$ 1,107,384	$ 1,146,084
Fuel ($/MM	$ 8.66	$ 8.47	$ 8.05	$ 7.84	$ 7.27	$ 5.76	$ 4.78	$ 5.13	$ 5.42	$ 5.49

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	3.4	3.8	4.3	4.7	5.2	5.6	5.9	6.1	6.3	6.5
aMW	3.0	3.4	3.9	4.3	4.7	5.0	5.3	5.5	5.7	5.8
Total Cost	$ 1,185,906	#######	$ 1,269,038	$ 1,312,410	$ 1,357,029	$ 1,238,706	$ 1,112,811	$ 809,083	$ 833,659	$ 858,903
Fuel ($/MM	$ 5.56	$ 5.77	$ 5.69	$ 5.64	$ 5.66	$ 5.67	$ 5.64	$ 5.59	$ 5.55	$ 5.57

Table E.76. Low Avoided Cost Scenario:Non-Renewable WY

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-Renewable	**Com**	**Ind**												
Recip Engine	65%	35%												
			MW	0.01	0.07	0.31	0.66	1.35	2.30	3.25	4.20	5.14	6.09	7.04
line loss:	9.2%		aMW	0.01	0.06	0.28	0.60	1.22	2.07	2.92	3.78	4.63	5.48	6.33
			Inst costs ($/kW)	$ 1,969	$ 1,987	$ 2,005	$ 2,023	$ 2,041	$ 2,060	$ 2,078	$ 2,097	$ 2,116	$ 2,135	$ 2,154
			O&M ($/MW)	$ 78,905	$ 80,404	$ 81,932	$ 83,488	$ 85,075	$ 86,691	$ 88,338	$ 90,017	$ 91,727	$ 93,470	$ 95,246
			Fuel ($/kW)	$ 303	$ 308	$ 298	$ 298	$ 278	$ 219	$ 181	$ 191	$ 202	$ 205	$ 207
			Lump sum ($)	$ 32,528	$ 138,550	$ 629,454	$ 993,764	$ 1,962,003	$ 2,743,800	$ 2,925,242	$ 3,231,892	$ 3,561,371	$ 3,869,395	$ 4,185,211
Microturbine	65%	35%												
			MW	0.00	0.01	0.04	0.08	0.17	0.28	0.40	0.52	0.63	0.75	0.87
line loss:	9.2%		aMW	0.00	0.01	0.03	0.07	0.15	0.26	0.36	0.47	0.57	0.68	0.78
			Inst costs ($/kW)	$ 2,831	$ 2,814	$ 2,797	$ 2,780	$ 2,764	$ 2,747	$ 2,731	$ 2,714	$ 2,698	$ 2,682	$ 2,666
			O&M ($/MW)	$ 69,934	$ 71,263	$ 72,617	$ 73,997	$ 75,403	$ 76,836	$ 78,295	$ 79,783	$ 81,299	$ 82,844	$ 84,418
			Fuel ($/kW)	$ 449	$ 456	$ 441	$ 442	$ 412	$ 324	$ 267	$ 283	$ 299	$ 303	$ 307
			Lump sum ($)	$ 5,091	$ 24,019	$ 107,709	$ 167,728	$ 326,852	$ 449,529	$ 471,116	$ 515,291	$ 563,354	$ 607,216	$ 652,205
Fuel Cell	65%	35%												
			MW	0.00	0.00	0.02	0.05	0.09	0.16	0.23	0.29	0.36	0.42	0.49
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.28	0.34	0.40	0.47
			Inst costs ($/kW)	$ 5,697	$ 5,520	$ 5,349	$ 5,183	$ 5,023	$ 4,867	$ 4,716	$ 4,570	$ 4,428	$ 4,291	$ 4,158
			O&M ($/MW)	$ 16,866	$ 17,186	$ 17,513	$ 17,845	$ 18,184	$ 18,530	$ 18,882	$ 19,241	$ 19,606	$ 19,979	$ 20,358
			Fuel ($/kW)	$ 369	$ 375	$ 363	$ 363	$ 339	$ 267	$ 220	$ 233	$ 246	$ 249	$ 252
			Lump sum ($)	$ 4,586	$ 23,818	$ 104,275	$ 151,873	$ 289,511	$ 386,871	$ 384,747	$ 393,287	$ 403,797	$ 412,508	$ 426,150
Gas Turbine	65%	35%												
			MW	0.00	0.00	0.02	0.05	0.09	0.16	0.22	0.29	0.35	0.41	0.48
line loss:	9.2%		aMW	0.00	0.00	0.02	0.04	0.09	0.15	0.21	0.27	0.33	0.39	0.45
			Inst costs ($/kW)	$ 1,838	$ 1,854	$ 1,871	$ 1,888	$ 1,905	$ 1,922	$ 1,939	$ 1,957	$ 1,974	$ 1,992	$ 2,010
			O&M ($/MW)	$ 57,566	$ 58,660	$ 59,775	$ 60,910	$ 62,068	$ 63,247	$ 64,449	$ 65,673	$ 66,921	$ 68,193	$ 69,488
			Fuel ($/kW)	$ 420	$ 427	$ 413	$ 413	$ 385	$ 304	$ 250	$ 265	$ 279	$ 284	$ 287
			Lump sum ($)	$ 1,733	$ 9,313	$ 42,246	$ 67,958	$ 133,696	$ 185,849	$ 198,590	$ 222,980	$ 249,371	$ 273,587	$ 298,380

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost		
Non-Renewable	**Com**	**Ind**											Avg Lev Avoided C	$0.07	$/kWh
Recip Engine	65%	35%													
			MW	7.98	8.93	9.88	10.83	11.64	12.31	12.72	13.13	13.53			
line loss:	9.2%		aMW	7.19	8.04	8.89	9.74	10.47	11.08	11.45	11.81	12.18	Capacity Factor	90%	
			Inst costs ($/kW)	$ 2,173	$ 2,193	$ 2,213	$ 2,232	$ 2,253	$ 2,273	$ 2,293	$ 2,314	$ 2,335			
			O&M ($/MW)	$ 97,055	$ 98,899	$ 100,778	$ 102,693	$ 104,644	$ 106,633	$ 108,659	$ 110,723	$ 112,827			
			Fuel ($/kW)	$ 215	$ 213	$ 211	$ 212	$ 212	$ 211	$ 209	$ 208	$ 208			
			Lump sum ($)	$ 4,546,659	$ 4,844,659	$ 5,145,812	$ 5,468,818	$ 5,421,589	$ 5,310,554	$ 4,763,945	$ 4,900,054	$ 5,066,910	Levelized Cost	$0.07	$/kWh
Microturbine	65%	35%													
			MW	0.98	1.10	1.22	1.33	1.43	1.52	1.57	1.62	1.67			
line loss:	9.2%		aMW	0.89	0.99	1.10	1.20	1.29	1.37	1.41	1.46	1.50	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,650	$ 2,634	$ 2,618	$ 2,602	$ 2,587	$ 2,571	$ 2,556	$ 2,540	$ 2,525			
			O&M ($/MW)	$ 86,022	$ 87,656	$ 89,321	$ 91,019	$ 92,748	$ 94,510	$ 96,306	$ 98,136	$ 100,000			
			Fuel ($/kW)	$ 319	$ 316	$ 313	$ 313	$ 314	$ 312	$ 310	$ 307	$ 308			
			Lump sum ($)	$ 705,223	$ 746,348	$ 787,728	$ 832,771	$ 829,418	$ 826,343	$ 814,946	$ 869,877	$ 1,010,250	Levelized Cost	$0.10	$/kWh
Fuel Cell	65%	35%													
			MW	0.56	0.62	0.69	0.75	0.81	0.86	0.89	0.91	0.94			
line loss:	9.2%		aMW	0.53	0.59	0.65	0.72	0.77	0.81	0.84	0.87	0.90	Capacity Factor	95%	
			Inst costs ($/kW)	$ 4,029	$ 3,904	$ 3,783	$ 3,666	$ 3,552	$ 3,442	$ 3,335	$ 3,232	$ 3,132			
			O&M ($/MW)	$ 20,745	$ 21,139	$ 21,541	$ 21,950	$ 22,367	$ 22,792	$ 23,225	$ 23,667	$ 24,116			
			Fuel ($/kW)	$ 262	$ 259	$ 257	$ 258	$ 258	$ 257	$ 255	$ 253	$ 253			
			Lump sum ($)	$ 451,700	$ 514,425	$ 550,583	$ 650,839	$ 684,915	$ 646,038	$ 570,197	$ 565,429	$ 563,436	Levelized Cost	$0.15	$/kWh
Gas Turbine	65%	35%													
			MW	0.54	0.61	0.67	0.74	0.79	0.84	0.86	0.89	0.92			
line loss:	9.2%		aMW	0.52	0.58	0.64	0.70	0.75	0.80	0.82	0.85	0.87	Capacity Factor	95%	
			Inst costs ($/kW)	$ 2,028	$ 2,047	$ 2,065	$ 2,084	$ 2,102	$ 2,121	$ 2,140	$ 2,160	$ 2,179			
			O&M ($/MW)	$ 70,808	$ 72,154	$ 73,525	$ 74,922	$ 76,345	$ 77,796	$ 79,274	$ 80,780	$ 82,315			
			Fuel ($/kW)	$ 298	$ 295	$ 293	$ 293	$ 294	$ 292	$ 290	$ 288	$ 288			
			Lump sum ($)	$ 327,309	$ 350,095	$ 373,006	$ 397,800	$ 398,480	$ 393,831	$ 360,088	$ 369,590	$ 381,892	Levelized Cost	$0.07	$/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.77. Low Avoided Cost Scenario:Renewable WY

	% Penetration (by MW)			2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	0.01	0.07	0.33	0.70	1.42	2.42	3.42	4.41	5.41	6.41	7.40
line loss:	6.9%		aMW	0.01	0.06	0.29	0.63	1.28	2.18	3.07	3.97	4.87	5.76	6.66
			Inst costs ($/kW)	$ 1,800	$ 1,825	$ 1,851	$ 1,877	$ 1,903	$ 1,930	$ 1,957	$ 1,984	$ 2,012	$ 2,040	$ 2,068
			O&M ($/MW)	$ 39,420	$ 40,169	$ 40,932	$ 41,710	$ 42,502	$ 43,310	$ 44,133	$ 44,971	$ 45,826	$ 46,696	$ 47,584
			Lump sum ($)	$ 27,734	$ 114,746	$ 525,205	$ 780,026	$ 1,557,833	$ 2,192,936	$ 2,270,972	$ 2,351,288	$ 2,433,944	$ 2,519,002	$ 2,606,528
Anaerobic Digester	100%	0%												
			MW	0.00	0.00	0.00	0.01	0.02	0.04	0.05	0.06	0.08	0.09	0.11
line loss:	10.4%		aMW	0.00	0.00	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.08	0.09
			Inst costs ($/kW)	$ 3,219	$ 3,200	$ 3,181	$ 3,162	$ 3,143	$ 3,124	$ 3,105	$ 3,087	$ 3,068	$ 3,050	$ 3,031
			O&M ($/MW)	$ 66,744	$ 68,013	$ 69,305	$ 70,622	$ 71,963	$ 73,331	$ 74,724	$ 76,144	$ 77,591	$ 79,065	$ 80,567
			Lump sum ($)	$ 573	$ 2,895	$ 12,996	$ 18,931	$ 37,090	$ 51,239	$ 52,125	$ 53,052	$ 54,023	$ 55,037	$ 56,096

	% Penetration (by MW)			2019	2020	2021	2022	2023	2024	2025	2026	2027	Levelized Cost	
Biomass	Com	Ind												
Industrial	0%	100%												
			MW	8.40	9.39	10.39	11.39	12.24	12.95	13.38	13.81	14.23		
line loss:	6.9%		aMW	7.56	8.46	9.35	10.25	11.02	11.66	12.04	12.43	12.81	Capacity Factor	80%
			Inst costs ($/kW)	$ 2,097	$ 2,127	$ 2,157	$ 2,187	$ 2,217	$ 2,248	$ 2,280	$ 2,312	$ 2,344		
			O&M ($/MW)	$ 48,488	$ 49,409	$ 50,348	$ 51,304	$ 52,279	$ 53,273	$ 54,285	$ 55,316	$ 56,367		
			Lump sum ($)	$ 2,696,586	$ 2,789,245	$ 2,884,573	$ 2,982,643	$ 2,722,579	$ 2,445,870	$ 1,778,302	$ 1,832,316	$ 1,887,802	Levelized Cost	$0.03 $/kWh
Anaerobic Digester	100%	0%												
			MW	0.12	0.14	0.15	0.17	0.18	0.19	0.20	0.20	0.21		
line loss:	10.4%		aMW	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.16	0.17	Capacity Factor	80%
			Inst costs ($/kW)	$ 3,013	$ 2,995	$ 2,977	$ 2,959	$ 2,941	$ 2,924	$ 2,906	$ 2,889	$ 2,871		
			O&M ($/MW)	$ 82,098	$ 83,658	$ 85,247	$ 86,867	$ 88,517	$ 90,199	$ 91,913	$ 93,659	$ 95,439		
			Lump sum ($)	$ 57,202	$ 58,355	$ 59,557	$ 60,808	$ 55,855	$ 52,158	$ 48,849	$ 54,856	$ 72,123	Levelized Cost	$0.07 $/kWh

NOTE: Red indicates levelized cost is more than avoided cost.

Table E.78. Combined Heat & Power Base Case Achievable Potential and Cost

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
MW	0.0	0.1	0.3	0.7	1.4	2.4	3.4	4.4	5.4	6.4
aMW	0.0	0.1	0.3	0.6	1.3	2.2	3.1	4.0	4.9	5.8
Total Cost	$ 27,734	$ 114,746	$ 525,205	$ 780,026	$ 1,557,833	$ 2,192,936	$ 2,270,972	$ 2,351,288	$ 2,433,944	$ 2,519,002
Fuel ($/MM	$ 7.65	$ 7.77	$ 7.52	$ 7.52	$ 7.01	$ 5.53	$ 4.56	$ 4.82	$ 5.09	$ 5.16

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
MW	7.4	8.4	9.4	10.4	11.4	12.2	13.0	13.4	13.8	14.2
aMW	6.7	7.6	8.5	9.4	10.2	11.0	11.7	12.0	12.4	12.8
Total Cost	$ 2,606,528	$ 2,696,586	$ 2,789,245	$ 2,884,573	$ 2,982,643	$ 2,722,579	$ 2,445,870	$ 1,778,302	$ 1,832,316	$ 1,887,802
Fuel ($/MM	$ 5.23	$ 5.43	$ 5.38	$ 5.33	$ 5.34	$ 5.35	$ 5.32	$ 5.28	$ 5.23	$ 5.25

Appendix E.2. Technical Supplements: Supplemental Resources On-Site Solar

Table E.79. Building Photovoltaic Market Potential:
Apply ramping, percent market potential, capacity factors, and degredation los

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
Apply Ramping Curve and % Market MW																						
WA	0.00	0.00	0.01	0.03	0.04	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.9
CA	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.2
ID	0.00	0.00	0.01	0.01	0.02	0.04	0.04	0.04	0.04	0.05	0.04	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.5
UT	0.00	0.01	0.12	0.26	0.42	0.69	0.74	0.80	0.85	0.91	0.85	0.90	0.71	0.62	0.52	0.41	0.36	0.30	0.23	0.24	0.23	10.2
WY	0.00	0.00	0.01	0.03	0.05	0.08	0.08	0.09	0.09	0.10	0.09	0.10	0.08	0.07	0.06	0.04	0.04	0.03	0.02	0.03	0.02	1.1
OR	0.00	0.00	0.09	0.18	0.28	0.45	0.46	0.48	0.50	0.52	0.48	0.50	0.39	0.33	0.28	0.21	0.18	0.15	0.12	0.12	0.11	5.8
Accumulative Tota	0.00	0.0	0.2	0.8	1.6	2.9	4.3	5.9	7.4	9.1	10.7	12.3	13.6	14.7	15.7	16.4	17.0	17.6	18.0	18.4	**18.8**	**18.8**
Apply CF and 1% degredation aMW																						Total
WA	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
CA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
ID	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
UT	0.00	0.00	0.02	0.04	0.06	0.09	0.10	0.11	0.11	0.12	0.11	0.12	0.09	0.08	0.06	0.04	0.04	0.03	0.02	0.02	0.02	1.25
WY	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.14
OR	0.00	0.00	0.01	0.02	0.04	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.04	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.67
Accumulative Tota	0.00	0.00	0.03	0.10	0.21	0.38	0.57	0.76	0.97	1.18	1.38	1.58	1.73	1.87	1.97	2.05	2.11	2.16	2.19	2.22	**2.25**	**2.25**

Table E.80. Photovoltaic Market Acceptance Factors (2006)

	WA	CA	ID	UT	WY	OR
Program Factor	95%	85%	85%	95%	85%	95%
Cultural Factor	95%	95%	85%	95%	85%	95%
Acceptance Climate Factor	85%	95%	95%	95%	95%	85%
Urban Factor	85%	85%	85%	95%	85%	95%
Estimated Base Market %	0.009%	0.009%	0.008%	0.011%	0.008%	0.010%

	Yes	No	
Program Factor	95%	85%	Existing Program?
Cultural Factor	95%	85%	Greening Cultural?
Acceptance Climate Factor	95%	85%	Belief in PV based on their climate?
Urban Factor	95%	85%	More expendable income (ubran high is based on 30% or more)?

Table E.81. Photovoltaic Technicial Potential in MW and AverageMW (aMW) Summary

	Total		WA		CA		ID		UT		WY		OR	
	2006	**2027**	**2006**	**2027**	**2006**	**2027**	**2006**	**2027**	**2006**	**2027**	**2006**	**2027**	**2006**	**2027**
Commercial MW	**7,150**	**21,843**	478	1,156	94	253	207	852	2,889	11,520	522	1,777	2,960	6,285
Commercial aMW	**942**	**2,906**	57	138	12	32	27	111	394	1,571	74	252	378	802
Residential MW	**2,123**	**4,748**	144	263	49	84	73	164	1,029	2,550	130	276	698	1,411
Residential aMW	**281**	**630**	17	31	6	11	9	21	140	348	18	39	89	180
PV MW	**9,273**	**26,591**	623	1,419	143	337	280	1,016	3,918	14,070	652	2,053	3,658	7,695
PV aMW	**1,223**	**3,537**	74	170	18	43	36	132	534	1,919	92	291	467	982

Table E.82. Photovoltaic Techential Potential by State and Sector:
Weighted Average between Urban and Rural. All Sectors in kW and all totals in MW

		WA		CA		ID		UT		WY		OR	
		2006	2027	2006	2027	2006	2027	2006	2027	2006	2027	2006	2027
Large Office	kW	46,379	132,642	-	-	31,075	150,137	540,448	2,481,648	35,136	152,339	330,046	700,844
Small Office	kW	51,682	148,690	12,798	48,476	60,137	294,278	258,022	1,211,054	56,148	244,297	94,939	201,600
Grocery	kW	29,863	53,272	1,963	3,029	1,464	4,746	87,384	303,463	26,612	79,069	243,747	517,591
Large Retail	kW	127,854	260,011	-	-	41,002	143,895	435,039	1,481,823	71,233	219,325	424,383	901,165
Small Retail	kW	31,965	64,892	33,052	88,236	9,774	34,170	59,063	201,600	30,112	91,924	85,181	180,879
Restaurant	kW	6,623	20,004	5,659	17,862	920	2,698	40,340	126,735	22,802	57,717	30,666	65,118
Warehouse	kW	3,742	6,118	298	460	47,644	160,424	159,124	564,129	30,544	75,033	6,246	13,263
Lodging	kW	38,394	59,255	6,436	15,502	4,526	17,567	148,747	495,518	17,514	49,177	175,056	371,727
Schools	kW	24,414	71,634	2,260	5,628	1,990	10,947	513,120	1,880,428	122,620	417,280	792,050	1,681,895
Health	kW	77,776	263,252	22,774	49,349	6,586	23,199	351,970	1,459,762	71,332	249,199	513,599	1,090,613
Misc	kW	39,625	75,807	8,768	24,911	2,082	9,666	295,246	1,314,105	38,233	141,481	263,775	560,119
Total Commercial	MW	478	1,156	94	253	207	852	2,889	11,520	522	1,777	2,960	6,285
Commercial All States	***MW***	***7,150***	***21,843***										
Single Family	kW	105,063	189,170	28,743	51,576	58,985	136,128	869,563	2,170,320	97,300	228,769	443,666	896,797
Multi-Family	kW	19,568	37,009	8,539	11,511	6,993	14,319	119,688	285,768	18,561	25,487	139,163	281,281
Manufactured Housing	kW	19,704	37,266	11,695	20,755	6,612	13,834	40,153	94,001	14,103	21,491	115,025	232,519
Total Residential	MW	144	263	49	84	73	164	1,029	2,550	130	276	698	1,411
Residential All States	***MW***	***2,123***	***4,748***										

Table E.83. Available Roof Area Calculation in SQ.FT.

	Washington					
	Roof sq.ft. per unit	% Roof Area Available	2006 # of Customers	2006 Available Roof Sq.Ft.	2027 # of Customers	2027 Available Roof Sq. Ft.
Large Office	13,013	67%	591	5,176,222	1,095	9,592,039
Small Office	2,982	67%	2,874	5,768,112	5,357	10,752,577
Grocery	7,898	67%	627	3,332,973	724	3,852,349
Large Retail	68,388	67%	310	14,269,460	409	18,802,749
Small Retail	4,779	67%	1,109	3,567,533	1,459	4,692,692
Restaurant	2,446	67%	449	739,213	879	1,446,621
Warehouse	11,934	67%	52	417,674	55	442,446
Lodging	8,781	67%	725	4,285,043	725	4,285,043
Schools	25,302	67%	160	2,724,807	304	5,180,211
Health	23,448	67%	550	8,680,303	1,207	19,037,125
Misc	4,867	67%	1,350	4,422,452	1,673	5,482,045
Total Commercial	*173,838*		*8,797*	*53,383,791*	*13,887*	*83,565,898*
Single Family	900	17%	77,572	11,725,828	90,499	13,679,891
Multi-Family	1,300	17%	9,984	2,183,908	12,234	2,676,290
Manufactured Housing	1,400	17%	9,352	2,199,076	11,461	2,694,876
Total Residential	*3,600*		*96,908*	*16,108,812*	*114,194*	*19,051,058*

	California					
	Roof sq.ft. per unit	% Roof Area Available	2006 # of Customers	2006 Available Roof Sq.Ft.	2027 # of Customers	2027 Available Roof Sq. Ft.
Large Office	N/A	70%	-	-	-	-
Small Office	5,076	70%	402	1,428,386	987	3,505,587
Grocery	5,215	70%	60	219,030	60	219,030
Large Retail	N/A	70%	-	-	-	-
Small Retail	3,009	70%	1,751	3,688,805	3,029	6,380,804
Restaurant	2,123	70%	425	631,593	869	1,291,703
Warehouse	4,753	70%	10	33,271	10	33,271
Lodging	6,414	70%	160	718,312	250	1,121,016
Schools	7,208	70%	50	252,280	81	406,978
Health	9,683	70%	375	2,541,788	527	3,568,670
Misc	3,994	70%	350	978,530	644	1,801,446
Total Commercial	*47,475*		*3,583*	*10,491,995*	*6,456*	*18,328,505*
Single Family	800	16%	25,160	3,207,900	29,253	3,729,713
Multi-Family	1,400	18%	3,890	953,050	3,398	832,390
Manufactured Housing	1,400	16%	5,850	1,305,281	6,727	1,500,917
Total Residential	*3,600*		*34,900*	*5,466,231*	*39,377*	*6,063,020*

	Idaho					
	Roof sq.ft. per unit	% Roof Area Available	2006 # of Customers	2006 Available Roof Sq.Ft.	2027 # of Customers	2027 Available Roof Sq. Ft.
Large Office	18,353	69%	275	3,468,152	861	10,857,207
Small Office	4,543	69%	2,150	6,711,682	6,817	21,280,835
Grocery	3,658	69%	65	163,408	136	343,234
Large Retail	53,704	69%	124	4,576,101	282	10,405,794
Small Retail	4,628	69%	343	1,090,884	777	2,470,983
Restaurant	2,576	69%	58	102,664	110	195,118
Warehouse	20,363	69%	380	5,317,398	829	11,601,082
Lodging	9,546	69%	77	505,098	193	1,270,351
Schools	10,424	69%	31	222,051	109	791,623
Health	7,131	69%	150	735,028	342	1,677,626
Misc	3,977	69%	85	232,325	256	699,008
Total Commercial	*138,902*		*3,738*	*23,124,791*	*10,712*	*61,592,861*
Single Family	1,000	16%	40,273	6,583,113	60,223	9,844,125
Multi-Family	1,300	17%	3,495	780,494	4,636	1,035,463
Manufactured Housing	1,200	16%	3,762	737,935	5,100	1,000,426
Total Residential	*3,500*		*47,530*	*8,101,542*	*69,959*	*11,880,013*

	Utah					
	Roof sq.ft. per unit	% Roof Area Available	2006 # of Customers	2006 Available Roof Sq.Ft.	2027 # of Customers	2027 Available Roof Sq. Ft.
Large Office	17,606	65%	5,244	60,317,851	15,602	179,461,251
Small Office	3,241	65%	13,600	28,797,104	41,360	87,577,805
Grocery	10,075	65%	1,482	9,752,699	3,333	21,945,001
Large Retail	43,562	65%	1,706	48,553,493	3,765	107,158,515
Small Retail	4,387	65%	2,300	6,591,807	5,087	14,578,758
Restaurant	3,138	65%	2,196	4,502,282	4,470	9,164,882
Warehouse	33,809	65%	804	17,759,391	1,848	40,795,204
Lodging	16,565	65%	1,534	16,601,273	3,310	35,833,557
Schools	41,160	65%	2,130	57,267,804	5,057	135,983,786
Health	28,631	65%	2,100	39,282,385	5,644	105,563,172
Misc	7,310	65%	6,900	32,951,585	19,899	95,029,925
Total Commercial	*209,483*		*39,995*	*322,377,675*	*109,376*	*833,091,856*
Single Family	1,000	17%	556,955	97,049,395	900,703	156,947,433
Multi-Family	1,400	16%	58,417	13,357,986	90,373	20,665,398
Manufactured Housing	1,200	17%	21,432	4,481,354	32,509	6,797,724
Total Residential	*3,600*		*636,803*	*114,888,735*	*1,023,586*	*184,410,555*

	Wyoming					
	Roof sq.ft. per unit	% Roof Area Available	2006 # of Customers	2006 Available Roof Sq.Ft.	2027 # of Customers	2027 Available Roof Sq. Ft.
Large Office	12,549	69%	453	3,921,461	1,273	11,016,448
Small Office	2,698	69%	3,367	6,266,522	9,493	17,666,424
Grocery	8,787	69%	490	2,970,116	943	5,717,909
Large Retail	47,819	69%	241	7,950,149	481	15,860,556
Small Retail	4,872	69%	1,000	3,360,698	1,978	6,647,482
Restaurant	3,236	69%	1,140	2,544,889	1,870	4,173,792
Warehouse	28,399	69%	174	3,408,901	277	5,426,042
Lodging	7,322	69%	387	1,954,730	704	3,556,287
Schools	39,283	69%	505	13,685,297	1,114	30,175,731
Health	21,371	69%	540	7,961,176	1,222	18,020,909
Misc	4,758	69%	1,300	4,267,030	3,117	10,231,229
Total Commercial	*181,092*		*9,597*	*58,290,968*	*22,471*	*128,492,809*
Single Family	900	16%	74,202	10,859,332	113,043	16,543,539
Multi-Family	1,200	17%	10,010	2,071,564	8,906	1,843,070
Manufactured Housing	1,400	16%	6,914	1,574,046	6,827	1,554,156
Total Residential	*3,500*		*91,126*	*14,504,943*	*128,775*	*19,940,765*

	Oregon			
	Roof sq.ft. per unit	% Roof Area Available	2006 # of Customers	2006 Available Roof Sq.Ft.
Large Office	13,013	67%	8,505	36,835,513
Small Office	2,982	67%	5,337	10,595,875
Grocery	7,898	67%	5,174	27,203,959
Large Retail	68,388	67%	1,040	47,364,176
Small Retail	4,779	67%	2,988	9,506,773
Restaurant	2,446	67%	2,102	3,422,509
Warehouse	11,934	67%	88	697,067
Lodging	8,781	67%	6,685	19,537,549
Schools	25,302	67%	5,248	88,398,414
Health	23,448	67%	3,672	57,321,307
Misc	4,867	67%	9,086	29,439,186
Total Commercial	*173,838*		*49,927*	*330,322,326*
Single Family	900	17%	323,040	49,516,310
Multi-Family	1,300	17%	71,790	15,531,541
Manufactured Housing	1,400	17%	53,840	12,837,562
Total Residential	*3,600*		*448,670*	*77,885,414*

Table E.84. Photovoltaic Assumptions: Commercial

(1% cell degredation loss per year is taken into account in market potential)

Area unavailable	Factors-placement and shading by obstructions	Total un-available	Available % of roof
20%	1.5	**30%**	**70%**

* all commercial buildings have flat roofs
* the 20% assumes that obstructions and equipment shade of an additional 50% of the roof to total 30%
* assume 10% more shading in urban setting by other buildings
* assume sectors are split evenly throughout rural and urban

Rural and Urban Split	WA	CA	ID	UT	WY	OR
% Rural	73%	100%	87%	53%	90%	66%
% Urban	27%	0%	13%	47%	10%	34%
Weighted Average %	67%	70%	69%	65%	69%	67%

Table E.85. Photovoltaic Assumptions: Residential

	Pitch
Single Family (SF)	18.4 degrees
Multi-Family (MF)	0 degrees
Manufactured Home (MH)	18.4 degrees

* all mulit-family units have flat roof and use similar commercial assumptions but also include an increase in the number of obstructions.
25% of useable area multiplied by commercial assumptions.

	Orientation	Half of pitched roof	Roof obstructions	Total without shading
Available Roof Area Factors (% Useable) - without shading	75%	50%	85%	32%

	Urban/Rural split	Shading - % useable	Roof area factors	Total % roof available
Total Available Roof Area Factors (% Useable)	Urban	60%	32%	19%
	Rural	50%	32%	16%

		WA	CA	ID	UT	WY	OR
Shading split	Rural	73%	100%	87%	53%	90%	66%
	Urban	27%	0%	13%	47%	10%	34%
SF	Rural	16%	16%	16%	16%	16%	16%
	Urban	19%	19%	19%	19%	19%	19%
MF	Rural	18%	18%	18%	18%	18%	18%
	Urban	15%	15%	15%	15%	15%	15%
MH	Rural	16%	16%	16%	16%	16%	16%
	Urban	19%	19%	19%	19%	19%	19%
SF Weighted Average %		17%	16%	16%	17%	16%	17%
MF Weighted Average %		17%	18%	17%	16%	17%	17%
MH Weighted Average %		17%	16%	16%	17%	16%	17%

Table E.86. Photovoltaics Power Density

Year	Module pd	System pd
2006	11.2	8.96
2007	11.43	9.15
2008	11.67	9.34
2009	11.92	9.53
2010	12.17	9.73
2011	12.42	9.94
2012	12.68	10.14
2013	12.94	10.35
2014	13.21	10.57
2015	13.49	10.79
2016	13.77	11.02
2017	14.06	11.25
2018	14.35	11.48
2019	14.65	11.72
2020	14.96	11.97
2021	15.27	12.22
2022	15.59	12.47
2023	15.91	12.73
2024	16.25	13.00
2025	16.59	13.27
2026	16.93	13.55
2027	17.29	13.83

System power density (Wp/sq. ft.) = 0.8 * Module power density (this accounts for the additional space required for installation such as space bewteen modules, racking, wiring, etc)

Technology	% shares in x-Si Production by	Module power density (Wp/sq.
Mono crystalline	32%	13.5
Poly-crystalline	44%	12.5
Amorphous silicon	24%	6
Weighted average		11.2

2.09% Increase in module efficiency per year (percent)

Sources:

Energy Information Administration (EIA): "Annual Photovoltaic Module/Cell Manufacturers Survey."

DOE: Photovoltaics - Energy for the New Millennium: The National Photovoltaics Program Plan 2000-2004

NREL: The Role of Polycrystalline Thin-Film PV Technologies for Achieving Mid-Term Market-Competitive PV Modules

International Energy Agency (IEA): Photovoltaic Power Systems Programme

Table E.87. Solar Attic Fan Market Potential in MWh and MW

(Apply ramping, % market, and capacity factors)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Apply Ramping Curve and % Market MWh																				
WA	0	1	2	3	6	8	11	13	16	18	20	22	23	24	25	25	26	26	27	27
CA	0	0	0	0	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3
ID	0	0	0	1	1	2	2	2	3	3	4	4	4	5	5	5	5	5	5	5
UT	0	9	27	54	95	135	175	216	256	292	328	355	377	395	409	420	429	436	443	449
WY	0	0	1	1	2	3	3	4	5	5	6	7	7	7	8	8	8	8	8	8
OR	0	3	8	16	27	39	51	62	74	84	95	102	109	114	118	121	124	126	127	129
Total	1	13	38	75	131	187	243	299	355	405	454	492	523	548	566	582	594	603	613	**621**
Market MW																				
WA	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03
CA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ID	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UT	0.00	0.01	0.02	0.05	0.08	0.11	0.15	0.18	0.21	0.24	0.27	0.30	0.32	0.33	0.34	0.35	0.36	0.36	0.37	0.38
WY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
OR	0.00	0.00	0.01	0.01	0.02	0.03	0.05	0.06	0.07	0.08	0.08	0.09	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.12
Total	0.00	0.01	0.03	0.06	0.11	0.16	0.21	0.26	0.30	0.35	0.39	0.42	0.45	0.47	0.48	0.50	0.51	0.52	0.52	**0.53**

Table E.88. Solar Water Heater Market Potential in MWh and MW

(Apply ramping, % market, and capacity factors)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Apply Ramping Curve and % Market MWh																				
WA	0	4	11	22	38	54	71	87	103	118	132	143	152	159	165	169	173	176	178	181
CA	0	1	4	7	13	19	24	30	35	40	45	49	52	54	56	58	59	60	61	62
ID	0	2	5	11	18	26	34	42	50	57	64	69	73	77	79	81	83	84	86	87
UT	0	6	17	34	59	84	109	134	160	182	204	221	235	246	255	262	267	271	276	279
WY	0	2	5	10	18	26	33	41	49	55	62	67	72	75	78	80	81	83	84	85
OR	1	18	52	104	181	259	336	413	491	559	628	679	722	757	783	804	821	834	847	859
Total	2	33	95	188	328	467	607	747	887	1011	1135	1229	1306	1368	1415	1454	1485	1508	1531	**1553**
Market MW																				
WA	0.00	0.00	0.01	0.02	0.04	0.05	0.07	0.08	0.10	0.11	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.17	0.17
CA	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06
ID	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.04	0.04	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.08
UT	0.00	0.00	0.01	0.03	0.05	0.07	0.09	0.11	0.13	0.15	0.17	0.19	0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.23
WY	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07
OR	0.00	0.02	0.05	0.09	0.16	0.23	0.30	0.37	0.44	0.50	0.56	0.61	0.65	0.68	0.70	0.72	0.73	0.75	0.76	0.77
Total	0.00	0.03	0.08	0.17	0.29	0.41	0.54	0.66	0.79	0.90	1.01	1.09	1.16	1.21	1.25	1.29	1.31	1.34	1.36	**1.37**

Table E.89. Solar Attic Fan and Solar Water Heater Accumulative Technical Potential in MWh and aMW

	Total		WA		CA		ID		UT		WY		OR	
	2008	2027	2008	2027	2008	2027	2008	2027	2008	2027	2008	2027	2008	2027
Solar Water Heater MWh	790	16,366	97	1,907	31	649	40	916	152	2,945	38	897	432	9,052
Solar Water Heater aMW	0.09	1.87	0.01	0.22	0.00	0.07	0.00	0.10	0.02	0.34	0.00	0.10	0.05	1.03
Solar Attic Fan MWh	378	6,558	17	287	2	38	2	54	277	4,729	4	88	76	1,362
Solar Attic Fan aMW	0.04	0.75	0.00	0.03	0.00	0.00	0.00	0.01	0.03	0.54	0.00	0.01	0.01	0.16
Percent (%) of Technical														
Solar Thermal	9.5%													
Solar Attic Fan	9.5%													

Table E.90. Cost Calculations: PV

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
PV Cost	**Year**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
	Admin	**15%**	**15.3%**	**15.6%**	**15.9%**	**16.2%**	**16.5%**	**16.8%**	**17.1%**	**17.4%**	**17.8%**	**18.1%**	**18.5%**	**18.8%**	**19.2%**	**19.5%**	**19.9%**	**20.3%**	**20.7%**	**21.0%**	**21.4%**
WA		$1,843.18	$64,221.48	$129,130.88	$194,745.85	$293,168.35	$296,343.30	$299,518.27	$302,693.23	$305,868.19	$276,941.15	$279,763.35	$218,381.48	$188,396.09	$134,762.36	$127,366.94	$112,374.22	$97,205.12	$81,859.61	$82,388.78	$81,312.84
CA		$438.12	$15,265.12	$30,693.75	$46,290.09	$69,684.61	$70,439.29	$71,193.96	$71,948.63	$72,703.30	$65,827.49	$66,498.32	$51,908.16	$44,780.79	$32,032.32	$30,274.47	$26,710.78	$23,105.16	$19,457.61	$19,583.39	$19,327.64
ID		$1,068.96	$37,245.45	$74,889.86	$112,943.47	$170,023.91	$171,865.24	$173,706.57	$175,547.89	$177,389.23	$160,612.90	$162,249.64	$126,651.03	$109,260.91	$78,155.86	$73,866.86	$65,171.79	$56,374.41	$47,474.74	$47,781.63	$47,157.64
UT		$22,563.16	$786,161.18	$1,580,743.56	$2,383,963.07	$3,588,792.74	$3,627,658.70	$3,666,524.69	$3,705,390.71	$3,744,256.74	$3,390,149.10	$3,424,696.73	$2,673,296.39	$2,306,232.99	$1,649,680.74	$1,559,150.40	$1,375,618.50	$1,189,927.28	$1,002,076.76	$1,008,554.47	$995,383.43
WY		$2,399.52	$83,605.69	$168,106.94	$253,526.73	$381,656.45	$385,789.72	$389,922.99	$394,056.26	$398,189.54	$360,531.34	$364,205.37	$284,296.39	$245,260.39	$175,438.19	$165,810.58	$146,292.56	$126,544.90	$106,567.61	$107,256.49	$105,855.79
OR		$11,106.29	$386,973.19	$778,091.56	$1,173,461.40	$1,766,516.36	$1,785,647.41	$1,804,778.47	$1,823,909.54	$1,843,040.62	$1,668,737.73	$1,685,743.16	$1,315,880.34	$1,135,200.22	$812,024.61	$767,462.74	$677,122.57	$585,719.53	$493,253.61	$496,442.15	$489,958.95

PV Levelized Cost		NPV 2007 $	NPV 2007 ($000)
WA	$0.90	$1,916,260.07	$1,916.26
CA	$0.85	$455,485.20	$455.49
ID	$0.83	$1,111,341.08	$1,111.34
UT	$0.79	$23,457,717.43	$23,457.72
WY	$0.76	$2,494,652.04	$2,494.65
OR	$0.85	$11,546,624.35	$11,546.62
Total		$40,982,080.17	$40,982.08

$9,000.00	Equipment/install $/kW
15%	Admin
$10,350.00	Total Equipment + Admin $/kW
$100.00	O&M $/kW
25	Measure Life
1.9%	Inflation
7.10%	Discount rate

Table E.91. Cost Calculations: SWH

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SWH Cost	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
WA	$347.91	$13,950.84	$27,971.98	$42,065.40	$63,262.31	$63,429.64	$63,600.16	$63,773.91	$63,950.96	$57,005.67	$57,169.09	$43,001.71	$35,940.81	$28,839.10	$21,997.95	$32,644.10	$43,662.68	$54,753.13	$76,903.72	$76,790.38
CA	$110.79	$4,442.75	$8,907.88	$13,396.03	$20,146.34	$20,199.63	$20,253.93	$20,309.26	$20,365.65	$18,153.87	$18,205.91	$13,694.20	$11,445.61	$9,184.02	$7,005.41	$10,395.75	$13,904.70	$17,436.53	$24,490.55	$24,454.45
ID	$153.62	$6,159.99	$12,351.01	$18,573.95	$27,933.44	$28,007.32	$28,082.61	$28,159.33	$28,237.51	$25,170.82	$25,242.98	$18,987.38	$15,869.65	$12,733.89	$9,713.18	$14,413.98	$19,279.23	$24,176.21	$33,956.80	$33,906.75
UT	$470.78	$18,877.90	$37,850.91	$56,921.75	$85,604.83	$85,831.26	$86,061.99	$86,297.11	$86,536.69	$77,138.52	$77,359.65	$58,188.74	$48,634.12	$39,024.29	$29,767.02	$44,173.10	$59,083.14	$74,090.44	$104,064.01	$103,910.65
WY	$138.14	$5,539.24	$11,106.38	$16,702.23	$25,118.54	$25,184.98	$25,252.68	$25,321.67	$25,391.97	$22,634.32	$22,699.20	$17,073.99	$14,270.44	$11,450.68	$8,734.37	$12,961.46	$17,336.43	$21,739.94	$30,534.91	$30,489.91
OR	$1,545.89	$61,988.65	$124,289.62	$186,911.79	$281,097.35	$281,840.87	$282,598.52	$283,370.56	$284,157.27	$253,296.83	$254,022.96	$191,072.16	$159,698.04	$128,142.58	$97,744.85	$145,049.54	$194,009.09	$243,287.97	$341,711.07	$341,207.46

SWH Levelized Cost		2007 $	2007 ($000)
WA	$0.40	$423,659.71	$423.66
CA	$0.37	$134,917.50	$134.92
ID	$0.36	$187,066.72	$187.07
UT	$0.35	$573,284.76	$573.28
WY	$0.33	$168,215.70	$168.22
OR	$0.37	$1,882,473.50	$1,882.47
Total		$3,369,617.89	$3,369.62

kWh	Dollar
$3,500.00	Equipment/install $/kW
15%	Admin
$4,025.00	Total Equipment + Admin $/kW
0	O&M $/kW
15	Measure Life
1.9%	Inflation
7.10%	Discount rate

Table E.92. Cost Calculations: SAF

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SAF Cost	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
WA	$806.82	$215,241.60	$431,567.63	$649,009.00	$976,047.07	$978,628.78	$981,259.55	$983,940.29	$986,671.98	$880,342.30	$1,102,546.70	$1,105,758.22	$1,219,933.83	$1,446,075.11	$1,338,916.25	$1,287,110.10	$1,235,030.06	$1,182,667.57	$1,073,513.15	$1,071,391.14
CA	$74.66	$68,545.24	$137,435.83	$206,681.61	$310,829.24	$311,651.41	$312,489.19	$313,342.90	$314,212.82	$280,164.70	$351,113.96	$352,136.70	$388,496.74	$460,513.07	$426,387.55	$409,889.51	$393,304.25	$376,629.03	$341,868.02	$341,192.25
ID	$139.36	$95,039.81	$190,558.45	$286,569.57	$430,973.06	$432,113.01	$433,274.62	$434,458.31	$435,664.48	$388,492.55	$486,828.90	$488,246.94	$538,661.12	$638,513.68	$591,197.75	$568,322.77	$545,326.86	$522,206.23	$474,009.15	$473,072.18
UT	$11,663.78	$291,259.06	$583,985.53	$878,221.26	$1,320,760.25	$1,324,253.75	$1,327,813.63	$1,331,441.14	$1,335,137.58	$1,202,081.71	$1,491,936.09	$1,496,281.83	$1,650,781.15	$1,956,789.35	$1,811,784.91	$1,741,682.24	$1,671,208.96	$1,600,353.46	$1,452,648.69	$1,449,777.24
WY	$209.62	$85,462.49	$171,355.57	$257,691.49	$387,543.20	$388,568.28	$389,612.83	$390,677.23	$391,761.86	$349,429.85	$437,770.35	$439,045.50	$484,379.36	$574,169.61	$531,621.78	$511,051.95	$490,373.38	$469,582.65	$426,242.47	$425,399.92
OR	$3,589.74	$956,396.35	$1,917,611.23	$2,883,781.96	$4,336,930.53	$4,348,402.00	$4,360,091.43	$4,372,002.96	$4,384,140.81	$3,911,684.43	$4,899,014.17	$4,913,284.10	$5,420,607.67	$6,425,435.24	$5,949,289.63	$5,719,096.17	$5,487,685.70	$5,255,020.20	$4,770,007.61	$4,760,578.73

SAF Levelized Cost		2007 $	2007 ($000)
WA	$7.92	$8,783,054.52	$8,783.05
CA	$7.42	$2,796,762.98	$2,796.76
ID	$7.28	$3,877,838.60	$3,877.84
UT	$6.94	$11,900,313.21	$11,900.31
WY	$6.69	$3,487,184.64	$3,487.18
OR	$7.42	$39,026,297.99	$39,026.30
Total		$69,871,451.95	$69,871.45

kWh	Dollar
$54,000.00	Equipment/install $/kW
15%	Admin
$62,100.00	Total Equipment + Admin $/kW
0	O&M $/kW
10	Measure Life
1.9%	Inflation
7.10%	Discount rate

PV = Photovoltaic
SWH = Solar Water Heater
SAF = Solar Attic Fan

Table E.93. PV Incentives by State Program (2007)

State/Program Name	Sector	State Rebate Program ($/Watt)	Program Size Maximum (kW)
Nevada	Residential	$2.50/W AC	30 kW
SolarGenerations PV Rebate Program	Business	$2.50/W AC	30 kW
	Other: Public/School	$5.00/W AC	30 kW
New Jersey	Residential	$2.60/W DC	10 kW
New Jersey Clean Energy Rebate Program	Business	$2.00 - $3.80/W DC	10 - 700 kW
	Other: Public/School	$2.05 - $4.40/W DC	10 - 700 kW
Connecticut	Residential	$4.30 - $5.00/W PTC rating	5 - 10 kW
CCEF - Solar PV Rebate Program	Business	$5.00/W PTC rating	Unlimited > 10 kW
	Other: Public/School	$5.00/W PTC rating	10kW
Massachusetts	Residential*	$2.00/W DC	3.5 kW
MTC - Small Renewables Initiative Rebate	Business*	$2.00/W DC	10 kW
	Other: Public/School	$2.00/W DC	10 kW
Florida	Residential	$4.00/W DC	5 kW
Solar Energy System Incentives Program	Business*	$4.00/W DC	25 kW
	Other: Public/School	$4.00/W DC	25 kW
California	Residential	$2.50/W PTC rating	100 kW
California Solar Initiative Incentives	Business	$2.50/W PTC rating	100 kW
	Other: Public/School	$3.25/W PTC rating	100 kW
Oregon	Residential*	$2.00/W DC	5 kW
Energy Trust - Solar Electric Buy-Down Program	Business*	$1.25 - $1.00/W DC	50 kW
	Other: Public/School	$1.25 - $1.00/W DC	50 kW
Utah[1]	Residential	$2.00/W AC	3 kW
Solar Incentive Program	Business	$2.00/W AC	15 kW
	Other: Public/School	$2.00/W AC	15 kW

* State tax credits also available

[1] Utah's Solar Incentive Program began in 2007 as a pilot project and provides a comparison to the other programs.

Appendix E.3. Technical Supplements: Supplemental Resources DSG

Table E.94. Program Basics

Program Name	Dispatchable Standby Generation
Market Segments and Subsectors Eligible	All Commercial and Insustrial Subsectors
End Uses Eligible for Program	Total Load
Customer Size Requirements, if any	All
Summer Load Basis	Top 40 Summer
Winter Load Basis	Top 40 Winter

Table E.95. Inputs and Sources not Varying by State or Sector

Inputs	Existing	New	Sources or Assumptions
Annual Attrition (%)	5%	5%	Based on changes in electrical service
Annual Administrative Costs (%)	15%	15%	All resource classes assume admin adder of 15%
Per kW First Cost	$250	$175	Interconnection Equipment and Controls: PGE Mark Osborn and Mark Reynolds
Per kW Ongoing	$29	$26	Include $21 dollars for fuel incentive and $7.50/$5 for general O&M (existing/new): PGE Mark Osborn and Mark Reynolds
Program Participation Base Case	10%	10%	Estimate of achievable, assuming that base of achievable is the % of load that currently participate in the PGE program
Program Participation High	15%	15%	

Table E.96. State Sector Inputs

Sector/Subsector	End Use	Eligible Load Existing (%)	Eligible Load New (%)	Tech Pot Savings as % of Gross	Program Participation (%)	Event Participation (%)
	Total Load	Based on % of peak load typically met by a backup generator and the percentage of customers that currently have a generator SOURCE: Energy Insights Survey	Based on % of peak load typically met by a backup generator and the percentage of customers that currently do not have a generator SOURCE: Energy Insights Survey	Based on % of load that will be met with a backup generator SOURCE: Energy Insights	Estimate of achievable, assuming that base of achievable is the % of load that currently participate in the PGE program(10%)	Assumption: PGE has had one event during which 1 customer out 40 could not participate.
California						
Small_Office	Segment Total	16%	84%	0%	10%	98%
Restaurant	Segment Total	30%	70%	0%	10%	98%
Small_Retail	Segment Total	10%	90%	0%	10%	98%
Grocery	Segment Total	20%	80%	22%	10%	98%
Warehouse	Segment Total	30%	70%	0%	10%	98%
School	Segment Total	40%	60%	7%	10%	98%
Health	Segment Total	69%	31%	31%	10%	98%
Lodging	Segment Total	60%	40%	7%	10%	98%
Miscellaneous	Segment Total	30%	70%	12%	10%	98%
Lumber_Wood_Products	Segment Total	21%	79%	87%	10%	98%
Miscellaneous_Mfg	Segment Total	17%	83%	24%	10%	98%
Idaho						
Small_Office	Segment Total	16%	84%	0%	10%	98%
Large_Office	Segment Total	16%	84%	0%	10%	98%
Restaurant	Segment Total	30%	70%	0%	10%	98%
Large_Retail	Segment Total	10%	90%	9%	10%	98%
Small_Retail	Segment Total	10%	90%	0%	10%	98%
Grocery	Segment Total	20%	80%	28%	10%	98%
Warehouse	Segment Total	30%	70%	0%	10%	98%
School	Segment Total	40%	60%	34%	10%	98%
Health	Segment Total	69%	31%	9%	10%	98%
Lodging	Segment Total	60%	40%	0%	10%	98%
Miscellaneous	Segment Total	30%	70%	20%	10%	98%
Food_Mfg	Segment Total	95%	5%	88%	10%	98%
Chemical_Mfg	Segment Total	17%	83%	100%	10%	98%
Miscellaneous_Mfg	Segment Total	17%	83%	8%	10%	98%

Sector/Subsector	End Use	Eligible Load Existing (%)	Eligible Load New (%)	Tech Pot Savings as % of Gross	Program Participation (%)	Event Participation (%)
	Total Load	Based on % of peak load typically met by a backup generator and the percentage of customers that currently have a generator SOURCE: Energy Insights Survey	Based on % of peak load typically met by a backup generator and the percentage of customers that currently do not have a generator SOURCE: Energy Insights Survey	Based on % of load that will be met with a backup generator SOURCE: Energy Insights	Estimate of achievable, assuming that base of achievable is the % of load that currently participate in the PGE program(10%)	Assumption: PGE has had one event during which 1 customer out 40 could not participate.
Oregon						
Small_Office	Segment Total	16%	84%	0%	10%	98%
Large_Office	Segment Total	16%	84%	34%	10%	98%
Restaurant	Segment Total	30%	70%	1%	10%	98%
Large_Retail	Segment Total	10%	90%	12%	10%	98%
Small_Retail	Segment Total	10%	90%	0%	10%	98%
Grocery	Segment Total	20%	80%	35%	10%	98%
Warehouse	Segment Total	30%	70%	26%	10%	98%
School	Segment Total	40%	60%	23%	10%	98%
Health	Segment Total	69%	31%	35%	10%	98%
Lodging	Segment Total	60%	40%	19%	10%	98%
Miscellaneous	Segment Total	30%	70%	35%	10%	98%
Food_Mfg	Segment Total	95%	5%	80%	10%	98%
Lumber_Wood_Products	Segment Total	21%	79%	85%	10%	98%
Paper_Mfg	Segment Total	3%	97%	99%	10%	98%
Primary_Metal_Mfg	Segment Total	63%	37%	92%	10%	98%
Miscellaneous_Mfg	Segment Total	17%	83%	10%	10%	98%
Utah						
Small_Office	Segment Total	16%	84%	0%	10%	98%
Large_Office	Segment Total	16%	84%	37%	10%	98%
Restaurant	Segment Total	30%	70%	0%	10%	98%
Large_Retail	Segment Total	10%	90%	32%	10%	98%
Small_Retail	Segment Total	10%	90%	0%	10%	98%
Grocery	Segment Total	20%	80%	52%	10%	98%
Warehouse	Segment Total	30%	70%	18%	10%	98%
School	Segment Total	40%	60%	19%	10%	98%
Health	Segment Total	69%	31%	24%	10%	98%
Lodging	Segment Total	60%	40%	16%	10%	98%
Miscellaneous	Segment Total	30%	70%	34%	10%	98%
Food_Mfg	Segment Total	95%	5%	67%	10%	98%
Chemical_Mfg	Segment Total	17%	83%	6%	10%	98%
Petroleum_Refining	Segment Total	14%	86%	9%	10%	98%
Stone_Clay_Glass_Products	Segment Total	26%	74%	19%	10%	98%
Primary_Metal_Mfg	Segment Total	63%	37%	6%	10%	98%
Industrial_Machinery	Segment Total	2%	98%	32%	10%	98%
Electronic_Equipment_Mfg	Segment Total	19%	81%	45%	10%	98%
Transportation_Equipment_Mfg	Segment Total	20%	80%	41%	10%	98%
Mining	Segment Total	17%	83%	13%	10%	98%
Miscellaneous_Mfg	Segment Total	17%	83%	11%	10%	98%

Sector/Subsector	End Use	Eligible Load Existing (%)	Eligible Load New (%)	Tech Pot Savings as % of Gross	Program Participation (%)	Event Participation (%)
	Total Load	Based on % of peak load typically met by a backup generator and the percentage of customers that currently have a generator SOURCE: Energy Insights Survey	Based on % of peak load typically met by a backup generator and the percentage of customers that currently do not have a generator SOURCE: Energy Insights Survey	Based on % of load that will be met with a backup generator SOURCE: Energy Insights	Estimate of achievable, assuming that base of achievable is the % of load that currently participate in the PGE program(10%)	Assumption: PGE has had one event during which 1 customer out 40 could not participate.
Washington						
Small_Office	Segment Total	16%	84%	0%	10%	98%
Large_Office	Segment Total	16%	84%	18%	10%	98%
Restaurant	Segment Total	30%	70%	0%	10%	98%
Large_Retail	Segment Total	10%	90%	4%	10%	98%
Small_Retail	Segment Total	10%	90%	0%	10%	98%
Grocery	Segment Total	20%	80%	44%	10%	98%
Warehouse	Segment Total	30%	70%	8%	10%	98%
School	Segment Total	40%	60%	0%	10%	98%
Health	Segment Total	69%	31%	2%	10%	98%
Lodging	Segment Total	60%	40%	5%	10%	98%
Miscellaneous	Segment Total	30%	70%	11%	10%	98%
Food_Mfg	Segment Total	95%	5%	37%	10%	98%
Lumber_Wood_Products	Segment Total	21%	79%	9%	10%	98%
Paper_Mfg	Segment Total	3%	97%	4%	10%	98%
Miscellaneous_Mfg	Segment Total	17%	83%	3%	10%	98%
Wyoming						
Small_Office	Segment Total	16%	84%	0%	10%	98%
Large_Office	Segment Total	16%	84%	11%	10%	98%
Restaurant	Segment Total	30%	70%	0%	10%	98%
Large_Retail	Segment Total	10%	90%	17%	10%	98%
Small_Retail	Segment Total	10%	90%	0%	10%	98%
Grocery	Segment Total	20%	80%	36%	10%	98%
Warehouse	Segment Total	30%	70%	0%	10%	98%
School	Segment Total	40%	60%	39%	10%	98%
Health	Segment Total	69%	31%	47%	10%	98%
Lodging	Segment Total	60%	40%	11%	10%	98%
Miscellaneous	Segment Total	30%	70%	55%	10%	98%
Chemical_Mfg	Segment Total	17%	83%	6%	10%	98%
Petroleum_Refining	Segment Total	14%	86%	4%	10%	98%
Mining	Segment Total	17%	83%	15%	10%	98%
Miscellaneous_Mfg	Segment Total	17%	83%	5%	10%	98%

Appendix F. Simulations & Home Electronics

Scope

The purpose of this appendix is twofold. First, there is a detailed description of methodology employed in conducting building simulations, which provide some of the key inputs into this study. The second is a thorough treatment of the of the load associated with home electronics, which, in addition to being an area of increasing interest and importance, is also an important source of consumption that building simulations cannot adequately characterize.

Building Simulations

The consumption – both quantity and timing – of electricity associated with different end uses across states and building types is a critical component in the assessment of both capacity-based and energy efficiency potentials for the residential and commercial sectors. The primary source for these data are energy model simulations, which served the following purposes in this study:

- Establish the baseline consumption for various end uses in both existing and new construction vintages.
- Estimate the savings associated with equipment upgrades and improvements to both building shell and lighting
- Account for the interactive effects that occur between lighting improvements and HVAC
- Establish the annual hourly timing associated with consumption in different end uses

The two types of energy simulation programs used for this study are eQuest[1] (for commercial models) and Energy-10[2] (for residential models). eQuest is a user interface that uses the standard DOE-2 calculation engine with an emphasis on commercial building types. Energy-10 is a program developed by the National Renewable Energy Laboratory (NREL) Center for Building and Energy Storage with an emphasis on simulations for small commercial and residential building types.

Both of these programs provide hourly (8,760) demand and annual energy consumption for a specific end use (e.g., cooling, heating, water heating, etc.). The hourly values were then amalgamated and calibrated with actual hourly usage to determine the load basis for Class 1 and Class 3 DSM resources (see Volume I, Chapter 2 and Volume II, Appendix B). The annual energy consumption was used in the analysis of Class 2 DSM resources to determine specific building type end-use consumption. A secondary purpose of energy simulations is the ability to determine the energy savings associated with installing higher efficiency equipment (e.g., moving from a SEER 13 Central AC to a SEER 15) and shell improvements (e.g., increasing

[1] eQuest web page: http://doe2.com/equest/

[2] Energy-10 web page: http://www.nrel.gov/buildings/energy10.html

insulation values and/or using high efficiency windows). Lists of all measures modeled for the residential and commercial sectors are given in Table F.1 and Table F.2, respectively.

Table F.1. Residential Measures Modeled in Energy-10

End Use	Measure Name
Central AC	Central AC - Advanced Technology SEER 18
	Central AC - High Efficiency SEER 16
	Central AC - Premium Efficiency SEER 14
Heat Pump	ASHP - Advanced Efficiency
	ASHP - High Efficiency
	ASHP - Premium Efficiency
HVAC	Duct Insulation
	Insulation-Ceiling
	Insulation-Floor
	Insulation-Wall 2x4
	Insulation-Wall 2x6
	Windows, ENERGY STAR or better
	Room AC - Energy Star
	Ductless Heat Pump
Water Heat	Hot Water Pipe Insulation
	Water Heater Temperature Setback

Table F.2. Commercial Measures Modeled in eQuest

End Use	Measure Name
Cooling Chillers	Chiller-High Efficiency
	Chiller-Premium Efficiency
	Cooling Tower-Decrease Approach Temperature
	Cooling Tower-Two-Speed Fan Motor
	Chiller-Water Side Economizer
Cooling DX	DX Package-Air Side Economizer
	High Efficiency DX Package
	Premium Efficiency DX Package
Heat Pump	High Efficiency ASHP
HVAC	Windows-High Efficiency
Lighting	Lighting Package, High Efficiency
	Lighting Package, Premium Efficiency
HVAC	Insulation - 2*4 Walls
	Insulation - Floor
	Insulation - Roof / Ceiling
Water Heat	Water Heater Temperature Setback

There are three main steps involved in the building simulation process. The first step is the development of building prototypes, which define the typical characteristics associated with the different customer segments (residential dwelling type or commercial business type) for both existing and new construction across the five states assessed in this study (California, Idaho,

Utah, Washington, and Wyoming). These characteristics, which play an important role in driving energy consumption, were developed from a number of sources. For existing buildings, values come from information in PacifiCorp's Energy Decision Survey in addition to energy audits and other site visits performed by Nexant or Quantec. In cases where data are lacking, engineering judgment is applied. For new construction, the specific state energy code and/or federal code (whichever is the most stringent) is used to determine the building construction and equipment efficiency requirements. The Washington and California energy codes are used for those respective states and the IECC (International Energy Conservation Code for 2006) was used for Idaho, Utah, and Wyoming. Idaho and Utah have implemented the IECC code by adoption. Wyoming does not currently have a state energy code; therefore, the IECC code is used. These building characteristics are provided in Table F.3 through Table F.24 below for customer segments within both the residential and commercial sectors.

Table F.3. Pacific Power Office

Pacific Power Office	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	1	1	1	1
Floor Area [sqft]	4,819	4,819	2,569	2,569
Roof Area [sqft]	4,819	4,819	2,569	2,569
Envelope				
Window U-factor	U=0.6	U=0.55	U=0.6	U=0.55
Window to Wall Area	18%	18%	18%	18%
Wall Insulation (R Value)	R-3	R-19	R-3	R-19
Roof Insulation (R Value)	R-11	R-21	R-11	R-19
Floor Insulation (R Value)	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.6	1	1.6	1
Occupancy Schedule WkDay	8am-5pm			
Occupancy Schedule WkEnd	11am-4pm - Sat			
Water Heater Capacity (gal)	50	50	50	50
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135
HVAC				
Modeling Electric Resistance Heating?	yes	yes	yes	yes
Heating Efficiency	1	1	1	1
Modeling Heat Pump?	yes	yes	yes	yes
Heating Efficiency	2.7 COP	3.2 COP	2.7 COP	3.2 COP
Percent Of Building Heated			100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.3 EER	10.1 EER	9.3 EER	10.1 EER
Modeling Chillers Cooling?	yes	yes	yes	yes
Cooling Efficiency	0.793 kW/ton	0.675 kW/ton	0.793 kW/ton	0.675 kW/ton
Heating Daytime Set point [°F]	69	69	69	69
Heat. Setback/Setup Set point [°F]	61	61	61	61
Cooling Daytime Set point [°F]	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table F.4. Rocky Mountain Power Office

Rocky Mountain Power Office	Idaho		Utah		Wyoming	
	Existing	New	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.					
Roof Construction	standard wood frame built up roof					
# of Floors	1	1	2	2	1	1
Floor Area [sqft]	4,128	4,128	3,889	3,889	4,455	4,455
Roof Area [sqft]	4,128	4,128	3,889	3,889	4,455	4,455
Envelope						
Window U-factor	U=0.6	U=0.55	U=0.6	U=0.55	U=0.6	U=0.55
Window to Wall Area	18%	18%	18%	18%	18%	18%
Wall Insulation (R Value)	R-3	R-13+R-13	R-3	R-13+R-13	R-3	R-13+R-13
Roof Insulation (R Value)	R-11	R-19	R-11	R-19	R-11	R-19
Floor Insulation (R Value)	R-11	R-19	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.6	1	1.6	1	1.6	1
Occupancy Schedule WkDay	8am-5pm					
Occupancy Schedule WkEnd	11am-4pm - Sat					
Water Heater Capacity (gal)	50	50	50	50	50	50
Water Heating Fuel Type	Electric	Electric	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135	135	135
HVAC						
Modeling Electric Resistance Heating?	yes	yes	yes	yes	yes	yes
Heating Efficiency	1	1	1	1	1	1
Electric Heating Type 2	yes	yes	no	no	yes	yes
Heating Efficiency	2.7 COP	3.2 COP			2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	yes	yes	no	no	yes	yes
Cooling Efficiency	9.3 EER	10.1 EER			9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	yes	yes	yes	yes
Cooling Efficiency			0.793 kW/ton	0.675 kW/ton	0.793 kW/ton	0.675 kW/ton
Heating Daytime Set point [°F]	69	69	69	69	69	69
Heat. Setback/Setup Set point [°F]	61	61	61	61	61	61
Cooling Daytime Set point [°F]	72	72	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75	75	75

Table F.5. Pacific Power Grocery

Pacific Power Grocery	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	1	1	1	1
Total Floor Area [sqft]	12,474	12,474	5,661	5,661
Roof Area [sqft]	12,474	12,474	5,661	5,661
Envelope				
Window U-factor	U=0.65	U=0.55	U=0.65	U=0.55
Window to Wall Area	11%	11%	11%	11%
Wall Insulation (R Value)	R-3	R-19	R-3	R-19
Roof Insulation (R Value)	R-7	R-21	R-7	R-19
Floor Insulation (R Value)	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.7	1.5	1.7	1.5
Occupancy Schedule WkDay	7am-9pm			
Occupancy Schedule WkEnd	8am-9pm (Sat), 9am-8pm (Sun)			
Water Heater Capacity (gal)	100	100	100	100
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135
HVAC				
Modeling Electric Resistance Heating?	yes	yes	Yes	Yes
Heating Efficiency	1	1	1	1
Modeling Heat Pump?	yes	yes	no	no
Heating Efficiency	2.7 COP	3.2 COP		
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	yes	yes	no	no
Cooling Efficiency	9.3 EER	10.1 EER		
Modeling Chillers Cooling?	no	no	yes	yes
Cooling Efficiency	0.793 kW/ton		0.793 kW/ton	0.675 kW/ton
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	68	68	68	68
Heat. Setback/Setup Set point [°F]	62	62	62	62
Cooling Daytime Set point [°F]	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table F.6. Rocky Mountain Power Grocery

Rocky Mountain Power Grocery	Idaho		Utah		Wyoming	
	Existing	New	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.					
Roof Construction	standard wood frame built up roof					
# of Floors	1	1	1	1	1	1
Total Floor Area [sqft]	8,130	8,130	15,136	15,136	5,212	5,212
Roof Area [sqft]	8,130	8,130	15,136	15,136	5,212	5,212
Envelope						
Window U-factor	U=0.65	U=0.55	U=0.65	U=0.55	U=0.65	U=0.55
Window to Wall Area	11%	11%	11%	11%	11%	11%
Wall Insulation (R Value)	R-3	R-13+R-13	R-3	R-13+R-13	R-3	R-13+R-13
Roof Insulation (R Value)	R-7	R-19	R-7	R-19	R-7	R-19
Floor Insulation (R Value)	R-11	R-19	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.7	1.5	1.7	1.5	1.7	1.5
Occupancy Schedule WkDay	7am-9pm					
Occupancy Schedule WkEnd	8am-9pm (Sat), 9am-8pm (Sun)					
Water Heater Capacity (gal)	100	100	100	100	100	100
Water Heating Fuel Type	Electric	Electric	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135	135	135
HVAC						
Modeling Electric Resistance Heating?	yes	yes	yes	yes	yes	yes
Heating Efficiency	1	1	1	1	1	1
Modeling Heat Pump?	yes	yes	yes	yes	yes	yes
Heating Efficiency	2.7 COP	3.2 COP	2.7 COP	3.2 COP	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	9.3 EER	10.1 EER	9.3 EER	10.1 EER	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	no	no	no	no
Cooling Efficiency						
Percent Of Building Cooled	100	100	100	100	100	
Heating Daytime Set point [°F]	68	68	68	68	68	68
Heat. Setback/Setup Set point [°F]	62	62	62	62	62	62
Cooling Daytime Set point [°F]	72	72	72	72	72	72
Cool. Setback/Setup Setpoint [°F]	75	75	75	75	75	75

Table F.7. Pacific Power Retail

Pacific Power Retail	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	1	1	1	1
Total Floor Area [sqft]	6,176	6,176	3,697	3,697
Roof Area [sqft]	6,176	6,176	3,697	3,697
Envelope				
Window U-factor	U=0.68	U=0.55	U=0.68	U=0.55
Window to Wall Area	15%	15%	15%	15%
Wall Insulation (R Value)	R-3	R-19	R-3	R-19
Roof Insulation (R Value)	R-7	R-21	R-7	R-21
Floor Insulation (R Value)	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.95	1.5	1.95	1.5
Occupancy Schedule WkDay	9am-7pm			
Occupancy Schedule WkEnd	10am-4pm (Sat)			
Water Heater Capacity (gal)	50	50	50	50
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135
HVAC				
Modeling Electric Resistance Heating?	yes	yes	yes	yes
Heating Efficiency	1	1	1	1
Modeling Heat Pump?	yes	yes	yes	yes
Heating Efficiency	2.7 COP	3.2 COP	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.3 EER	10.1 EER	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	no	no
Cooling Efficiency				
Percent Of Building cooled	100	100	100	100
Heating Daytime Set point [°F]	69	69	69	69
Heat. Setback/Setup Set point [°F]	62	62	62	62
Cooling Daytime Set point [°F]	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table F.8. Rocky Mountain Power Retail

Rocky Mountain Power Retail	Idaho		Utah		Wyoming	
	Existing	New	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.					
Roof Construction	standard wood frame built up roof					
# of Floors	1	1	1	1	1	1
Total Floor Area [sqft]	6,601	6,601	7,389	7,389	17,697	17,697
Roof Area [sqft]	6,601	6,601	7,389	7,389	17,697	17,697
Envelope						
Window U-factor	U=0.68	U=0.55	U=0.68	U=0.55	U=0.68	U=0.55
Window to Wall Area	15%	15%	15%	15%	15%	15%
Wall Insulation (R Value)	R-3	R-13+R-13	R-3	R-13+R-13	R-3	R-13+R-13
Roof Insulation (R Value)	R-7	R-19	R-7	R-19	R-7	R-19
Floor Insulation (R Value)	R-11	R-19	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.95	1.5	1.95	1.5	1.95	1.5
Occupancy Schedule WkDay	9am-7pm					
Occupancy Schedule WkEnd	10am-4pm (Sat)					
Water Heater Capacity (gal)	50	50	50	50	50	50
Water Heating Fuel Type	Electric	Electric	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135	135	135
HVAC						
Modeling Electric Resistance Heating?	yes	yes	yes	yes	yes	yes
Heating Efficiency	1	1	1	1	1	1
Modeling Heat Pump?	yes	yes	no	no	yes	yes
Heating Efficiency	2.7 COP	3.2 COP			2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	yes	yes	no	no	yes	yes
Cooling Efficiency	9.3 EER	10.1 EER			9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	no	no	no	no
Cooling Efficiency						
Percent Of Building cooled	100	100	100	100	100	100
Heating Daytime Set point [°F]	69	69	69	69	69	69
Heat. Setback/Setup Set point [°F]	62	62	62	62	62	62
Cooling Daytime Set point [°F]	72	72	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75	75	75

Table F.9. Pacific Power Restaurant

Pacific Power Restaurant	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	1	1	1	1
Total Floor Area [sqft]	2,247	2,247	2,212	2,212
Roof Area [sqft]	2,247	2,247	2,212	2,212
Envelope				
Window U-factor	U=0.65	0	U=0.65	0
Window to Wall Area	15%	15%	15%	15%
Wall Insulation (R Value)	R-3	0	R-3	0
Roof Insulation (R Value)	R-11	0	R-11	0
Floor Insulation (R Value)	R-11	0	R-11	0
Lighting Density [W/sqft]	1.75	1	1.75	1.2
Occupancy Schedule WkDay	9am-9pm (Customer Operating Hours)			
Occupancy Schedule WkEnd	9-9 Sat 11-7 Sun (Customer Operating Hours)			
Water Heater Capacity (gal)	80	80	80	80
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135
HVAC				
Modeling Electric Resistance Heating?	yes	yes	yes	yes
Heating Efficiency	1	1	1	1
Modeling Heat Pump?	yes	yes	yes	yes
Heating Efficiency	2.7 COP	3.2 COP	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.3 EER	10.1 EER	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	no	no
Cooling Efficiency	0.793 kW/ton			
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	67	67	67	67
Heat. Setback/Setup Set point [°F]	64	64	64	64
Cooling Daytime Set point [°F]	71	71	71	71
Cool. Setback/Setup Set point [°F]	74	74	74	74

Table F.10. Rocky Mountain Power Restaurant

Rocky Mountain Power Restaurant	Idaho		Utah		Wyoming	
	Existing	New	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.					
Roof Construction	standard wood frame built up roof					
# of Floors	1	1	1	1	1	1
Total Floor Area [sqft]	2,960	2,960	3,265	3,265	3,847	3,847
Roof Area [sqft]	2,960	2,960	3,265	3,265	3,847	3,847
Envelope						
Window U-factor	U=0.65	0	U=0.65	0	U=0.65	0
Window to Wall Area	15%	15%	15%	15%	15%	15%
Wall Insulation (R Value)	R-3	0	R-3	0	R-3	0
Roof Insulation (R Value)	R-11	0	R-11	0	R-11	0
Floor Insulation (R Value)	R-11	0	R-11	0	R-11	0
Lighting Density [W/sqft]	1.75	1.4	1.75	1.4	1.75	1.4
Occupancy Schedule WkDay	9am-9pm (Customer Operating Hours)					
Occupancy Schedule WkEnd	9-9 Sat 11-7 Sun (Customer Operating Hours)					
Water Heater Capacity (gal)	80	80	80	80	80	80
Water Heating Fuel Type	Electric	Electric	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135	135	135
HVAC						
Modeling Electric Resistance Heating?	Yes	Yes	Yes	Yes	yes	yes
Heating Efficiency	1	1	1	1	1	1
Modeling Heat Pump?	no	no	yes	yes	no	no
Heating Efficiency			2.7 COP	3.2 COP		
Percent Of Building Heated	100	100	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes	no	no
Cooling Efficiency			9.3 EER	10.1 EER		
Modeling Chillers Cooling?	no	no	no	no	no	no
Cooling Efficiency						
Percent Of Building Cooled	100	100	100	100	100	100
Heating Daytime Set point [°F]	67	67	67	67	67	67
Heat. Setback/Setup Set point [°F]	64	64	64	64	64	64
Cooling Daytime Set point [°F]	71	71	71	71	71	71
Cool. Setback/Setup Set point [°F]	74	74	74	74	74	74

Table F.11. Pacific Power Lodging

Pacific Power Lodging	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	4	4	2	2
Total Floor Area [sqft]	3,559	3,559	6,279	6,279
Roof Area [sqft]	3,559	3,559	6,279	6,279
Envelope				
Window U-factor	U=0.65	U=0.55	U=0.65	U=0.55
Window to Wall Area	30%	30%	30%	30%
Wall Insulation (R Value)	R-3	0	R-3	R-13
Roof Insulation (R Value)	R-11	0	R-11	0
Floor Insulation (R Value)	R-7	0	R-7	0
Lighting Density [W/sqft]	1.52	1.35	1.52	1.35
Occupancy Schedule WkDay	24 hrs	24 hrs	24 hrs	24 hrs
Occupancy Schedule WkEnd	24 hrs	24 hrs	24 hrs	24 hrs
Water Heater Capacity (gal)	400	400	400	400
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135
HVAC				
Modeling Electric Resistance Heating?	yes	yes	yes	yes
Heating Efficiency	1	1	1	1
Modeling Heat Pump?	yes	yes	yes	yes
Heating Efficiency	2.7 COP	2.7 COP	2.7 COP	2.7 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	9.2 EER	9.2 EER	9.2 EER
Modeling Heat Pump Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.3 EER	9.3 EER	9.3 EER	9.3 EER
Modeling Chillers Cooling?	yes	yes	yes	yes
Cooling Efficiency	0.793 kW/ton	0.793 kW/ton	0.793 kW/ton	0.793 kW/ton
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	68	68	68	68
Heat. Setback/Setup Set point [°F]	63	63	63	63
Cooling Daytime Set point [°F]	74	74	74	74
Cool. Setback/Setup Set point [°F]	78	78	78	78

Table F.12. Rocky Mountain Power Lodging

Rocky Mountain Power Lodging	Idaho		Utah		Wyoming	
	Existing	New	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.					
Roof Construction	standard wood frame built up roof					
# of Floors	2	2	3	3	2	2
Total Floor Area [sqft]	2,867	2,867	25,099	25,099	6,257	6,257
Roof Area [sqft]	2,867	2,867	25,099	25,099	6,257	6,257
Envelope						
Window U-factor	U=0.65	U=0.55	U=0.65	U=0.55	U=0.65	U=0.55
Window to Wall Area	30%	30%	30%	30%	30%	30%
Wall Insulation (R Value)	R-3	0	R-3	0	R-3	0
Roof Insulation (R Value)	R-11	0	R-11	0	R-11	0
Floor Insulation (R Value)	R-7	0	R-7	0	R-7	0
Lighting Density [W/sqft]	1.52	1.2	1.52	1.2	1.52	1.2
Occupancy Schedule WkDay	24 hrs					
Occupancy Schedule WkEnd	24 hrs					
Water Heater Capacity (gal)	400	400	400	400	400	400
Water Heating Fuel Type	Electric	Electric	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135	135	135
HVAC						
Modeling Electric Resistance Heating?	yes	yes	yes	yes	yes	yes
Heating Efficiency	1	1	1	1	1	1
Modeling Heat Pump?	yes	yes	yes	yes	yes	yes
Heating Efficiency	2.7 COP	2.7 COP	2.7 COP	2.7 COP	2.7 COP	2.7 COP
Percent Of Building Heated	100	100	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	9.2 EER	9.2 EER	9.2 EER	9.2 EER	9.2 EER
Modeling Heat Pump Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	9.3 EER	9.3 EER	9.3 EER	9.3 EER	9.3 EER	9.3 EER
Modeling Chillers Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	0.793 kW/ton	0.793 kW/ton	0.793 kW/ton	0.793 kW/ton	0.793 kW/ton	0.793 kW/ton
Percent Of Building Cooled	100	100	100	100	100	100
Heating Daytime Set point [°F]	68	68	68	68	68	68
Heat. Setback/Setup Set point [°F]	63	63	63	63	63	63
Cooling Daytime Set point [°F]	74	74	74	74	74	74
Cool. Setback/Setup Set point [°F]	78	78	78	78	78	78

Table F.13. Pacific Power School

Pacific Power School	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	2	2	1	1
Total Floor Area [sqft]	27,289	27,289	7,438	7,438
Roof Area [sqft]	27,289	27,289	7,438	7,438
Envelope				
Window U-factor	U=0.67	U=0.55	U=0.67	U=0.55
Window to Wall Area	27%	27%	27%	27%
Wall Insulation (R Value)	R-0	R-19	R-0	R-13
Roof Insulation (R Value)	R-7	R-21	R-7	R-19
Floor Insulation (R Value)	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.66	1.35	1.8	1.2
Occupancy Schedule WkDay	School sch.(8am-3pm), Winter-spring Break sch. (9am-2pm) Summer (9am-2pm)			
Occupancy Schedule WkEnd	closed			
Water Heater Capacity (gal)	400	400	400	400
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A
Supply Temp	135	135	135	135
HVAC				
Modeling Electric Resistance Heating?	yes	yes	yes	yes
Heating Efficiency	1	1	1	1
Modeling Heat Pump?	yes	yes	yes	yes
Heating Efficiency	2.7 COP	3.2 COP	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.3 EER	10.1 EER	9.3 EER	10.1 EER
Modeling Chillers Cooling?	yes	yes	no	no
Cooling Efficiency	0.793 kW/ton	0.675 kW/ton		
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	70	70	70	70
Heat. Setback/Setup Set point [°F]	66	66	66	66
Cooling Daytime Set point [°F]	74	74	74	74
Cool. Setback/Setup Set point [°F]	78	78	78	78

Table F.14. Rocky Mountain Power School

Rocky Mountain Power School	Idaho		Utah		Wyoming	
	Existing	New	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.					
Roof Construction	standard wood frame built up roof		2x4 -16" o.c. wood with brick exterior finish medium abs.			
# of Floors	1	1	1	1	1	1
Total Floor Area [sqft]	22,360	22,360	65,768	65,768	29,431	29,431
Roof Area [sqft]	22,360	22,360	65,768	65,768	29,431	29,431
Envelope						
Window U-factor	U=0.67	U=0.55	U=0.67	U=0.55	U=0.67	U=0.55
Window to Wall Area	27%	27%	27%	27%	27%	27%
Wall Insulation (R Value)	R-0	R-13+R-13	R-0	R-13+R-13	R-0	R-13+R-13
Roof Insulation (R Value)	R-7	R-19	R-7	R-19	R-7	R-19
Floor Insulation (R Value)	R-11	R-19	R-11	R-19	R-11	R-19
Lighting Density [W/sqft]	1.8	1.2	1.66	1.2	1.66	1.2
Occupancy Schedule WkDay	School sch.(8am-3pm), Winter-spring Break sch. (9am-2pm) Summer (9am-2pm)					
Occupancy Schedule WkEnd	closed					
Water Heater Capacity (gal)	400	400	400	400	400	400
Water Heating Fuel Type	Electric	Electric	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A	N/A	N/A
Supply Temp	135	135	135	135	135	135
HVAC						
Modeling Electric Resistance Heating?	Yes	Yes	Yes	Yes	Yes	Yes
Heating Efficiency	1	1	1	1	1	1
Modeling Heat Pump?	no	no	no	no	no	no
Heating Efficiency						
Percent Of Building Heated	100	100	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	no	no	no	no
Cooling Efficiency						
Modeling Chillers Cooling?	no	no	yes	yes	no	no
Cooling Efficiency			0.793 kW/ton	0.675 kW/ton		
Percent Of Building Cooled	100	100	100	100	100	100
Heating Daytime Set point [°F]	70	70	70	70	70	70
Heat. Setback/Setup Set point [°F]	66	66	66	66	66	66
Cooling Daytime Set point [°F]	74	74	74	74	74	74
Cool. Setback/Setup Set point [°F]	78	78	78	78	78	78

Table F.15. Pacific Power Health

Pacific Power Health	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	2	2	1	1
Total Floor Area [sqft]	13,561	13,561	3,775	3,775
Roof Area [sqft]	13,561	13,561	3,775	3,775
Envelope				
Window U-factor	U=0.67	U=0.55	U=0.67	U=0.55
Window to Wall Area	25%	25%	25%	25%
Wall Insulation (R Value)	R-0	R-19	R-0	R-19
Roof Insulation (R Value)	R-11	R-21	R-11	R-19
Floor Insulation (R Value)	R-19	R-19	R-19	R-19
Lighting Density [W/sqft]	1.6	1	1.6	1
Occupancy Schedule WkDay	7am-6pm			
Occupancy Schedule WkEnd	9am-4pm (Sat)			
Water Heater Capacity (gal)	600	600	150	150
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A			
Supply Temp	135	135	135	135
HVAC				
Modeling Electric Resistance Heating?	yes	yes	yes	yes
Heating Efficiency	1	1	1	1
Modeling Heat Pump?	yes	yes	yes	yes
Heating Efficiency	2.7 COP	3.2 COP	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.3 EER	10.1 EER	9.3 EER	10.1 EER
Modeling Chillers Cooling?	yes	yes	no	no
Cooling Efficiency	0.793 kW/ton	0.675 kW/ton		
Percent Of Building Cooled	100	100	100	100
Heating Daytime Set point [°F]	71	71	71	71
Heat. Setback/Setup Set point [°F]	67	67	67	67
Cooling Daytime Set point [°F]	73	73	73	73
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table F.16. Rocky Mountain PowerHealth

Rocky Mountain Power Health	Idaho		Utah		Wyoming	
	Existing	New	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.					
Roof Construction	standard wood frame built up roof					
# of Floors	1	1	1	1	1	1
Total Floor Area [sqft]	17,030	17,030	30,808	30,808	11,010	11,010
Roof Area [sqft]	17,030	17,030	30,808	30,808	11,010	11,010
Envelope						
Window U-factor	U=0.67	U=0.55	U=0.67	U=0.55	U=0.67	U=0.55
Window to Wall Area	25%	25%	25%	25%	25%	25%
Wall Insulation (R Value)	R-0	R-13+R-13	R-0	R-13+R-13	R-0	R-13+R-13
Roof Insulation (R Value)	R-11	R-19	R-11	R-19	R-11	R-19
Floor Insulation (R Value)	R-19	R-19	R-19	R-19	R-19	R-19
Lighting Density [W/sqft]	1.6	1	1.6	1	1.6	1
Occupancy Schedule WkDay	7am-6pm					
Occupancy Schedule WkEnd	9am-4pm (Sat)					
Water Heater Capacity (gal)	600	600	600	600	600	600
Water Heating Fuel Type	Electric	Electric	Electric	Electric	Electric	Electric
Water Heater Energy Factor						
Supply Temp	135	135	135	135	135	135
HVAC						
Modeling Electric Resistance Heating?	yes	yes	yes	yes	yes	yes
Heating Efficiency	1	1	1	1	1	1
Modeling Heat Pump?	yes	yes	yes	yes	yes	yes
Heating Efficiency	2.7 COP	3.2 COP	2.7 COP	3.2 COP	2.7 COP	3.2 COP
Percent Of Building Heated	100	100	100	100	100	100
Modeling DX Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	yes	yes	yes	yes	yes	yes
Cooling Efficiency	9.3 EER	10.1 EER	9.3 EER	10.1 EER	9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	yes	yes	yes	yes
Cooling Efficiency			0.793 kW/ton	0.675 kW/ton	0.793 kW/ton	0.675 kW/ton
Percent Of Building Cooled	100	100	100	100	100	100
Heating Daytime Set point [°F]	71	71	71	71	71	71
Heat. Setback/Setup Set point [°F]	67	67	67	67	67	67
Cooling Daytime Set point [°F]	73	73	73	73	73	73
Cool. Setback/Setup Set point [°F]	75	75	75	75	75	75

Table F.17. Pacific Power Warehouse

Pacific Power Warehouse	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.			
Roof Construction	standard wood frame built up roof			
# of Floors	2	2	1	1
Total Floor Area [sqft]	171,167	171,167	9,123	9,123
Aspect Ratio				
Roof Area [sqft]	171,167	171,167	9,123	9,123
Envelope				
Window U-factor	U=0.65	U=0.55	U=0.65	U=0.55
Window to Wall Area	5%	5%	5%	5%
Wall Insulation (R Value)	R-3	R-19	R-3	R-13
Roof Insulation (R Value)	R-8	R-21	R-8	R-19
Floor Insulation (R Value)	R-8	R-19	R-8	R-19
Lighting Density [W/sqft]	0.75	0.5	1.05	0.7
Occupancy Schedule WkDay	10am-9pm M-F			
Occupancy Schedule WkEnd	10am-6pm Sat only.			
Water Heater Capacity (gal)	35	35	35	35
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135
HVAC				
Modeling Electric Resistance Heating?	Yes	Yes	yes	yes
Heating Efficiency	1	1	1	1
Modeling Heat Pump?	no	no	yes	yes
Heating Efficiency			2.7 COP	3.2 COP
Percent Of Building Heated	80	80	80	80
Modeling DX Cooling?	yes	yes	yes	yes
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER
Modeling Heat Pump Cooling?	no	no	yes	yes
Cooling Efficiency			9.3 EER	10.1 EER
Modeling Chillers Cooling?	no	no	no	no
Cooling Efficiency	0.793 kW/ton			
Percent Of Building Cooled	80	80	80	80
Heating Daytime Set point [°F]	68	68	68	68
Heat. Setback/Setup Set point [°F]	60	60	60	60
Cooling Daytime Set point [°F]	75	75	75	75
Cool. Setback/Setup Set point [°F]	79	79	79	79

Table F.18. Rocky Mountain Power Warehouse

Rocky Mountain Power Warehouse	Idaho		Utah		Wyoming	
	Existing	New	Existing	New	Existing	New
Exterior Wall Construction	2x4 -16" o.c. wood with brick exterior finish medium abs.					
Roof Construction	standard wood frame built up roof					
# of Floors	1	1	1	1	1	1
Total Floor Area [sqft]	18,500	18,500	32,854	32,854	5,200	5,200
Aspect Ratio						
Roof Area [sqft]	18,500	18,500	32,854	32,854	5,200	5,200
Envelope						
Window U-factor	U=0.65	U=0.55	U=0.65	U=0.55	U=0.65	U=0.55
Window to Wall Area	5%	5%	5%	5%	5%	5%
Wall Insulation (R Value)	R-3	R-13 + R-13	R-3	R-13 + R-13	R-3	R-13 + R-13
Roof Insulation (R Value)	R-8	R-19	R-8	R-19	R-8	R-19
Floor Insulation (R Value)	R-8	R-19	R-8	R-19	R-8	R-19
Lighting Density [W/sqft]	1.2	0.8	1.2	0.8	1.2	0.8
Occupancy Schedule WkDay	10am-9pm M-F					
Occupancy Schedule WkEnd	10am-6pm Sat only.					
Water Heater Capacity (gal)	35	35	35	35	35	35
Water Heating Fuel Type	Electric	Electric	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A	N/A	N/A
Supply Temperature	135	135	135	135	135	135
HVAC						
Modeling Electric Resistance Heating?	Yes	Yes	Yes	Yes	Yes	Yes
Heating Efficiency	1	1	1	1	1	1
Modeling Heat Pump?	no	no	no	no	no	no
Heating Efficiency						
Percent Of Building Heated	80	80	80	80	80	80
Modeling DX Cooling?	yes	yes	yes	yes	no	no
Cooling Efficiency	9.2 EER	10.3 EER	9.2 EER	10.3 EER		
Modeling Heat Pump Cooling?	no	no	no	no	no	no
Cooling Efficiency						
Modeling Chillers Cooling?	no	no	yes	yes	yes	yes
Cooling Efficiency			0.793 kW/ton	0.675 kW/ton	0.793 kW/ton	0.675 kW/ton
Percent Of Building Cooled	80	80	80	80	80	80
Heating Daytime Set point [°F]	68	68	68	68	68	68
Heat. Setback/Setup Set point [°F]	60	60	60	60	60	60
Cooling Daytime Set point [°F]	75	75	75	75	75	75
Cool. Setback/Setup Set point [°F]	79	79	79	79	79	79

Table F.19. Pacific Power Manufactured Homes

Pacific Power Manufactured	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	Stucco, Standard 2*4 Wood Framing, Insulation,			
Roof Construction	Shingle Roof, insulation, Dark Colored			
# of Floors	1	1	1	1
Total Floor Area [sqft]	1,570	1,570	1,423	1,423
Roof Area [sqft]	1,570	1,570	1,423	1,423
Envelope				
Window U-factor	U=0.67	U-0.40-Elec Res, U-0.55 Heat Pump	U=0.67	U-0.40-Elec Res, U-0.55 Heat Pump
Window to Wall Area	20%	20%	20%	20%
Wall Insulation (R Value)	R-11	R-19	R-11	R-19
Roof Insulation (R Value)	R-25	R-38	R-25	R-38
Floor Insulation (R Value)	R-15	R-30	R-15	R-30
Lighting Density [W/sqft]	1.52	1.00	1.52	1.00
Occupancy Schedule WkDay	5pm-9am (Only Occupancy)			
Occupancy Schedule WkEnd	24 Hours (Only Occupancy)			
Water Heater Capacity (gal)	50	50	50	50
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A
HVAC				
Electric Heating Type 1	Electric Furnace	Electric Furnace	Electric Furnace	Electric Furnace
Heating Efficiency				
Electric Heating Type 2	Heat Pump	Heat Pump	Heat Pump	Heat Pump
Heating Efficiency	6.0 HSPF	6.6 HSPF	COP = 2.9	COP = 3.1
Cooling Type 1	Central AC	Central AC	Central AC	Central AC
Cooling Efficiency	SEER 10.7	SEER 13	SEER 10.7	SEER 13
Cooling Type 2	Room AC	Room AC	Room AC	Room AC
Cooling Efficiency	EER 8.7	EER 9.7	EER 8.7	EER 9.7
Cooling Type 3	Heat Pump	Heat Pump	Heat Pump	Heat Pump
Cooling Efficiency	SEER 10.7	SEER 13	SEER 10.7	SEER 13
Heating Daytime Set point [°F]	68	68	68	68
Heat. Setback/Setup Set point [°F]	64	64	64	64
Cooling Daytime Set point [°F]	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table F.20. Rocky Mountain Power Manufactured Homes

Rocky Mountain Power Manufactured	Utah, Wyoming and Idaho	
	Existing	New
Exterior Wall Construction	Stucco, Standard 2*4 Wood Framing, Insulation,	
Roof Construction	Shingle Roof, insulation, Dark Colored	
# of Floors	1	1
Total Floor Area [sqft]	1,390	1,390
Roof Area [sqft]	1,390	1,390
Envelope		
Window U-factor	U=0.67	U-0.40-Elec Res, U-0.55 Heat Pump
Window to Wall Area	20%	20%
Wall Insulation (R Value)	R-11	R-19
Roof Insulation (R Value)	R-25	R-38
Floor Insulation (R Value)	R-15	R-30
Lighting Density [W/sqft]	1.52	1.00
Occupancy Schedule WkDay	5pm-9am (Only Occupancy)	
Occupancy Schedule WkEnd	24 Hours (Only Occupancy)	
Water Heater Capacity (gal)	50	50
Water Heating Fuel Type	Electric	Elecrtic
Water Heater Energy Factor	N/A	N/A
HVAC		
Electric Heating Type 1	Electric Furnace	Electric Furnace
Heating Efficiency		
Electric Heating Type 2	Heat Pump	Heat Pump
Heating Efficiency	COP = 2.9	COP = 3.1
Cooling Type 1	Central AC	Central AC
Cooling Efficiency	SEER 10.7	SEER 13
Cooling Type 2	Room AC	Room AC
Cooling Efficiency	EER 8.7	EER 9.7
Cooling Type 3	Heat Pump	Heat Pump
Cooling Efficiency	SEER 10.7	SEER 13
Heating Daytime Set point [°F]	68	68
Heat. Setback/Setup Set point [°F]	64	64
Cooling Daytime Set point [°F]	72	72
Cool. Setback/Setup Set point [°F]	75	75

Table F.21. Pacific Power Single-Family

Pacific Power Single-Family	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	Stucco, Standard 2*4 Wood Framing, Insulation,			
Roof Construction	Shingle Roof, insulation, Dark Colored			
# of Floors	2	2	2	2
Total Floor Area [sqft]	960.5	960.5	858	858
Roof Area [sqft]	960.5	960.5	858	858
Envelope				
Window U-factor	U=0.67	U-0.40-Elec Res, U-0.55 Heat Pump	U=0.67	U-0.40-Elec Res, U-0.55 Heat Pump
Window to Wall Area	20%	20%	20%	20%
Wall Insulation (R Value)	R-11	R-19	R-11	R-19
Roof Insulation (R Value)	R-25	R-38	R-25	R-38
Floor Insulation (R Value)	R-15	R-30	R-15	R-30
Lighting Density [W/sqft]	1.52	1.52	1.52	1.52
Equipment Density [W/sqft]				
Occupancy Schedule WkDay	5pm-9am (Only Occupancy)			
Occupancy Schedule WkEnd	24 Hours (Only Occupancy)			
Water Heater Capacity (gal)	50	50	50	50
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A
HVAC				
Electric Heating Type 1	Electric Furnace	Electric Furnace	Electric Furnace	Electric Furnace
Heating Efficiency	1	1		
Electric Heating Type 2	Heat Pump	Heat Pump	Heat Pump	Heat Pump
Heating Efficiency	6.0 HSPF	6.6 HSPF	COP = 2.9	COP = 3.1
Cooling Type 1	Central AC	Central AC	Central AC	Central AC
Cooling Efficiency	SEER 10.7	SEER 13	SEER 10.7	SEER 13
Cooling Type 2	Room AC	Room AC	Room AC	Room AC
Cooling Efficiency	EER 8.7	EER 9.7	EER 8.7	EER 9.7
Cooling Type 3	Heat Pump	Heat Pump	Heat Pump	Heat Pump
Cooling Efficiency	SEER 10.7	SEER 13	SEER 10.7	SEER 13
Heating Daytime Set point [°F]	68	68	68	68
Heat. Setback/Setup Set point [°F]	64	64	64	64
Cooling Daytime Set point [°F]	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table F.22. Rocky Mountain Power Single-Family

Rocky Mountain Power Single-Family	Utah, Wyoming and Idaho	
	Existing	New
Exterior Wall Construction	Stucco, Standard 2*4 Wood Framing, Insulation,	
Roof Construction	Shingle Roof, insulation, Dark Colored	
# of Floors	2	2
Total Floor Area [sqft]	1,030	1,030
Roof Area [sqft]	1,030	1,030
Envelope		
Window U-factor	U=0.67	U-0.40-Elec Res, U-0.55 Heat Pump
Window to Wall Area	20%	20%
Wall Insulation (R Value)	R-11	R-19
Roof Insulation (R Value)	R-25	R-38
Floor Insulation (R Value)	R-15	R-30
Lighting Density [W/sqft]	1.52	1.52
Equipment Density [W/sqft]		
Occupancy Schedule WkDay	5pm-9am (Only Occupancy)	
Occupancy Schedule WkEnd	24 Hours (Only Occupancy)	
Water Heater Capacity (gal)	50	50
Water Heating Fuel Type	Electric	Electric
Water Heater Energy Factor	N/A	N/A
HVAC		
Electric Heating Type 1	Electric Furnace	Electric Furnace
Heating Efficiency		
Electric Heating Type 2	Heat Pump	Heat Pump
Heating Efficiency	COP = 2.9	COP = 3.1
Cooling Type 1	Central AC	Central AC
Cooling Efficiency	SEER 10.7	SEER 13
Cooling Type 2	Room AC	Room AC
Cooling Efficiency	EER 8.7	EER 9.7
Cooling Type 3	Heat Pump	Heat Pump
Cooling Efficiency	SEER 10.7	SEER 13
Heating Daytime Set point [°F]	68	68
Heat. Setback/Setup Set point [°F]	64	64
Cooling Daytime Set point [°F]	72	72
Cool. Setback/Setup Set point [°F]	75	75

Table F.23. Pacific Power Multi-Family

Pacific Power Multi-Family	Washington		California	
	Existing	New	Existing	New
Exterior Wall Construction	Stucco, Standard 2*4 Wood Framing, Insulation,			
Roof Construction	standard wood frame built up roof			
# of Floors	1	1	1	1
Total Floor Area [sqft]	1,300	1,300	1,300	1,300
Roof Area [sqft]	1,300	1,300	1,300	1,300
Envelope				
Window U-factor	U=0.67	U-0.40-Elec Res, U-0.55 Heat Pump	U=0.67	U-0.40-Elec Res, U-0.55 Heat Pump
Window to Wall Area	20%	20%	20%	20%
Wall Insulation (R Value)	R-11	R-19	R-11	R-19
Roof Insulation (R Value)	R-25	R-38	R-25	R-38
Floor Insulation (R Value)	R-15	R-30	R-15	R-30
Lighting Density [W/sqft]	1.52	1.00	1.52	1.00
Occupancy Schedule WkDay	5pm-9am (Only Occupancy)			
Occupancy Schedule WkEnd	24 Hours (Only Occupancy)			
Water Heater Capacity (gal)	40	40	40	40
Water Heating Fuel Type	Electric	Electric	Electric	Electric
Water Heater Energy Factor	N/A	N/A	N/A	N/A
HVAC				
Electric Heating Type 1	Electric Furnace	Electric Furnace	Electric Furnace	Electric Furnace
Heating Efficiency				
Electric Heating Type 2	Heat Pump	Heat Pump	Heat Pump	Heat Pump
Heating Efficiency	6.0 HSPF	6.6 HSPF	6.0 HSPF	6.6 HSPF
Cooling Type 1	Central AC	Central AC	Central AC	Central AC
Cooling Efficiency	SEER 10.7	SEER 13	SEER 10.7	SEER 13
Cooling Type 2	Room AC	Room AC	Room AC	Room AC
Cooling Efficiency	EER 8.7	EER 9.7	EER 8.7	EER 9.7
Cooling Type 3	Heat Pump	Heat Pump	Heat Pump	Heat Pump
Cooling Efficiency	SEER 10.7	SEER 13	SEER 10.7	SEER 13
Heating Daytime Set point [°F]	68	68	68	68
Heat. Setback/Setup Set point [°F]	64	64	64	64
Cooling Daytime Set point [°F]	72	72	72	72
Cool. Setback/Setup Set point [°F]	75	75	75	75

Table F.24. Rocky Mountain Power Multi-Family

Rocky Mountain Power Multi-Family	Utah, Wyoming and Idaho	
	Existing	New
Exterior Wall Construction	Stucco, Standard 2*4 Wood Framing, Insulation,	
Roof Construction	standard wood frame built up roof	
# of Floors	1	1
Total Floor Area [sqft]	1,300	1,300
Roof Area [sqft]	1,300	1,300
Envelope		
Window U-factor	U=0.67	U-0.40-Elec Res, U-0.55 Heat Pump
Window to Wall Area	20%	20%
Wall Insulation (R Value)	R-11	R-19
Roof Insulation (R Value)	R-25	R-38
Floor Insulation (R Value)	R-15	R-30
Lighting Density [W/sqft]	1.52	1.00
Occupancy Schedule WkDay	5pm-9am (Only Occupancy)	
Occupancy Schedule WkEnd	24 Hours (Only Occupancy)	
Water Heater Capacity (gal)	40	40
Water Heating Fuel Type	Electric	Electric
Water Heater Energy Factor	N/A	N/A
HVAC		
Electric Heating Type 1	Electric Furnace	Electric Furnace
Heating Efficiency		
Electric Heating Type 2	Heat Pump	Heat Pump
Heating Efficiency	6.0 HSPF	6.6 HSPF
Cooling Type 1	Central AC	Central AC
Cooling Efficiency	SEER 10.7	SEER 13
Cooling Type 2	Room AC	Room AC
Cooling Efficiency	EER 8.7	EER 9.7
Cooling Type 3	Heat Pump	Heat Pump
Cooling Efficiency	SEER 10.7	SEER 13
Heating Daytime Set point [°F]	68	68
Heat. Setback/Setup Set point [°F]	64	64
Cooling Daytime Set point [°F]	72	72
Cool. Setback/Setup Set point [°F]	75	75

After the building prototypes are established, the second step is to select the appropriate weather station location representing the most typical weather conditions for each state. Although this step is not complicated, it is very important because weather is one of the most important factors underlying annual energy consumption for the HVAC-related measures. Weather is based on a "typical meteorological year," or TMY, and there is a separate TMY file used to represent each state. The selection of the TMY file involves two considerations. First, the location should have the closest proximity to the area of the highest energy consumption and population. For example, Salt Lake City in Utah is such a location. Second, the TMY should closely match typical weather

conditions throughout the respective service territory. The weather file chosen for each state is as follows:

- Medford, OR, for California
- Pocatello, ID, for Idaho
- Salt Lake City, UT, for Utah
- Yakima, WA, for Washington
- Rock Springs, WY, for Wyoming

Once the building characteristics and weather files are determined, an individual model is prepared for each building type in each of the five states.

The third and final step in the modeling process is calibration to secondary data sources for typical end-use consumption. Sources used were: ELCAP (Enduse Load and Conservation Assessment Program), CBSA (Commercial Building Stock Assessment), NWPCC (Northwest Power and Conservation Council), and CBECS (Commercial Building Energy Consumption Survey). Individual building type models for Washington (the state for which the most data is readily available) were calibrated to within 5% of these values and used as the basis for the other states by substituting the appropriate building characteristics and weather data.

Once the models are calibrated and run for every state, both eQuest and Energy-10 produce output files that contain the estimates of energy consumption and hourly load by end use. For the commercial customer segments, the building-level estimates are converted to represent the kWh per square foot, also called the and end use intensity (EUI). Energy consumption for residential simulations remain at the site level and are referred to as the unit energy consumption, or UEC. The full set of UECs and EUIs are presented in the Tables F.25 through F.32 below.

For the resulting hourly load shapes, graphs for key end uses in single-family homes and large offices in Utah are displayed in Figure F.1 through Figure F.9.

Table F.25. Single-Family Electric UECs

	UEC (kWh/yr)										Sources
	WA		ID		UT		WY		CA		
	Existing	New	Existing	New	Existing	New	Existing	New	Existing	New	
Central AC	1,394	1,199	1,317	1,294	2,351	2,265	779	697	1623	1,392	Energy-10 Simulations
Central Heat	12,844	9,203	16,517	12,673	12,237	8,941	16,879	12,749	9,480	6,554	Energy-10 Simulations
Cooking Oven	440	440	440	440	440	440	440	440	440	440	RECS
Cooking Range	536	536	536	536	536	536	536	536	536	536	RECS
Dryer	1,275	868	1,275	868	1,275	868	1,275	868	1,275	868	
Evaporative AC	349	300	329	324	588	566	195	174	406	348	Energy-10 Simulations
Freezer	950	560	950	560	950	560	950	560	950	560	RECS
Heat Pump	12,035	8,367	14,865	11,249	13,009	11,870	12,592	8,792	9,687	6,472	Energy-10 Simulations
Lighting	2,117	2,352	2,351	2,822	2,351	2,621	2,116	2,351	1,881	2,040	Energy-10 Simulations
Plug Load	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,390	3,390	
Refrigeration	1,100	496	1,100	496	1,100	496	1,100	496	1,100	496	RECS
Room AC	711	611	671	660	1,199	1,155	397	356	828	710	Energy-10 Simulations
Room Heat	9,890	7,086	12,718	9,759	9,422	6,884	12,997	9,816	7,300	5,046	Energy-10 Simulations
Water Heat	2,807	2,656	3,012	2,850	3,012	2,850	3,012	2,850	2,515	2,380	Energy-10 Simulations

Table F.26. Multi-Family Electric UECs

	UEC (kWh/yr)										Sources
	WA		ID		UT		WY		CA		
	Existing	New	Existing	New	Existing	New	Existing	New	Existing	New	
Central AC	961	745	958.73	674.3	1594.7	1118	606.75	463.7	1072.4	847	Energy-10 Simulations
Central Heat	9,315.3	5,770	11,545	6333	9292.8	4743	11644	7767	6534.9	4177	Energy-10 Simulations
Cooking Oven	440	440	440	440	440	440	440	440	440	440	RECS
Cooking Range	536	536	536	536	536	536	536	536	536	536	RECS
Dryer	960.49	654	960.49	654	960.49	654	960.49	654	960.49	654	
Evaporative AC	240.25	186	239.68	168.6	398.66	279.5	151.69	115.9	268.1	212	Energy-10 Simulations
Freezer	950	560	950	560	950	560	950	560	950	560	RECS
Heat Pump	6,404.8	3,875	7946.9	5487	7237.2	3806	7139.8	4523	4749.9	3762	Energy-10 Simulations
Lighting	1,618.5	1,556	1743	1494	1743	1494	1618.5	1556	1494	1494	Energy-10 Simulations
Plug Load	1,534.2	1,534	1,534.2	1534	1534.2	1534	1534.2	1534	1534.2	1534	
Refrigeration	1100	496	1,100	496	1,100	496	1,100	496	1,100	496	RECS
Room AC	490.11	395	454.03	372.6	755.18	524.9	309.44	246	615.73	468	Energy-10 Simulations
Room Heat	7,172.7	4,443	8,890	4,877	7,155.4	3,652	8,965.7	5,981	5,031.9	3,216	Energy-10 Simulations
Water Heat	1,612.5	1,526	1,612.5	1,526	1,612.5	1,526	1,612.5	1,526	1,612.5	1,526	Energy-10 Simulations

Table F.27. Manufactured Home Electric UECs

	UEC (kWh/yr)										Sources
	WA		ID		UT		WY		CA		
	Existing	New	Existing	New	Existing	New	Existing	New	Existing	New	
Central AC	1,102	941	900	903	1,674	1,637	679	713	1,450	1,122	Energy-10 Simulations
Central Heat	11,514	8,072	13,513	11,499	10,306	8,220	17,821	12,706	9,544	6,389	Energy-10 Simulations
Cooking Oven	440	440	440	440	440	440	440	440	440	440	RECS
Cooking Range	536	536	536	536	536	536	536	536	536	536	RECS
Dryer	1,070	729	1,070	729	1070	729	1,070	729	1,070	729	
Evaporative AC	276	235	225	226	418	409	170	178	363	280	Energy-10 Simulations
Freezer	950	560	950	560	950	560	950	560	950	560	RECS
Heat Pump	10,241	8,186	11,428	11,383	10,152	9,139	12,583	11,218	13,168	6,945	Energy-10 Simulations
Lighting	1,985	2,127	1,702	2,127	1,702	2,127	1,985	2,127	1,985	1,985	Energy-10 Simulations
Plug Load	1,266	1,266	1,266	1,266	1,266	1,266	1,266	1,266	1,266	1,266	
Refrigeration	1,100	496	1,100	496	1,100	496	1,100	496	1,100	496	RECS
Room AC	630	502	531	427	989	774	344	337	752	581	Energy-10 Simulations
Room Heat	8,866	6,216	10,405	8,854	7,936	6,329	13,722	9,783	7,349	4,920	Energy-10 Simulations
Water Heat	2,713	2,567	2,402	2,273	2,402	2,273	2,402	2,273	2,459	2,327	Energy-10 Simulations

Commercial Sector

For the commercial sector, existing and new EUIs and sources by state are presented in Table F.28 through Table F.32.

Table F.28. Electric EUIs for Commercial Sector by Building Type (kWh/sq. ft. per Year) for Washington

Building Type	Space Heat		Cooling Chillers		Cooling DX		Heat Pump		HVAC Aux		Lighting		Water Heat		Refrigeration		Cooking		Plug Load	
	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New
Grocery	4.52	2.71	- - -	- - -	4.82	2.71	7.61	3.84	3.98	3.89	7.18	6.32	0.31	0.29	24.14	24.14	5.16	5.16	0.41	0.41
Health	5.43	3.39	1.87	0.80	2.56	1.19	5.77	3.06	6.01	5.03	6.72	4.21	1.41	1.41	2.10	2.10	0.36	0.36	0.52	0.52
Large Office	5.12	2.45	1.85	1.03	- - -	- - -	5.61	2.74	2.09	1.83	5.87	3.62	0.48	0.45	- - -	- - -	- - -	- - -	1.59	1.59
Large Retail	3.59	2.02	- - -	- - -	3.10	1.99	5.22	3.11	2.95	2.43	8.19	6.27	0.29	0.28	- - -	- - -	- - -	- - -	0.15	0.15
Lodging	6.22	3.54	- - -	- - -	2.59	1.57	6.37	3.52	2.51	2.47	4.00	3.55	1.79	1.69	- - -	- - -	1.62	1.62	0.10	0.10
Misc.	4.35	2.23	1.85	1.03	2.82	1.76	5.41	2.92	2.52	2.13	7.03	4.94	0.38	0.37	- - -	- - -	- - -	- - -	0.09	0.09
Restaurant	4.18	2.04	- - -	- - -	5.20	2.91	7.82	4.34	4.33	4.05	7.35	4.25	8.79	8.32	5.80	5.80	52.39	52.39	0.23	0.23
School	8.52	3.70	- - -	- - -	0.70	0.52	5.98	2.54	1.57	1.19	5.82	4.71	1.45	1.45	2.10	2.10	0.36	0.36	0.11	0.11
Small Office	5.12	2.45	- - -	- - -	2.54	1.53	5.61	2.74	2.09	1.83	5.87	3.62	0.48	0.45	- - -	- - -	- - -	- - -	1.59	1.59
Small Retail	3.59	2.02	- - -	- - -	3.10	1.99	5.22	3.11	2.95	2.43	8.19	6.27	0.29	0.28	- - -	- - -	- - -	- - -	0.15	0.15
Warehouse	2.11	1.75	- - -	- - -	0.50	0.37	- - -	- - -	0.51	0.50	2.83	1.91	0.20	0.20	18.18	18.18	- - -	- - -	0.15	0.15
Warehouse CA	2.11	1.75	- - -	- - -	0.50	0.37	- - -	- - -	0.51	0.50	2.83	1.91	0.20	0.20	92.18	92.18	- - -	- - -	0.15	0.15

Table F.29. Electric EUIs for Commercial Sector by Building Type (kWh/sq. ft. per Year) for California

Building Type	Space Heat		Cooling Chillers		Cooling DX		Heat Pump		HVAC Aux		Lighting		Water Heat		Refrigeration		Cooking		Plug Load	
	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New
Grocery	4.68	1.77	- - -	- - -	5.40	2.97	- - -	- - -	4.51	4.30	7.19	6.32	0.37	0.35	24.18	24.18	5.16	5.16	0.41	0.41
Health	9.06	6.25	- - -	- - -	3.45	1.91	8.50	5.11	6.71	5.71	6.72	4.21	1.69	1.68	2.10	2.10	0.36	0.36	0.52	0.52
Lodging	6.06	4.04	- - -	- - -	2.72	1.65	6.33	3.92	2.59	2.53	3.93	3.11	1.69	1.60	- - -	- - -	1.62	1.62	0.10	0.10
Misc.	3.14	1.65	2.74	1.49	3.94	2.36	5.79	3.15	3.06	2.60	7.04	4.95	0.43	0.42	- - -	- - -	- - -	- - -	0.09	0.09
Restaurant	3.93	2.05	- - -	- - -	6.26	3.32	8.58	4.53	4.51	4.13	7.35	5.12	8.48	8.03	5.80	5.80	52.39	52.39	0.23	0.23
School	12.50	7.45	- - -	- - -	1.38	0.92	8.16	4.39	2.74	2.06	6.46	4.19	1.70	1.69	2.10	2.10	0.36	0.36	0.11	0.11
Small Office	3.97	2.08	- - -	- - -	3.75	2.21	6.07	3.04	2.58	2.34	5.88	3.63	0.52	0.49	- - -	- - -	- - -	- - -	1.59	1.59
Small Retail	2.32	1.21	- - -	- - -	4.12	2.51	5.50	3.25	3.54	2.86	8.19	6.27	0.35	0.34	- - -	- - -	- - -	- - -	0.15	0.15
Warehouse	2.25	1.73	- - -	- - -	1.21	0.79	- - -	- - -	1.04	0.81	3.98	2.66	0.26	0.26	18.18	18.18	- - -	- - -	0.15	0.15

Table F.30. Electric EUIs for Commercial Sector by Building Type (kWh/sq. ft. per Year) for Idaho

Building Type	Space Heat		Cooling Chillers		Cooling DX		Heat Pump		HVAC Aux		Lighting		Water Heat		Refrigeration		Cooking		Plug Load	
	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New
Grocery	5.96	2.22	- - -	- - -	4.65	2.61	9.01	4.34	4.35	4.27	7.19	6.32	0.35	0.33	24.18	24.18	5.16	5.16	0.41	0.41
Health	9.26	6.62	- - -	- - -	2.05	1.02	8.11	5.09	6.42	5.50	6.72	4.21	1.71	1.70	2.10	2.10	0.36	0.36	0.52	0.52
Large Office	7.57	3.45	- - -	- - -	.	.	7.14	3.51	2.26	1.95	5.88	3.62	0.51	0.51	- - -	- - -	- - -	- - -	1.59	1.59
Large Retail	5.53	2.82	- - -	- - -	2.69	1.75	6.46	3.59	2.75	2.24	8.19	6.27	0.29	0.28	- - -	- - -	- - -	- - -	0.15	0.15
Lodging	7.53	5.16	- - -	- - -	3.00	1.67	- - -	- - -	3.28	3.27	4.04	3.20	1.87	1.77	- - -	- - -	1.62	1.62	0.10	0.10
Miscellaneous	6.55	3.13	- - -	- - -	2.51	1.58	6.80	3.55	2.51	2.09	7.03	4.95	0.40	0.39	- - -	- - -	- - -	- - -	0.09	0.09
Restaurant	4.39	1.73	- - -	- - -	5.01	2.73	- - -	- - -	4.16	3.92	7.35	5.12	8.79	8.32	5.80	5.80	52.39	52.39	0.23	0.23
School	17.01	10.17	- - -	- - -	0.54	0.39	- - -	- - -	2.09	1.72	6.46	4.19	1.58	1.58	2.10	2.10	0.36	0.36	0.11	0.11
Small Office	7.57	3.45	- - -	- - -	2.33	1.40	7.14	3.51	2.26	1.95	5.88	3.62	0.51	0.51	- - -	- - -	- - -	- - -	1.59	1.59
Small Retail	5.53	2.82	- - -	- - -	2.69	1.75	6.46	3.59	2.75	2.24	8.19	6.27	0.29	0.28	- - -	- - -	- - -	- - -	0.15	0.15
Warehouse	4.07	3.21	- - -	- - -	0.70	0.45	- - -	- - -	0.96	0.70	4.53	3.05	0.24	0.24	18.18	18.18	- - -	- - -	0.15	0.15

Table F.31. Electric EUIs for Commercial Sector by Building Type (kWh/sq. ft. per Year) for Utah

Building Type	Space Heat		Cooling Chillers		Cooling DX		Heat Pump		HVAC Aux		Lighting		Water Heat		Refrigeration		Cooking		Plug Load	
	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New
Grocery	4.05	1.50	- - -	- - -	5.93	3.65	8.42	4.65	4.01	3.88	7.19	6.32	0.29	0.27	24.17	24.17	5.16	5.16	0.41	0.41
Health	5.43	4.15	2.12	1.04	2.91	1.55	6.21	3.87	6.14	5.26	6.72	4.21	1.35	1.35	2.10	2.10	0.36	0.36	0.52	0.52
Large Office	2.63	0.82	2.69	1.47	- - -	- - -	- - -	- - -	2.21	1.98	5.88	3.62	0.44	0.44	- - -	- - -	- - -	- - -	1.59	1.59
Large Retail	3.21	1.46	- - -	- - -	3.84	2.51	- - -	- - -	2.90	2.29	8.19	6.27	0.26	0.26	- - -	- - -	- - -	- - -	0.15	0.15
Lodging	3.84	2.22	- - -	- - -	2.85	1.67	5.30	3.06	2.57	2.55	3.97	3.15	1.72	1.63	- - -	- - -	1.62	1.62	0.10	0.10
Miscellaneous	2.92	1.14	2.69	1.47	3.76	2.35	- - -	- - -	2.56	2.14	7.03	4.94	0.35	0.35	- - -	- - -	- - -	- - -	0.09	0.09
Restaurant	3.74	1.75	- - -	- - -	6.86	3.76	9.21	4.89	4.17	4.13	7.35	5.12	8.56	8.10	5.80	5.80	52.39	52.39	0.23	0.23
School	10.87	6.37	- - -	- - -	0.95	0.64	- - -	- - -	1.90	1.51	5.82	4.19	1.41	1.41	2.10	2.10	0.36	0.36	0.11	0.11
Small Office	2.63	0.82	- - -	- - -	3.69	2.18	- - -	- - -	2.21	1.98	5.88	3.62	0.44	0.44	- - -	- - -	- - -	- - -	1.59	1.59
Small Retail	3.21	1.46	- - -	- - -	3.84	2.51	- - -	- - -	2.90	2.29	8.19	6.27	0.26	0.26	- - -	- - -	- - -	- - -	0.15	0.15
Warehouse	2.18	1.74	- - -	- - -	1.12	0.73	- - -	- - -	0.84	0.66	4.53	3.05	0.21	0.21	18.18	18.18	- - -	- - -	0.15	0.15

Table F.32. Electric EUIs for Commercial Sector by Building Type (kWh/sq. ft. per Year) for Wyoming

Building Type	Space Heat		Cooling Chillers		Cooling DX		Heat Pump		HVAC Aux		Lighting		Water Heat		Refrigeration		Cooking		Plug Load	
	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New	Exist.	New
Grocery	4.52	2.71	- - -	- - -	4.82	2.71	7.61	3.84	3.98	3.89	7.18	6.32	0.31	0.29	24.14	24.14	5.16	5.16	0.41	0.41
Health	5.43	3.39	1.87	0.80	2.56	1.19	5.77	3.06	6.01	5.03	6.72	4.21	1.41	1.41	2.10	2.10	0.36	0.36	0.52	0.52
Large Office	5.12	2.45	1.85	1.03	- - -	- - -	5.61	2.74	2.09	1.83	5.87	3.62	0.48	0.45	- - -	- - -	- - -	- - -	1.59	1.59
Large Retail	3.59	2.02	- - -	- - -	3.10	1.99	5.22	3.11	2.95	2.43	8.19	6.27	0.29	0.28	- - -	- - -	- - -	- - -	0.15	0.15
Lodging	6.22	3.54	- - -	- - -	2.59	1.57	6.37	3.52	2.51	2.47	4.00	3.55	1.79	1.69	- - -	- - -	1.62	1.62	0.10	0.10
Mis.	4.35	2.23	1.85	1.03	2.82	1.76	5.41	2.92	2.52	2.13	7.03	4.94	0.38	0.37	- - -	- - -	- - -	- - -	0.09	0.09
Restaurant	4.18	2.04	- - -	- - -	5.20	2.91	7.82	4.34	4.33	4.05	7.35	4.25	8.79	8.32	5.80	5.80	52.39	52.39	0.23	0.23
School	8.52	3.70	- - -	- - -	0.70	0.52	5.98	2.54	1.57	1.19	5.82	4.71	1.45	1.45	2.10	2.10	0.36	0.36	0.11	0.11
Small Office	5.12	2.45	- - -	- - -	2.54	1.53	5.61	2.74	2.09	1.83	5.87	3.62	0.48	0.45	- - -	- - -	- - -	- - -	1.59	1.59
Small Retail	3.59	2.02	- - -	- - -	3.10	1.99	5.22	3.11	2.95	2.43	8.19	6.27	0.29	0.28	- - -	- - -	- - -	- - -	0.15	0.15
Warehouse	2.11	1.75	- - -	- - -	0.50	0.37	- - -	- - -	0.51	0.50	2.83	1.91	0.20	0.20	18.18	18.18	- - -	- - -	0.15	0.15
Warehouse CA	2.11	1.75	- - -	- - -	0.50	0.37	- - -	- - -	0.51	0.50	2.83	1.91	0.20	0.20	92.18	92.18	- - -	- - -	0.15	0.15

Industrial Sector

As explained in Chapter 3 of the report, the distribution of energy consumption in the industrial sector is based on data from the Energy Information Administration's Manufacturing Energy Consumption Survey. The allocation of total energy consumption by end use for the various industrial facility types are presented in Table F.33.

Table F.33. Industrial Consumption by Industry Type and End Use

Industry Type	Other	HVAC	Indirect Boiler	Lighting	Process Electro Chem.	Process Heat	Process Other	Process Cool	Fans	Pumps	Process Air Comp.	Process Refridge	Motors Other
Chemical Mfg	2%	6%	1%	4%	18%	3%	0%	9%	7%	15%	16%	4%	15%
Electronic Mfg	8%	17%	0%	13%	3%	19%	1%	4%	4%	9%	10%	3%	10%
Food Mfg	7%	7%	1%	7%	0%	3%	0%	25%	4%	8%	4%	15%	19%
Industrial Machinery	7%	18%	0%	14%	1%	7%	1%	3%	7%	12%	8%	3%	19%
Lumber Wood Products	8%	7%	1%	7%	0%	5%	0%	1%	10%	18%	11%	5%	28%
Miscellaneous Mfg	4%	20%	9%	15%	0%	9%	0%	6%	6%	3%	5%	0%	22%
Paper Mfg	2%	4%	3%	4%	2%	2%	0%	1%	16%	25%	4%	4%	32%
Petroleum Mfg	1%	3%	1%	2%	0%	6%	0%	6%	11%	20%	13%	5%	31%
Primary Metal Mfg	1%	4%	0%	3%	31%	28%	0%	1%	5%	3%	5%	0%	20%
Stone Clay Glass Products	4%	6%	0%	5%	0%	20%	1%	3%	8%	15%	9%	4%	23%
Transportation Equipment Mfg	4%	19%	0%	15%	1%	10%	1%	5%	5%	11%	12%	3%	12%
Mining	0%	0%	0%	0%	0%	6%	5%	0%	0%	1%	0%	0%	88%
Irrigation	10%	0%	0%	0%	0%	0%	0%	0%	0%	90%	0%	0%	0%
Wastewater	14%	0%	0%	2%	0%	0%	0%	0%	0%	18%	66%	0%	0%
Water	14%	0%	0%	2%	0%	0%	0%	0%	10%	64%	0%	0%	10%

The load shapes for Utah follow in Figure F.1 through Figure F.9.

Figure F.1. Utah Single Family Cooling Load by Month and Average

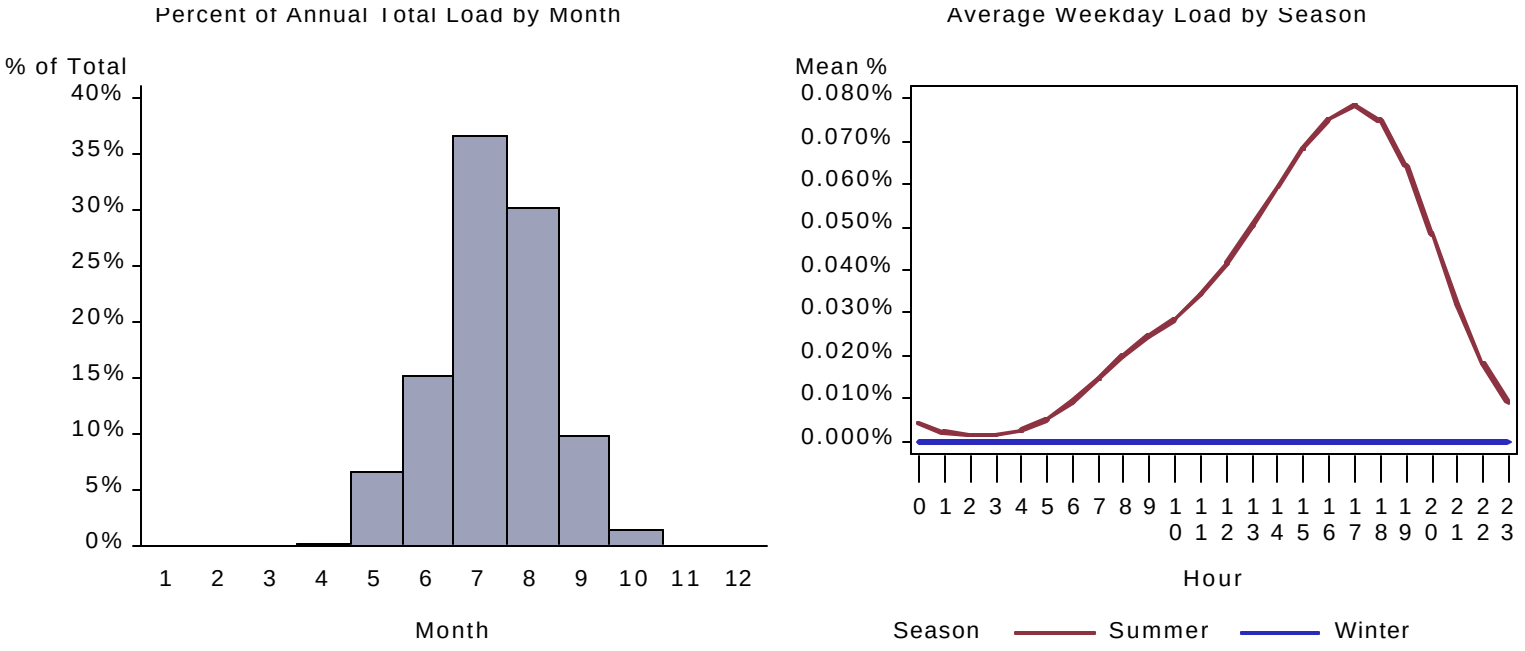


Figure F.2. Utah Single Family Heat Pump Load by Month and Average Weekday

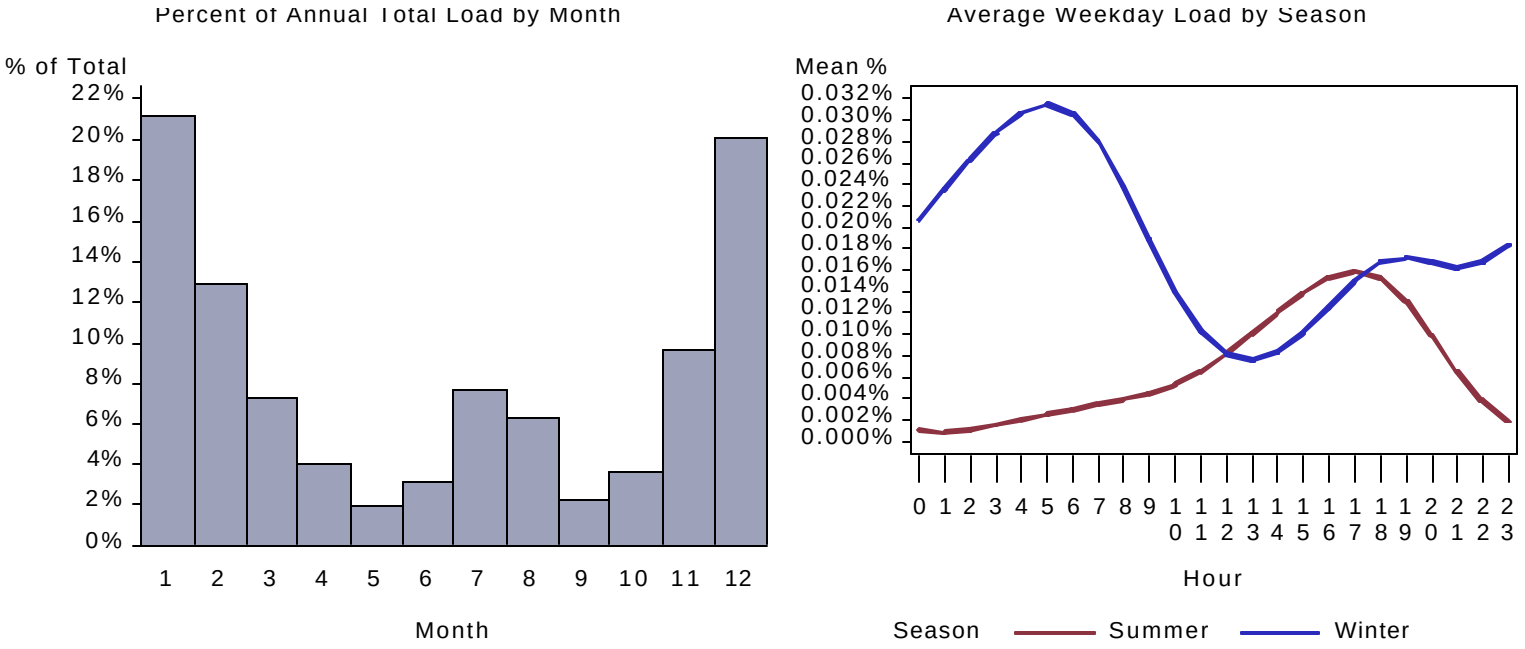


Figure F.3. Utah Single Family Heating Load by Month and Average Weekday

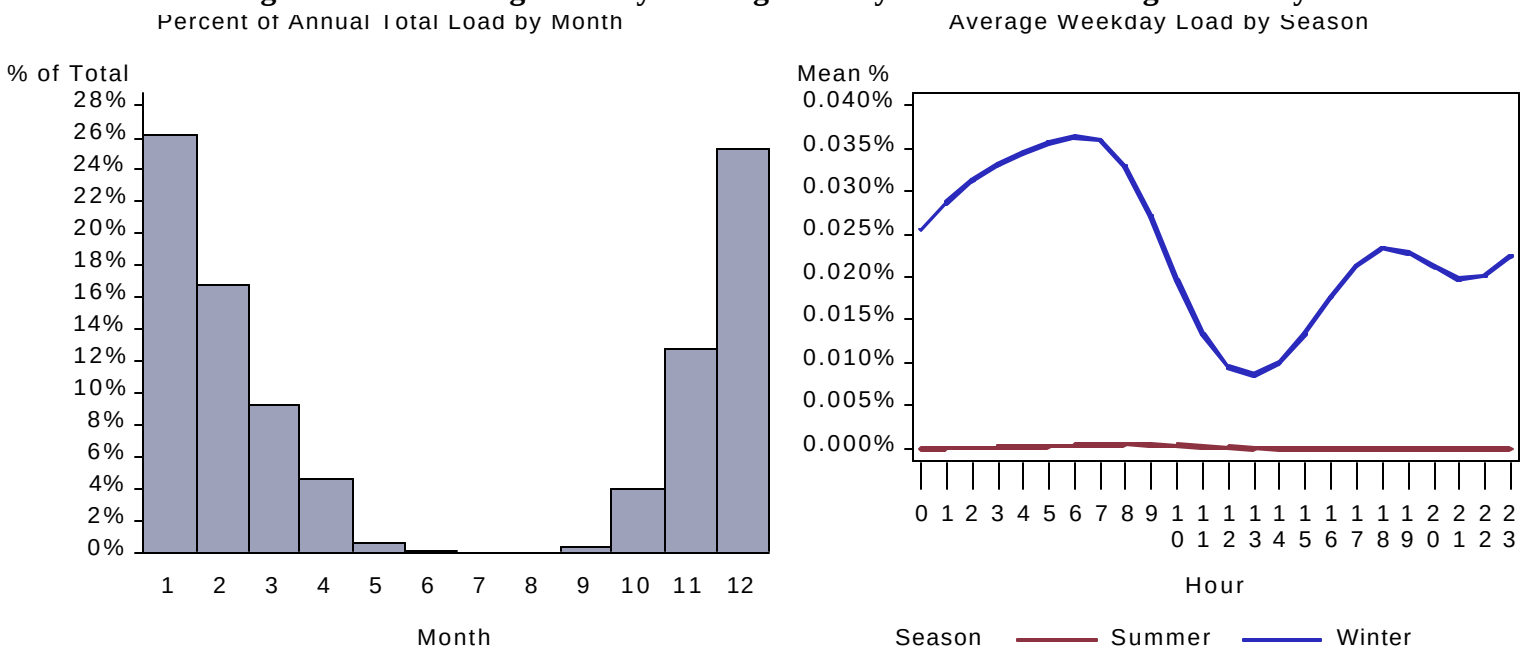


Figure F.4. Utah Single Family Water Heat Load by Month and Average Weekday

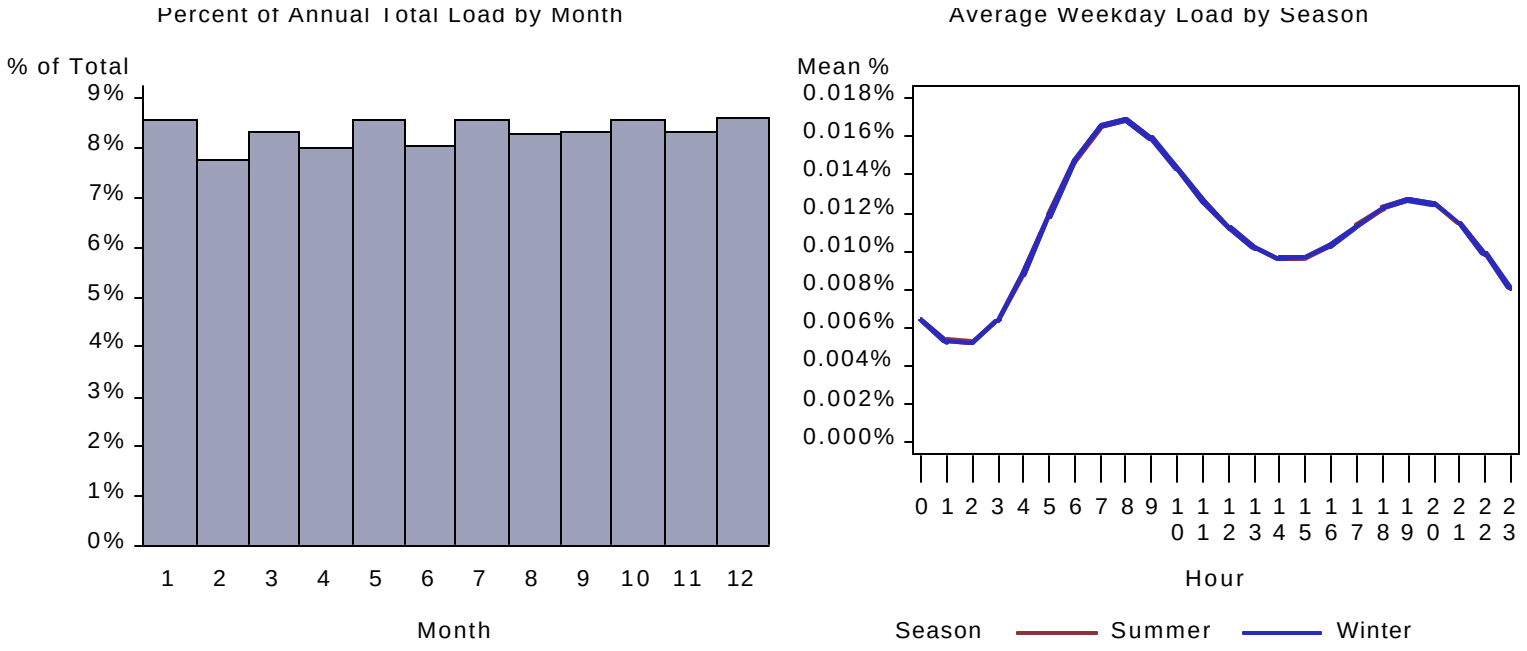


Figure F.5. UT Large Office HVAC Aux Load by Month and Average Weekday

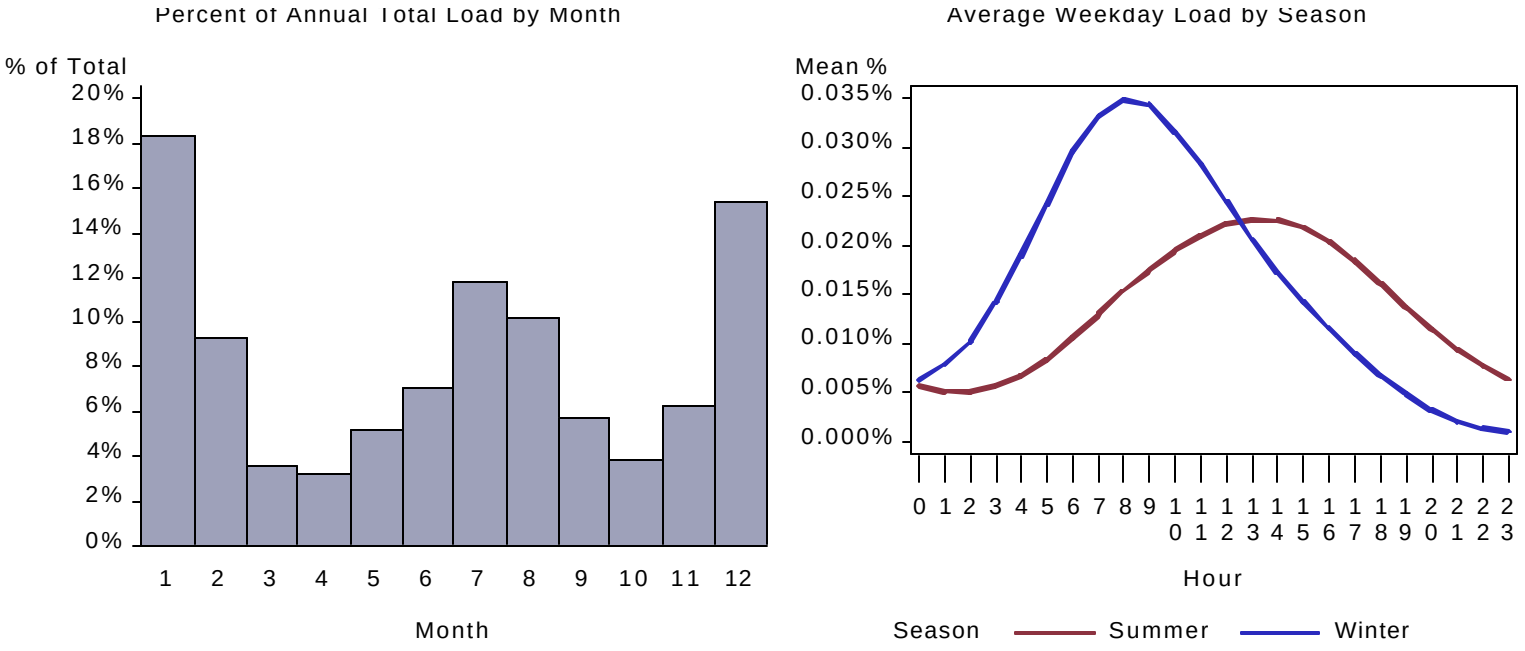


Figure F.6. UT Large Office Lighting Load by Month and Average Weekday

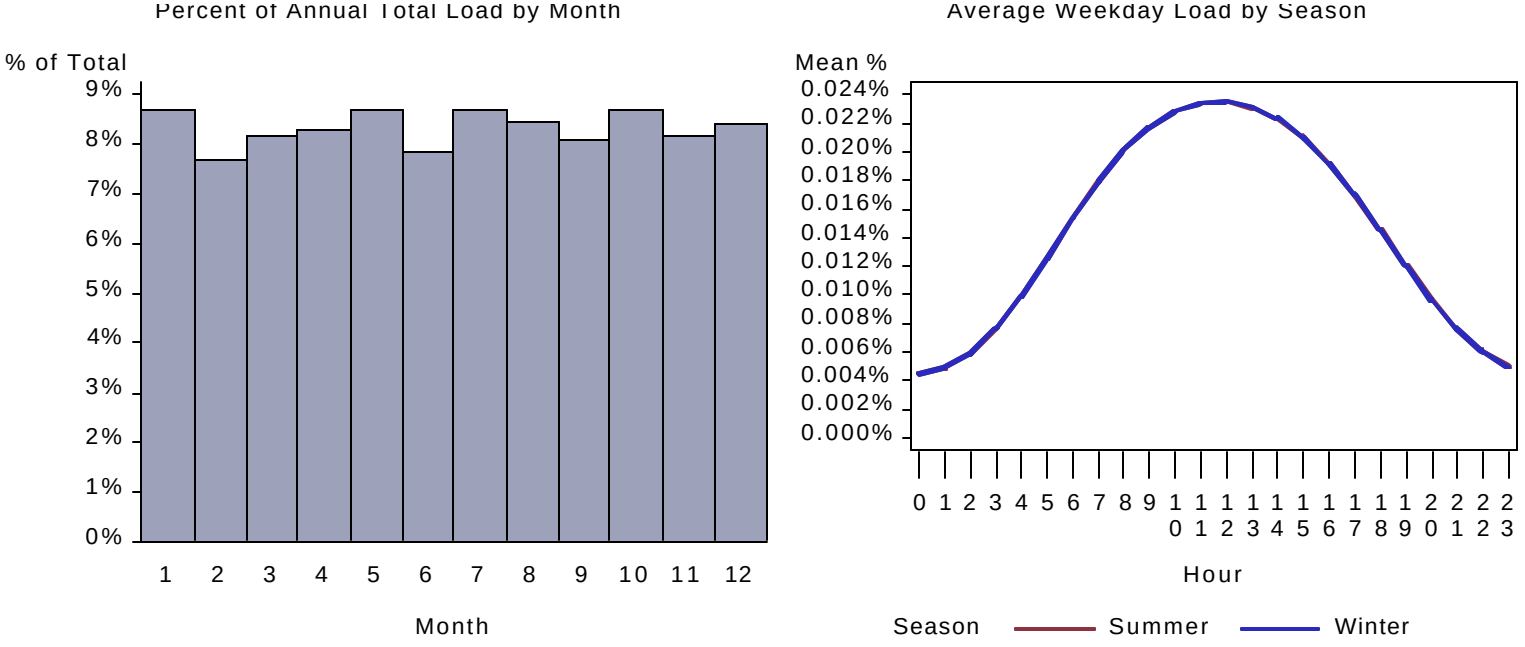


Figure F.7. UT Large Office Cooling Load by Month and Average Weekday

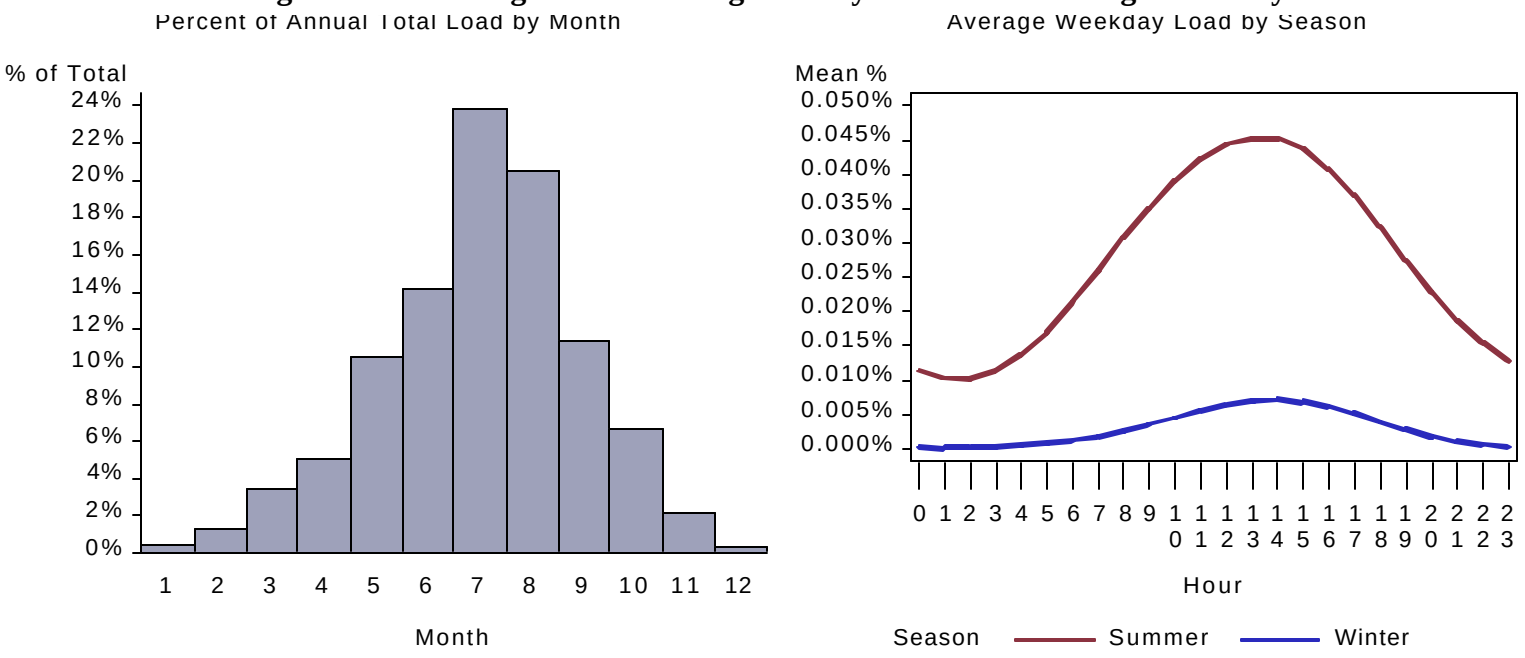


Figure F.8. UT Large Office Space Heat Load by Month and Average Weekday

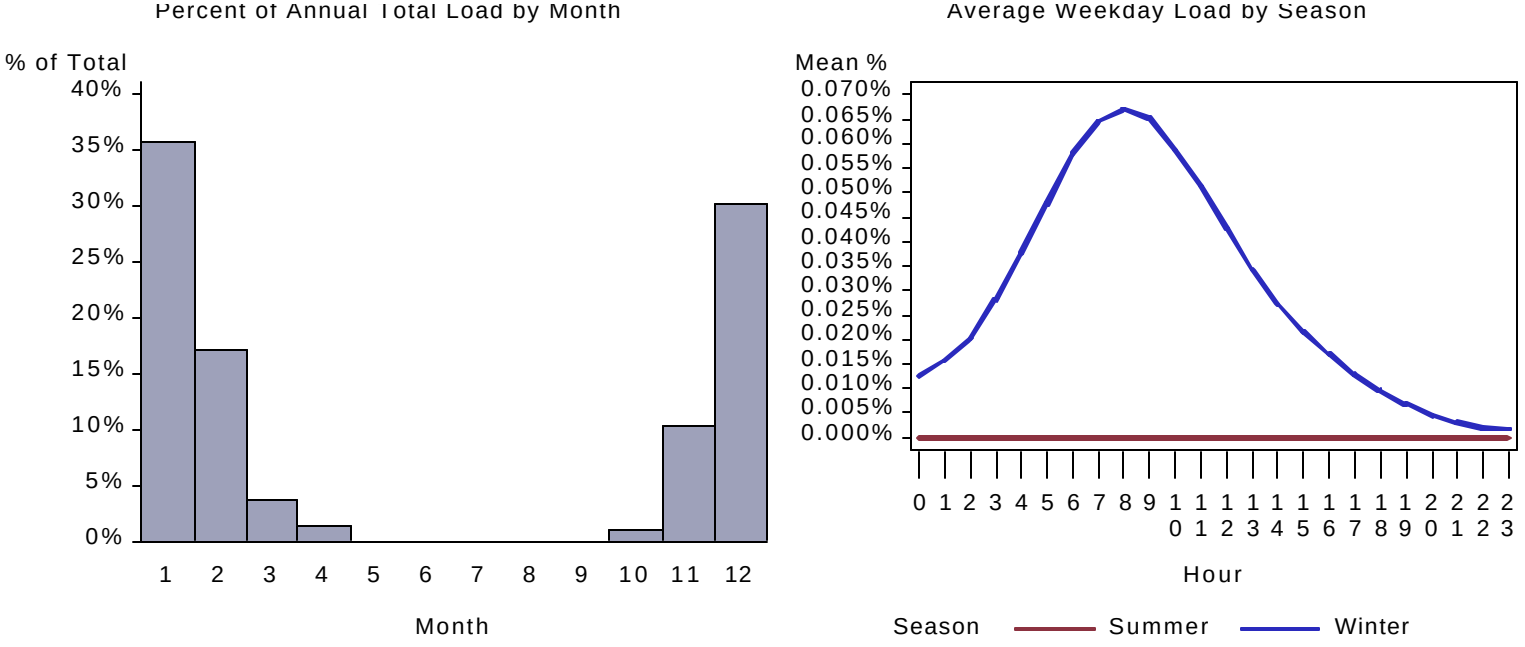
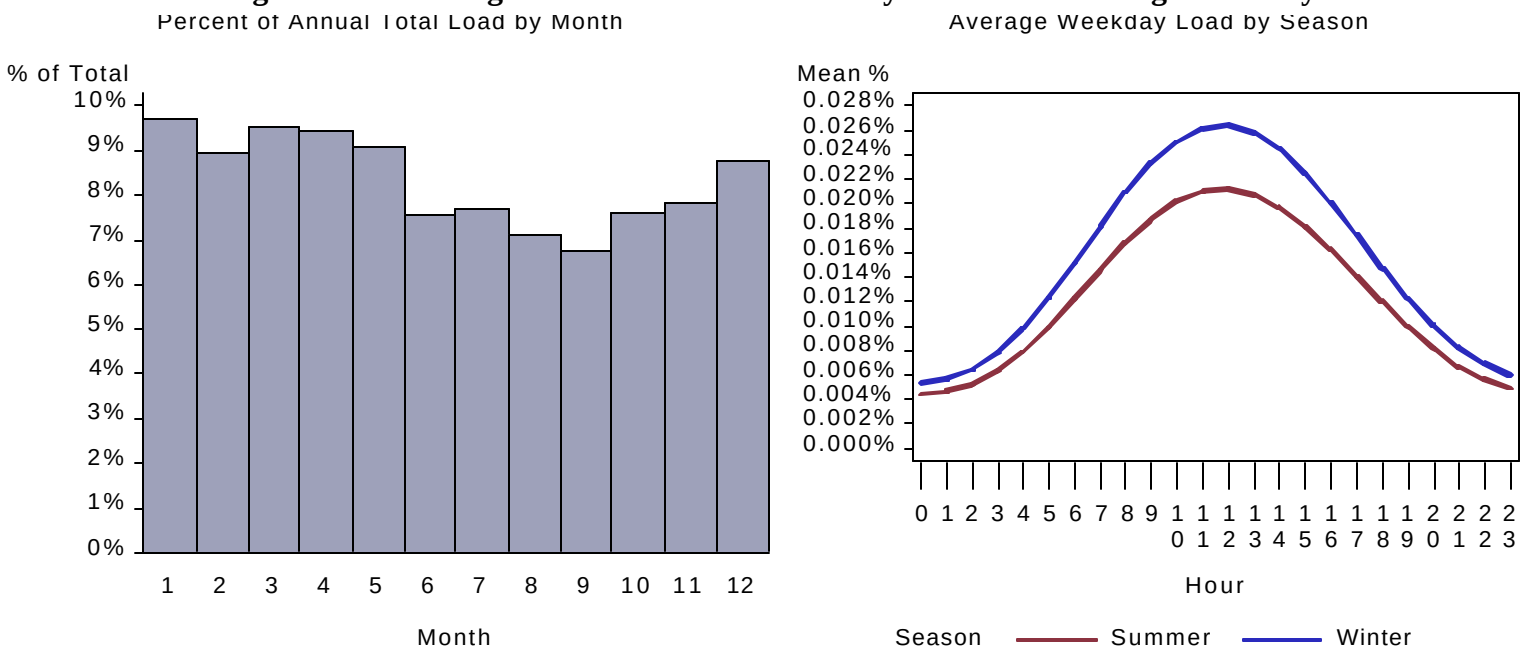


Figure F.9. UT Large Office Water Heat Load by Month and Average Weekday



Home Electronics

As the popularity of home electronics devices grows, so does their impact at the residential electricity meter. As a group, home electronics devices consumed more than 147 TWh in U.S. homes in 2006, which equates to more than 11% of U.S. residential electricity consumption and 4% of total U.S. electricity consumption. While much research has been conducted in the United States to understand the energy impact of these consumer electronics,[3] little is known about the associated daily load profile or impact during periods of peak demand. Thus, a 24-hour load shape for home electronics devices for residential customers in PacifiCorp's service territory was developed. This section describes, at a high level, the inputs, sources of information, and methodology necessary to derive a "typical" home electronics load shape for the "average" home.

Inputs and Sources

The primary inputs used to determine the load profile of consumer electronics equipment include:

- ***Power draw***. Each device will draw varying levels of power based on its type, size, and power mode. Power mode varies by device type and may include any of the following states: 'on,' 'in use,' 'active standby,' 'standby,' 'inactive standby,' 'idle,' or 'off.'

[3] Throughout this document, the terms "consumer electronics" and "home electronics" are used interchangeably.

- ***Units per household***. This is the average number of units for a particular device in the typical U.S. home.
- ***Usage patterns***. This defines the percentage of units in a device category that are in a particular power mode at each hour during a 24-hour period.

Of the three inputs necessary to derive a home electronics load shape, those that are least uncertain for PacifiCorp customers are power draw and units per household. Most of the information for these was taken from the TIAX report "Energy Consumption by Consumer Electronics in U.S. Residences," prepared for the Consumer Electronics Association (CEA). According to this report, the power draw data reflect the average of *actual measurements* instead of *rated* power draw. Rated power draw simply defines the maximum power draw that can be handled by the device's power supply, which often exceeds the active power draw by a factor of three and, therefore, does not accurately characterize the actual power draw. By using the average of actual measurements *for each power mode,* TIAX significantly reduced the uncertainty surrounding this variable.[4]

Units per household was most often determined from the estimates of residential equipment stock in the TIAX report. According to the report, most of these data came from industry markets reports, CEA shipment data, and a survey carried out by TIAX specifically for the report. The project team converted these estimates of residential stock to the average number of units per household using TIAX's estimate of 115 million households in the United States.

The *most* uncertain input is the usage patterns. Residential interval metering for a significant sample of end-uses other than lighting has not been conducted in the United States in over a decade. Furthermore, none of the old research contains data on the new electronics equipment that was the focus of this study. Since it was beyond the scope of this study to collect primary data from residences in PacifiCorp's service territory, and since no data specific to the United States exist indicating usage patterns as described above, the project team relied on a number of international reports to obtain a better understanding of typical usage. In all cases, the usage patterns for a particular device were calibrated to estimates of *annual* usage in the United States as reported by TIAX. The full methodology is described in more detail in the next section.

Methodology

The first step was to determine data availability for a list of devices. As noted above, the TIAX report proved to be extremely valuable to this effort. Ostensibly, this report included all of the necessary pieces of information to develop the home electronics load profile other than the *shape* of the load over a 24-hour period. The TIAX report did not, however, include any information

[4] The uncertainty that *does* exist for this variable is mostly a function of not knowing the make, model, and vintage of units in the installed base. According to the TIAX report, this was partially mitigated by attempting to obtain measurements for the best-selling products and the best-selling brands.

for digital televisions.[5] Although this group of TVs makes up just 14% of the current installed base of televisions, it does include most of the newer display technologies such as plasma and liquid crystal display (LCD). As a result, the project team conducted supplemental secondary research to determine appropriate values for the three input variables. Table F.35 presents the list of home electronics devices examined.

For each device in the list, except televisions, the project team recorded the appropriate power draw value for each power mode from the TIAX report. Annual operating hours by power mode was also recorded for each device. Next, the project team recorded the installed base of devices in U.S. homes and divided these values by the number of U.S. households (estimated by TIAX from EIA data to be 115 million in 2006) to get the average units per household for each device.

Since digital televisions were not included in the TIAX analysis, the project team conducted a separate, intensive analysis to determine appropriate values for the three input variables. Specifically, the TIAX report estimated a total of 277 million television sets in U.S. homes, of which 237 million (86%) are analog devices. Although no information is given by *display technology*, the report does state that "the majority of installed TVs . . . display images in the standard-definition format using cathode ray tube (CRT) display technology," Using data from the report, the project team determined power draw values, average units per household, and average annual operating hours by power mode for the group of 237 million analog TVs in U.S. homes. Furthermore, this data was disaggregated into "primary" and "secondary" TVs.[6] The critical assumptions used to derive appropriate values for *analog* TVs include:

- ***All analog TVs in the installed base use CRT display technology***. While this may not be strictly true, the promotion of enhanced- and high-definition displays (both of which use digital signals) has been ongoing for several years now. Furthermore, high-definition signals benefit most when combined with the more advanced display technologies such as LCD, plasma, and DLP. Since these display technologies are also relatively new, it seems reasonable that manufacturers of these more high-end display technologies would include a digital tuner so that their device could be labeled digital.
- ***All analog TVs with a screen size 41" and smaller use the CRT Direct-View display technology***. Conversely, all analog TVs with a screen size greater than 41" use CRT rear-projection display technology. TVs using a tube electron gun (i.e., CRT direct-view) aren't feasible over 41" because of the associated bulk and weight. Likewise, CRT rear-projection TVs (i.e., the traditional "big-screen" TV) do not make economic sense below a certain screen size.
- ***CRT rear-projection projection TVs are always the primary TV in a household.*** It is likely that households with a CRT rear-projection TV use it as their primary TV due to its

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[5] A digital television is simply a TV with a *built-in* digital tuner (i.e., it can receive and display digital signals without the use of a set-top box or other external tuner). As of March 1, 2007, all new televisions are required by the FCC to include a digital tuner or they must be marketed as a "monitor." Thus, although the installed base is heavily weighted toward analog TVs, all TVs sold as of March 2007 will be digital.

[6] In reality, 34% of U.S. households own three or more TVs, including 2% that own six or more. The data for secondary TVs uses a weighted average among all the TVs (other than the primary) in the house. (Table F.35)

inherent size. With this assumption, only CRT direct-view displays can be secondary TVs.

Table F.34. Home Electronics Device List

Device	Equipment Type	Included in TIAX Report?	Included in Current Analysis?
TV – Analog – CRT Direct-View - Primary	Entertainment	Yes	Yes
TV – Analog – CRT Direct-View – Secondary	Entertainment	Yes	Yes
TV – Analog – CRT Rear-Projection – Primary	Entertainment	Yes	Yes
TV – Digital – CRT Direct-View – Primary	Entertainment	No	Yes
TV – Digital – CRT Direct-View – Secondary	Entertainment	No	Yes
TV – Digital – LCD Direct-View – Primary	Entertainment	No	Yes
TV – Digital – Plasma Direct-View – Primary	Entertainment	No	Yes
TV – Digital – MicroDisplay Rear-Projection[7] – Primary	Entertainment	No	Yes
Set-Top Box (STB) – Cable – Analog	Entertainment	Yes	Yes
STB – Cable – Digital	Entertainment	Yes	Yes
STB – Cable – High-Definition (HD)	Entertainment	Yes	Yes
STB – Cable – Personal Video Recorder (PVR)	Entertainment	Yes	Yes
STB – Cable – HD PVR	Entertainment	Yes	Yes
STB – Satellite – Digital	Entertainment	Yes	Yes
STB – Satellite – HD	Entertainment	Yes	Yes
STB – Satellite – PVR	Entertainment	Yes	Yes
STB – Satellite – HD PVR	Entertainment	Yes	Yes
STB – Stand-Alone – PVR	Entertainment	Yes	Yes
DVD Player	Entertainment	Yes	Yes
DVD Player and Recorder	Entertainment	Yes	Yes
DVD/VCR Combination Unit	Entertainment	Yes	Yes
VCR	Entertainment	Yes	Yes
Video Game System	Entertainment	Yes	Yes
Compact Audio	Entertainment	Yes	Yes
Home Theater In A Box (HTIB)	Entertainment	Yes	Yes
Cordless Phone	Communication	Yes	Yes
Cordless Phone w/ Telephone Answering Device (TAD)	Communication	Yes	Yes
TAD Only	Communication	Yes	Yes
PC – Desktop	Office	Yes	Yes
PC – Notebook	Office	Yes	Yes
Monitor – CRT – 17"	Office	Yes	Yes
Monitor – LCD – 15"	Office	Yes	Yes
Monitor – LCD – 17"	Office	Yes	Yes
Monitor – LCD – 19"	Office	Yes	Yes
Total Number of Devices	34	29	34

[7] "Microdisplay rear-projection" is a generic term given to a new generation of rear-projection TVs that use a constant light source that is filtered by whatever display technology is being used. Rear-projection LCD, Digital Light Processing (DLP), and Liquid Crystal on Silicon (LCoS) are all examples of microdisplays. They typically draw about the same amount of power across all types of microdisplays because of the way the picture is displayed (i.e., with a constant backlight).

For the remaining 40 million digital television sets (representing 14% of all TVs), the project team conducted supplemental secondary research to determine appropriate values for the three input variables. Specifically, since the three critical assumptions above indicate that only CRT display technology is used for analog TVs, this group of 40 million digital TVs includes all of the other display technologies researched, including LCD, plasma, DLP, and LCoS. Since these display technologies have only recently become commercially available, little research has been conducted in the United States to quantify the power draw or saturation of these new devices. As a result, much of the data for the digital TVs was pieced together from a combination of reports and articles regarding the installed base in both the United States and internationally shows the active mode power draw, active mode annual operating hours, and the average number of devices per U.S. household for each of the eight TV types analyzed.

Table F.35. Active Mode Power Draw and Units Per Household for Televisions

	Active Mode Power Draw	Active Mode Annual Op Hrs	Average Units per U.S. Household
Analog			
CRT Direct-View - Primary	109 W	2,592	0.79
CRT Direct-View – Secondary	83 W	1,331	1.15
CRT Rear-Projection – Primary	160 W	2,592	0.11
Digital			
CRT Direct-View – Primary	146 W	2,592	0.01
CRT Direct-View – Secondary	146 W	1,331	0.02
LCD Direct-View – Primary	193 W	2,592	0.12
Plasma Direct-View – Primary	328 W	2,592	0.05
MicroDisplay Rear-Projection – Primary	208 W	2,592	0.14
Total			2.41

Usage Patterns Analysis

Without any sort of primary data collection or results from other end-use metering studies in the United States, determining the usage pattern for each device in Table F.35 required innovative use of international data and reports. Specifically, the project team drew heavily on a report completed for the European community, "Demand-Side Management End-Use Metering Campaign in the Residential Sector," nicknamed the "CIEL End-Use Measurement Campaign" That report illustrates the average hourly load curve for principal and secondary television sets, as well as seasonal variations for principal televisions. The average power draw from that report was recorded for each hour in the 24-hour period and then used to derive an algorithm to convert the average power draw into the percentage of units in active mode at each hour. These percentages were then indexed to the average daily usage (5.2 hours per day, or 1,886 hours per year) as stated in the CIEL report for homes in the European community. Finally, the percentage of units in active mode was calibrated evenly to the average daily usage as specified in the TIAX report (7.1 hours per day, or 2,592 hours per year). Given the lack of data for all the other devices analyzed, the remainder of the home electronics was given the same load profile as the TV under the assumption that this profile accurately represents the times at which people are home and likely to be using consumer electronics. As with the TVs, the load profile for each device was calibrated to the average daily usage as indicated in the TIAX report. This

methodology was repeated to determine the typical summertime home electronics profile, as well as the typical wintertime profile.

This methodology does have limitations, however. First and foremost, the shape of the load is representative of households in the European community, not necessarily the United States or PacifiCorp's service territory. Second, the analysis indicates that 64% of primary TVs are in active mode during the peak hour (Hour 22) in the European community. Extrapolated and calibrated to average usage according to the TIAX report, this indicates that 87% of primary TVs in the U.S. are in active mode during the peak hour, which is much higher than Nielsen's typical estimate of Households Using TV (HUT%) of approximately 60%-65% during primetime. The primary reason for this discrepancy is that Nielsen only records and presents HUT% for broadcast (or cable) television viewing time. It does not include time spent viewing DVDs, video cassettes, or playing video games.

In spite of these limitations, the project team considers the proposed methodology for determining television power draw during each hour of the day to be reasonable given the lack of additional targeted data.

Calculation Algorithm

Once all of the data for each of the three input variables were compiled, the project team derived a calculation algorithm in which the value for each device in each hour is a percentage of the maximum power draw for that device. *For each device type*, the power draw in each mode was multiplied by the number of devices in *that particular power mode*. These values were then summed across all power modes and divided by the maximum (active mode) power draw to derive the percentage of the maximum power draw for the particular device type.[8] This was then repeated for each hour in the 24-hour period.

The maximum power draw for *all the home electronics devices in an average U.S. household* is calculated by multiplying the active mode power draw by the average number of units per U.S. household for each device type, and then summing these values across the population of devices. This value came to 473 Watts. Next, the percentages in each hour bucket for home electronics as a group were calculated as the sum-product across all devices of 1) active mode power draw, 2) average units per household, and 3) the percentage of maximum power draw by device, divided by the average household maximum power draw.

Results

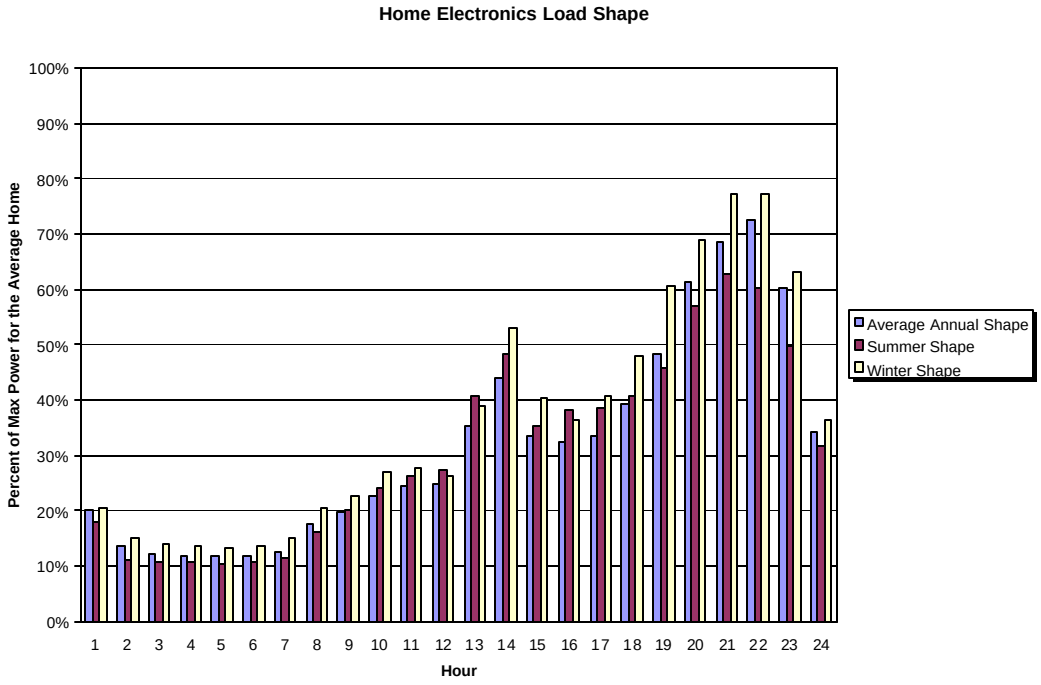
Table F.36 shows the annual, summer, and winter load profile for home electronics as a percentage of maximum home electronics power draw for an average U.S. home. Figure F.10 shows the same results in graphical form.

[8] For example, if 80% of the TVs are in active mode, which draws 100 Watts; and if 20% of the TVs are off, which draws 5 Watts, then the percentage of maximum power draw would be (80%*100 Watts + 20%*5 Watts) / (100 Watts) = 81%.

Table F.36. Home Electronics Load Profile as a Percentage of Maximum Home Electronics Power Draw for an Average U.S. Home

Hour	Annual Load Shape	Summer Load Shape	Winter Load Shape
Hour 1	20%	18%	21%
Hour 2	14%	11%	15%
Hour 3	12%	11%	14%
Hour 4	12%	11%	13%
Hour 5	12%	11%	13%
Hour 6	12%	11%	13%
Hour 7	12%	11%	15%
Hour 8	18%	16%	21%
Hour 9	20%	20%	23%
Hour 10	22%	24%	27%
Hour 11	24%	26%	28%
Hour 12	25%	27%	26%
Hour 13	35%	41%	39%
Hour 14	44%	48%	53%
Hour 15	33%	35%	40%
Hour 16	32%	38%	36%
Hour 17	33%	39%	41%
Hour 18	39%	41%	48%
Hour 19	48%	46%	60%
Hour 20	61%	57%	69%
Hour 21	69%	63%	77%
Hour 22	72%	60%	77%
Hour 23	60%	50%	63%
Hour 24	34%	32%	36%

Figure F.10. Home Electronics Load Shape Comparison



Appendix G. Treatment of Externalities

Introduction and Purpose

Externalities associated with providing electricity are defined as the " . . . costs to society (human health and other environmental damages) resulting from provision of electric services, which costs are not already incorporated in the price of electric services. They are those costs which occur after all government-imposed environmental standards and regulations are met."[1] This source notes that electric utilities produce about two-thirds of the sulfur dioxide (SO_2) and one-third of the nitrogen oxide (NO_x) emissions in the U.S. In addition, they produce about one-third of U.S. and 11% of global carbon dioxide (CO_2) emissions, the primary greenhouse gas (GHG). Externalities are not typically captured in utility cost analysis since they are not incurred by the utility; rather, they are estimated societal costs that have not been internalized through laws or regulations.

Identifying and quantifying externalities in utility planning and studies is important from a societal perspective because they can lead to approaches that reduce the societal costs of providing utility services. In demand-side management (DSM) potential studies, externalities can be accounted for when the costs of various energy and demand reduction options are evaluated. In planning approaches such as integrated resource planning (IRP), the societal costs of different resource plans can be compared more comprehensively if their associated externalities are included in the analysis.

Objectives and Approach

The purpose of this research was to review the scope of externalities considered by other utilities and how they are incorporated in the IRP process. The results are intended to inform – and if appropriate, prompt reconsideration, as to how externalities are taken into account in PacifiCorp's IRP. There were five steps in this research:

1. Review how PacifiCorp addressed externalities in its 2004 IRP.
2. Review and synthesize literature on inclusion of externalities in utility resource planning, valuation methods, and ranges for their values.[2]
3. Identify and interview key individuals with the most current knowledge of externalities.

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[1] Ottinger, R., D. Wooley, N. Robinson, D. Hodas, S. Babb, et al. 1991. Environmental Costs of Electricity. Prepared for New York State Energy Research and Development Authority by Pace University Center for Environmental Legal Studies, p.13.

[2] One study from the mid-1990s provided information on about 20 states with IRP and externality requirements. PacifiCorp's 2004 IRP summarized IRP requirements in the states in its service territory and provided summaries of IRP and externality analyses conducted by 10 utilities. The Regulatory Assistance Project provided relatively recent information on IRPs and the treatment of externalities in the majority of the states.

4. Assess and prioritize the "secondary" externalities; such as water usage and pollution, environmental effects of wind projects, carbon dioxide sequestration and global climate change effects on hydroelectric resources, taking into account the planned resources included in the IRP and the magnitude of their impacts.
5. Determine the ranges of likely externality values (including monetary, where possible) and assess the sensitivity of IRP outcomes to probable ranges.

Findings

Treatment of Externalities in PacifiCorp's 2004 IRP

PacifiCorp assessed the effect of externalities in its 2004 IRP by estimating a dollar value associated with the air emissions from the resources evaluated. Their analysis included SO_2, NO_x, mercury (Hg), and CO_2. Specifically, PacifiCorp included environmental externalities by modeling the prices of emissions allowances under cap and trade programs. Within the IRP analysis, the monetary values of emissions are estimated over the forecasting period and then reflected in the total resource cost of each potential new supply-side resource.

PacifiCorp's IRP base case used a CO_2 cost adder based on a starting value of $8/ton in 2008 (2008$). The IRP indicated that this price level was consistent with the upper range of offsets then available and with offset costs emerging internationally. This value was then adjusted by PacifiCorp's base case inflation rate schedule for future years. PacifiCorp's analysis assumed that by 2012, the full inflation-adjusted CO_2 cost adder would be imposed and that it would grow at the inflation rate thereafter. To take into account timing uncertainty, a CO_2 cost adder entered the analysis in 2010 by being weighted using a probability of 0.5. Likewise, 2011 prices were multiplied by a probability of 0.75.

The SO_2 emission costs used in the IRP were provided by PIRA Energy Group and assume that tighter limits will be implemented by 2010, resulting in growing market prices for SO_2 emissions. For NO_x, the emission price projections were derived from PIRA forecasts that assumed a national cap-and-trade program that would include NO_x emission limits on electricity generators in the western U.S. starting in 2010. Similarly, PIRA projected the emission costs for Hg based on a cap-and-trade policy beginning in 2010, with a backstop price of $35,000 to limit market price volatility.

To examine the effect of uncertainty, a range of values ($/ton) for CO_2 under a cap-and-trade program were examined. PacifiCorp analyzed four CO_2 emissions allowance charge scenarios. Three were consistent with the Oregon Public Utility Commission's Order 93-695 (May 17, 1993) using CO_2 emissions allowance charges of $10, $25, and $40 per ton in 1990 dollars.[3] The fourth scenario set the value at $0 per ton for comparison purposes. PacifiCorp further developed

[3] Unless noted otherwise, tons of emissions refer to short tons (2,000 pounds).

price adder forecasts for SO_2 and NO_x that were consistent with each of the CO_2 values.[4] The price adder forecast for Hg was assumed constant across all four scenarios.

PacifiCorp's approach for considering environmental externalities was in compliance with IRP standards and guidelines for the states it serves. The method of quantifying expected future costs of air emissions was extensively reviewed with stakeholders during Public Input Meetings, and with PacifiCorp's Environmental Forum, consisting of external parties representing a range of stakeholder interests.

As the 2004 IRP indicated, various resource alternatives can introduce environmental impacts beyond the specific air emissions examined. A full range of other potential impacts, such as those on water supplies, traffic and land use patterns, and visual or aesthetic qualities, were not examined in the 2004 IRP. These depend on the specifics of any particular project and their quantification is dependent on the characteristics of specific generation resource projects.

Other Externalities for Consideration

In response to public comments on the 2004 IRP and reflecting the nature of the resource mix in more detail, PacifiCorp identified additional externality considerations to be examined. Specific issues that were highlighted for further examination were: 1) impacts on water use and water quality, 2) impacts on land use, 3) environmental effects of wind generators, focusing on bird and bat populations as the main wildlife impact, 4) effects of global climate change on the hydroelectric system, and 5) carbon sequestration. The discussions are overviews of these topics and are not intended to provide comprehensive details.

Water Impacts

This research examined if and how water impacts were addressed in the utility resource planning process. We found no examples where water impacts were treated as an externality. Water impacts are usually addressed as part of the power plant siting and permitting process, often under a variety of local and federal laws and regulations vary greatly depending on type of plant, cooling system designs, and the environmental implications of the impacts.

Thermoelectric power plants – coal, oil, natural gas, and nuclear fueled power generators using a Rankine cycle steam turbine – require significant quantities of water for generating electrical energy.[5] For a coal-fired plant, water can be used for boiler make-up water, flue gas desulfurization (FGD) make-up water, and cooling water. The amount of water used in a typical power plant can be substantial; for example, a 500 MW coal-fired power plant uses more than

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[4] The model used indicated that as the emission allowance charge for CO_2 increased, the usage of coal would decline and the availability of allowances for the other two pollutants would increase, thus decreasing their value.

[5] Much of the information presented here on power plant water use is summarized from the recent report by G.J. Stiegel, Jr., A. McNemar, M. Nemeth, B. Schimmoller, J. Murphy, and L. Manfredo, "Freshwater Needs for Thermoelectric Generation," August 2006. Prepared by Research and Development Solutions, LLC, for National Energy Technology Laboratory.

12 million gallons of water per hour for cooling steam turbine exhaust. Makeup water requirements for the FGD system is on the order of 36,000 gallons per hour.

Environmental Impacts. The use of water to cool power plants can create environmental damages by both the water intake and discharge. The types of potential damage include:

- Impingement and entrainment in water intake structures of fish and fish eggs, resulting in direct kills
- High temperatures of discharge water that damage fish and aquatic ecosystems
- Toxic chemical discharges of materials such as chlorine, nickel, and copper

Cooling Systems and Water Usage. There are two basic types of cooling water systems: open-loop (once-through) and closed-loop (re-circulating). Open loop systems withdraw cooling water from a local body of water (fresh or salt water) and then discharge the warm cooling water to the same water body after it passes through the condenser.

There are three main types of closed-loop systems: wet cooling towers, cooling ponds, and dry cooling towers. In wet cooling towers, the most common type, . some of the cooling water is evaporated in a cooling tower and the bulk of the water is then re-circulated back to the condenser. The evaporated water and another portion withdrawn to prevent mineral buildup (blowdown) must be replenished. Cooling ponds function similarly, but a cooling pond to provide evaporation and convective cooling is used instead of a cooling tower. Dry re-circulating cooling systems use either direct or indirect air-cooled steam condensers. In a direct system, no cooling water is used at all; in an indirect system, water use is very minimal.

Water use in thermoelectric generating plants is assessed in terms of the amount *withdrawn* and the amount *consumed*. Withdrawn water is that taken from a source such as a lake and the amount withdrawn is quantified, even if the water is returned to the source (e.g., in an open-loop system). Water consumption is the loss of that water, typically through evaporation into the air. Power plants equipped with once-through cooling water systems have relatively high water withdrawal, but low water consumption. Closed-loop systems typically withdraw a small amount of water to replace the water consumed by evaporative loss and blowdown.

The United States Geological Survey (USGS) estimated that thermoelectric generation accounted for approximately 39% of freshwater withdrawals, second only to agricultural irrigation as the largest source of freshwater withdrawals in the United States in 2000.[6] Based on consumption, however, thermoelectric generation accounted for only 2.5% of the total in 1995.[7] As demand for electricity increases, power plants may increasingly compete for freshwater with other sectors, particularly where freshwater supplies are limited.

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[6] United States Geological Survey (USGS). Estimated Use of Water in the United States in 2000; USGS Circular 1268; March 2004.

[7] USGS. Estimated Use of Water in the United States in 1995; USGS Circular 1200; 1998. http://water.usgs.gov/watuse/pdf1995/pdf/circular1200.pdf

Effect of Environmental Regulations and Legislation. Existing and future environmental regulations and requirements will affect how water can be used to cool power plants and the associated costs. Local, state, and federal regulations affect the use of water in power plants. According to the report by the National Energy Technology Laboratory (NETL), "In considering long-term water withdrawal and consumption patterns in the power sector, the cooling water intake structure regulations established under the Clean Water Act, Section 316(b) will likely have the greatest impact." These regulations are designed to protect aquatic life from inadvertently being killed by intake structures and require the Environmental Protection Agency (EPA) to ensure that the "location, design, construction and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." The regulations have specific requirements for both new and existing power plants. Compliance is coordinated through the individual states' NPDES (National Pollutant Discharge Elimination System) permitting program.

The largest effect of 316(b) compliance will likely be to require most new power plants to use closed-loop, recirculating cooling systems or dry (air-cooled) systems. As a result, water withdrawal levels will likely remain relatively constant, while consumption is expected to increase as more plants are added.

Water usage will also be affected by air quality regulations. The use of FGD systems to remove sulfur emissions has grown in recent years, and, though the consumption of these systems is small relative to the main cooling water use, the cumulative impact will be significant. One response may be the use of semi-dry FGD systems that reduce water requirements by about 30% to 40%; they cost less initially, but they have higher operating costs.[8]

Water quality regulations also could impact power plants. Section 303(d) of the 1972 Clean Water Act requires states and authorized tribes to develop a list of impaired waters not meeting water quality standards and then establish total maximum daily loads (TMDL) for them. These TMDLs could limit the amount of cooling water and pollutants from flue-gas cleanup that a power plant can discharge.

If power plants use CO_2 sequestration (discussed later), the amount of water needed may increase. The net effect of sequestration on water use, however, would have to be determined on a case-by-case basis.

Power Plant Siting. Recent studies indicate that water concerns will constrain future power plant siting, while existing plants will be under increasing pressure to reduce both their water withdrawal and consumption, and such concerns are already impacting power plant projects. Examples include the following:

- In March 2006, an Idaho state House committee approved a two-year moratorium on construction of coal-fired power plants in the state based on environmental and water supply concerns.

8 http://pepei.pennnet.com/Articles/Article_Display.cfm?Section=ARCHI&ARTICLE_ID=238323&VERSION_NUM=2&p=6

- Arizona recently rejected permitting for a proposed power plant because of concerns about how much water it would withdraw from a local aquifer.
- In early 2005, the governor of South Dakota called for a summit to discuss drought-induced low flows on the Missouri River and the impacts on irrigation, drinking-water systems, and power plants.
- In February 2006, Diné Power Authority in New Mexico reached an agreement with the Navajo Nation for its proposed Desert Rock Energy Project to pay $1,000 per acre foot and a guaranteed minimum total of $3 million for water.
- In an article discussing a 1,200 MW proposed plant in Nevada, opposition to the plant stated that, "there's no way Washoe County has the luxury anymore to have a fossil-fuel plant site in the county with the water issues we now have. It's too important for the county's economic health to allow water to be blown up in the air in a cooling tower."[9]

Regional Water Demands. The NETL report examined probable demands in various regions under a wide range of scenarios, including the Western Electricity Coordinating Council/Northwest Power Pool (WECC/NWPP) region, which is most coincident with PacifiCorp's service area; it encompasses the Northwest states and most of Montana, Utah, Nevada, and part of Wyoming.

The report defined five different scenarios reflecting different choices about cooling technologies that would be installed. They ranged from a status quo case, in which cooling choices for additions and retirements followed current trends, to a case emphasizing dry cooling.

At the national level, freshwater withdrawal was projected to decline through 2030 in all cases, with the smallest decline under the status quo scenario. In all cases, however, withdrawal was projected to increase in the WECC/NWPP region; the largest increase, 21%, was projected under a scenario where generating additions use freshwater and recirculating cooling and regulatory and public pressure would lead to conversion of a significant share of existing generation capacity from once-through to wet recirculating cooling systems. Withdrawal under this scenario increased more in WECC/NWPP than in any other region in the country.

At the national level, water consumption was projected to increase under all scenarios, from 26% (the scenario emphasizing dry cooling) to 48% (the scenario requiring conversion to wet recirculating systems). For the WECC/NWPP region, consumption was projected to increase under all scenarios, ranging from about a 30% to a 60% increase.

Cost Issues. Unlike air emissions, the costs associated with the environmental effects of water use in power plants cannot be addressed through cap-and-trade type programs. Typically, the costs associated with externalities of water use are internalized to some extent through power plant siting requirements and steps taken to comply with regulations such as the Clean Water Act. Given the variety of plant types, cooling system variations, local water conditions, and other factors, the costs associated with water impacts are very plant specific.

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[9] The Associated Press, Sempra Energy Halts Gerlach Project Study, March 8, 2006.

Although the costs vary, one recent study summarized the range of costs associated with the approach of adopting water-conserving cooling systems. The main conclusions of that study were that the use of more water-efficient cooling systems would have the following impacts:[10]

- Increased capital costs ranging from 0.4% to 12.5% (500 MW plant)
- Increased power required for cooling system ranging from 0.5 MW to 3.0 MW
- Increasing plant heat rate from 0.4% to 4%
- Increased power production costs ranging from 1.9% to 4.9%

Land Use Impacts

During our interviews with state regulators and literature review, we also examined how land use impacts were addressed as externalities. We found no examples where land impacts were treated as an externality in the resource planning process. Land impacts are usually addressed as part of the power plant siting and permitting process. The responsible authority varies by state and power plant type and size and can range from the county to a state permitting body or agency with specialized authority.

Some locales (such as California) require power plants to go through a comprehensive environmental impact assessment process. Others have much less complete requirements. Land impacts are typically identified and required mitigation is established. The result is that at least some of the land impacts are internalized either in the initial capital or subsequent operating or shutdown costs. It appears that no resource planning processes treat land impacts as externalities, using an approach such as an adder, because they are very case specific, they get addressed in the siting/permitting process, and they tend to be quite localized and directly related to plant construction and operations.

Environmental Impacts of Wind Generators

Wind turbines have fairly unique environmental impacts that can be considered as externalities. The most widely discussed impacts are negative effects on wildlife, particularly the death of birds and bats through collisions and, potentially, the disruption of their population movement or migration patterns. Other effects that have been of concern are land and aesthetic impacts. This section briefly discusses land and aesthetic impacts, with a focus on wildlife impacts.

Wildlife Impacts. Recent studies indicate that the impacts of wind power facilities on birds and other wildlife vary significantly by region and by species. A report from the American Bird Conservancy (ABC) notes that estimates of bird kills range from less than one to 7.5 birds/turbine-year; bat deaths range from l7 to nearly 48 bats/turbine-year.[11] The concerns of scientists, regulators, and the public about such impacts have been elevated by wildlife mortality studies in two locations in particular. A recent study showed that more than 1,000 raptors are killed by wind power facilities in northern California each year. Many experts, however, attribute

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[10] Maulbetsch, J.S. Maulbetsch Consulting. December 2005. "Power Plant Cooling—What are the tradeoffs?" Presented to California State Water Resource Control Board Workshop.

[11] http://www.abcbirds.org/policy/windpolicy.htm

this large number of fatalities to unique aspects of wind power development in northern California. In West Virginia, a recent study of a wind facility estimated that more than 2,000 bats were killed during a one-year period. In both cases, however, the findings from these studies are significantly different from studies of other wind power facilities, which show relatively less bird and bat mortality.

In general, significant gaps in the literature make it difficult for scientists to draw conclusions about wind power's impact on wildlife. One gap is in information on migratory bird routes and bat behavior, as well as the ways in which topography, weather, and turbine type affect mortality. In addition, because of site and wildlife population differences, studies conducted at one location can rarely be used to extrapolate potential impacts or mitigation effectiveness to other locations.

The following paragraphs discuss specific issues associated with the wildlife impacts of wind projects.

Regulations. A few states with emerging wind generation projects have studied the environmental effects of such projects and developed policies and requirements affecting them.[12] The effort has probably been most extensive in California.

Washington's Department of Fish and Wildlife issued wind project guidelines in 2003 that addressed the direct effects on birds, other wildlife, and habitat.[13] The ABC identifies these guidelines and those developed by Kansas[14] as both useful and comprehensive. The Washington guidelines include a requirement for pre-project assessment studies to 1) collect information suitable for predicting the potential impacts of the project on wildlife and plants and 2) design the project layout (e.g., turbine locations) so that impacts on biological resources are avoided and minimized. To the extent possible, the studies may utilize existing information from projects in comparable, nearby habitat types. The guidelines indicate the site-specific components and the duration of the assessment should depend on the size of the project, the availability and extent of existing and applicable information in the vicinity of the project, the habitats potentially affected, the likelihood and timing of occurrence of Threatened, Endangered, and other Sensitive- Status species at the site, and other factors such as issues and concerns identified during public scoping. One goal of the pre-project assessment is to help design the project in a way that avoids, reduces, and minimizes habitat and wildlife impacts. The guidelines also establish monitoring requirements to quantify and minimize the impacts. In addition, the guidelines set forth mitigation approaches to address the project impacts.

In Minnesota, authority for permitting wind energy systems 5 MW or larger was given to the Minnesota Public Utilities Commission in July 2005. Smaller projects are regulated at the local level. For the larger projects, the Commission requires an analysis of the proposed facility's potential environmental and wildlife impacts, proposed mitigation measures, and any adverse

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[12] A recent report from the Government Accountability Office provides a good summary of recent state and federal requirements – GAO-05-906, September 2005. Wind Power – Impacts on Wildlife and Government Responsibilities for Regulating Development and Protecting Wildlife.

[13] Wind Power Guidelines, August 2003, available at http://wdfw.wa.gov/hab/engineer/windpower/index.htm

[14] http://www.naseo.org/committees/energyproduction/documents/wind/kansas_siting_guidelines.pdf

environmental effects that cannot be avoided. Since much of the wind power development is concentrated in the southwestern part of the state, the state conducted a single large-scale study, rather than requiring individual studies for each project. A four-year avian study and a two-year study of impacts on bat populations were conducted. They concluded that the impacts to birds and bats from wind power are minimal. Consequently, state and local agencies are not requiring post-construction studies for wind power development in this portion of the state.

As in Minnesota, wind power regulation in Oregon is subject to either local or state permitting procedures, depending on generating capacity. Local governments issue conditional use permits for facilities up to 105 MW peak capacity. Through this mechanism counties can impose requirements such as an avian post-construction study (as Sherman County did on one project). Larger projects must be permitted by the Oregon Energy Facility Siting Council, which requires wind power projects to comply with the facility standards and applicable statutes, some of which are specific to wind power, such as design and construction requirements to reduce visual and environmental impacts. The Council also ensures that state fish and wildlife habitat mitigation goals and standards are met. Specifically, the Council requires that developers avoid creating artificial habitat for raptors or raptor prey.

Two other states are interesting in terms of regulatory and environmental issues of wind generators. In Pennsylvania, wind power regulation has been left totally to local governments and (as of late 2005) the only project that was sited was subject to just setback and land use type requirements. Many developers, however, have undertaken environmental studies, including wildlife impacts, in an attempt to head off criticism or opposition to a proposed project. In West Virginia, the Public Service Commission has been the only agency involved in regulating wind power to date, although local governments could get involved through their zoning authorities. Prior to 2005, wind power facilities were not covered by the same requirements that applied to utilities providing service directly to consumers since wind power was sold on the wholesale market. In 2003, the state amended the legislation to specifically address the permitting of wholesale electric generators, such as wind power.

California is one of the few states with significant wind power development on federal land where federal regulations would apply directly. On non-federal land, the state relies on local governments to regulate wind power. In addition to the local permitting process, the California Environmental Quality Act (CEQA) requires all state and local government agencies to assess the environmental impacts of proposed actions they undertake or permit. This law requires agencies to identify significant environmental effects of a proposed action and either avoid or mitigate significant environmental effects, where feasible. Significance is generally determined at the population level (i.e., the impacts have to affect the viability of the population). With regard to effects on bird populations, the wind industry in California has stressed that a balance is needed between the direct mortality associated with wind turbines and the mortality resulting from externalities associated with other types of power plants.[15]

[15] Mudge, A. September 27, 2006. "A CEQA Context for Impact Analysis and Mitigation," presented on behalf of the California Wind Industry Association to the California Energy Commission Avian Guidelines Two-Day Staff Workshop.

The regulatory role of the federal government for wind projects is generally limited to when development occurs on federal land or involves some form of federal participation, such as providing funding for projects. In these cases, the development and operation must comply with any state and local laws as well as federal laws, such as the National Environmental Policy Act and the Endangered Species Act. The effect of these laws can be to require pre-construction studies or analyses and possibly modifications to proposed projects to avoid adverse environmental effects. The U.S. EPA issued a Programmatic Environmental Impact Statement covering wind projects on Bureau of Land Management land in 11 western states.[16]

Implications for Wind Projects. Approaches for addressing the impacts of wind generation projects on birds, bats, and other wildlife are less fully developed than they are for several of the impacts of the more common power plant types. This is due in part to the limited operational experience with wind turbine systems, lack of research, variations in the impacts from one site to another, and inconsistent regulations and regulatory responsibilities. Nevertheless, it seems clear that as the amount of installed wind generation capacity grows, more effort will go into research and developing and implementing requirements and regulations to address wind project impacts, particularly on bird and bat populations.[17]

One expert defines a set of typical categories of actions that can be implemented to address the impacts of wind projects on wildlife:

- Avoid and minimize impact (pre and post construction)
- Reduce or eliminate impact over time (post)
- Compensate for impact (pre and post)
- Adaptive mitigation/effectiveness monitoring (post)
- Decommissioning (post)

Assuming that wind projects will be subject to environmental requirements to control their impacts, one or more of these actions are likely to be implemented on future wind projects, and they will impose costs on the project. The first action is to avoid creating negative impacts in the first place by selecting overall project and unit locations that avoid effects on wildlife. To do this effectively requires investing in research or information that allows adequate site assessment and possibly selecting less-than-optimally-efficient sites.

Impacts can be minimized through standard steps such as reducing the footprint of access roads and equipment; system design (such as not using guy wires on vertical structures) also is instrumental in minimizing impacts. Information is required to minimize impacts and construction costs may be higher. After the wind generation system is constructed, impacts can be reduced or minimized over time through activities such as taking steps to reduce wildlife

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[16] http://www.epa.gov/fedrgstr/EPA-IMPACT/2006/January/Day-11/i157.htm

[17] Good examples of recent research are presented in: McMahon, S. November 2, 2006. "Understanding and Mitigating Bird and Bat Impacts at Wind Facilities," PPM Energy; and Hogan, B. Date unknown. "Review of Bat Research at Wind Facilities," California Department of Fish and Game.

attractions or shutting down operations during migration seasons. These actions can increase operating costs or reduce project revenues.

Compensation for impacts can take many different forms and can be implemented either before or after construction is complete.[18] Compensation can be implemented through a fee (linked to project size or output), habitat enhancement, or approaches such as conservation easements.

Adaptive mitigation is an approach used in conjunction with monitoring and is designed to tie mitigation to impacts observed through an appropriate monitoring scheme. This approach helps reduce uncertainties and allows for better matching of mitigation to actual impacts since monitoring should reveal the type and extent of impacts better than pre-construction predictions. A monitoring program, however, has ongoing costs associated with it.

Finally, as with any facility, a plan should be developed for mitigating impacts of a wind generating system after its useful life is exceeded. An agreed-upon approach for removing or modifying the system would ensure that no long-term negative impacts are imposed. This approach is often implemented through a bond or escrow account method.

Land and Aesthetic Impacts. In addition to birds and wildlife, wind generation has been associated with land and aesthetic changes. Virtually all electricity generation technologies have some land and aesthetic impacts, but our focus here is on wind generation. For wind projects, these include possible loss of vegetation, soil erosion, and water quality; impacts on noise and light levels; and the interruption of skylines or scenic views. While each of these will vary by project and may be mitigated through planning efforts and appropriate siting, they are an important component in evaluating the externalities associated with wind power.

- *Loss of Vegetation, Soil Erosion, and Water Quality.* Though these activities will vary significantly between projects, the construction of access roads and support structures, and placement of wind turbines may result in a loss of vegetation to the surrounding areas and environments. Additionally, according to the National Wind Coordinating Committee (NWCC) report, "Permitting of Wind Energy Facilities: A Handbook," these activities may result in the loosening of soil which could make it susceptible to wind and water erosion, both of which could result in numerous ecological impacts. Drainage patterns may be disturbed, and runoff that is left uncontrolled could also negatively impact water and soil systems. The spillage of fuels used during construction and maintenance is a potential contributor to reduced water and soil quality.
- *Noise Levels*. According to the Department of Energy, "modern wind turbines are very quiet. The noise produced by a wind turbine is a combination of the 'swoosh' of the blades flying through the air and the hum from the gearbox and generator. The overall noise level has been compared to that of a modern refrigerator."[19] Cases have been made, however, that the noise levels generated by wind farms have been unacceptable to nearby

[18] The details of various compensation approaches are presented in: Flint, S.A. "Compensatory Mitigation," California Department of Fish and Game, presented September 27-28, 2006.

[19] U.S. Department of Energy Efficiency and Renewable Energy Wind and Hydropower Technologies, August 2003. State Wind Working Group Handbook.

residences. However, as reported in the on-line energy journal Inside Greentech a recent court decision found in favor of a large wind-farm that had a case filed against it for excessive noise levels.[20]

- *Light Levels*. Depending on the height of the turbine, the NWCC report states that the Federal Aviation Agency (FAA) may require "lighting and possibly marking . . . certain portions of the turbines installed in a wind project. More lights or markings may be required in installations near airports where the project may extend into the flight paths." In addition to possibly disrupting air traffic and attracting avian life, the location of the project could impact nearby residents.
- An additional nuisance may present itself in the form of "shadow flicker," as described in a January 2007 study.[21] This term describes the shadow that may be produced on nearby structures "when the turbine's blades interfere with very low-angle sunlight."
- *Skylines and Scenic Views.* The appearance of surrounding landscapes may be negatively impacted by the construction of wind farms, whether as the direct result of turbine placement, or due to the disruption of vegetation or natural land features through construction efforts and placement of access roads. The appearance of maintenance buildings and materials, as well as the turbines themselves, may be considered unappealing to some observers, especially when contrasted by the otherwise flat or uninterrupted surroundings which are often sought for turbine placement. [22]

Global Climate Change Effects on Hydroelectric System

According to the Northwest Power and Conservation Council's report, *The Fifth Northwest Electric Power and Conservation Plan*, "most global climate change models seem to agree that temperatures will be higher but they disagree somewhat on levels of precipitation." In fact, two predictions seem to exist for the future climate of the Northwest: hot and wet, or hot and dry. A hot-wet scenario could result in an increase in generation capabilities due to greater precipitation levels, while a hot-dry scenario could result in a reduction. However, the greatest impacts to the Columbia River Basin will likely be driven by temperature, not precipitation.[23]

Higher temperatures could reduce electric demand across the winter peak periods that typically see the highest consumption, but could also result in higher energy consumption over the

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20 Inside Greentech, December 2006. Wind energy scores major legal victory in U.S. http://www.insidegreentech.com/node/509

21 Bolton, R.H., January 2007. "Evaluation of Environmental Shadow Flicker Analysis for Dutch Hill Wind Power Project."

22 NWCC Siting Subcommittee, August 2002. "Permitting of Wind Energy Facilities: A Handbook."

23 Multiple sources echo this sentiment, including the California Energy Commission (CEC) report, The Potential Changes in Hydropower Production From Global Climate Change In California and the Western United States. June 2005 - Prepared in support of the 2005 Integrated Energy Policy Report Proceeding (Docket # 04-IEPR-01G), and the Northwest Power and Conservation Council report, The Fifth Northwest Electric Power and Conservation Plan, Appendix N. May 2005. Additionally, the CEC cites the Northwest Power and Conservation report in its presentation of findings, as well as J T Payne, AW. Wood, AF Hamlet, RN Palmer, and D P Lettenmaier "Mitigating the Effects of Climate Change on the Water Resources of the Columbia River Basin," Climatic Change, v.62, n.1-3, Jan 2004.

summer months. A warmer climate could also cause the snow that is crucial for the development of winter snowpacks to be replaced by rain. This is true for both the hot-wet and hot-dry scenarios. While this increase in rain would raise water levels during the peak energy use periods, the inability to form snowpacks as a result of a warmer climate could threaten generation capabilities for the spring and summer periods. Additionally, existing snowpacks would melt earlier in the season, reducing the runoff available during the summer months. Each of these issues would be further compounded in a hot-dry scenario.

Generation capabilities for the summer months may also be influenced by increased air-quality constraints enacted to address climate change concerns and by regulations governing salmon protection, which would be negatively impacted by increased water temperatures and decreased summer river flows.

Efforts to address climate change in utility resource planning processes have been fairly limited so far.[24] Most have been at the state level with states setting goals to reduce greenhouse gas emissions, and the focus has been largely on the development of renewable energy generation.

Carbon Capture and Storage

The process of carbon capture and sequestration includes a wide range of alternatives. Though not to be considered a replacement for the further development of more energy-efficient options, the process of capturing, compressing, transporting, and sequestering CO_2 has been demonstrated as well as researched. Multiple sequestration options exist, though not all are considered feasible or likely. The use of soils, vegetation, and ocean processes for the purpose of sequestration is technically possible, but have met with resistance, specifically within Kyoto Protocol negotiations. Discussed in much of the available literature, geologic sequestration is reported by Herzog as being "the most promising large-scale approach for the 2050 timeframe."[25] This option is usually referred to as carbon capture and storage (CCS) and has been investigated as an alternative to the release of CO_2 into the earth's atmosphere for many years. While economic and societal uncertainties exist, as a technology CCS appears promising. As described later, however, the CCS projects implemented to date are much smaller than needed for a typical power plant, and we were unable to locate any reliable estimates of when the technology would be commercially available for a conventional size power plant.

Carbon Capture. In their report, *Carbon Capture and Storage from Fossil Fuel Use*,[26] Herzog and Golomb define carbon capture as "the separation and entrapment of CO_2 from large stationary sources." They go further to establish three general carbon capture processes: flue gas separation, oxy-fuel combustion in power plants, and pre-combustion separation. They point out that "each of these technologies carries both an energy and economic penalty." It should also be noted that compression and transportation are additional components of this process.

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[24] One example we were able to find was Seattle City Light's efforts in its IRP process, described briefly at http://www.seattle.gov/light/news/issues/irp/docs/SCLIRP2006_chpt3.pdf

[25] Herzog, H. April 1, 2001. "What Future for Carbon Capture and Sequestration?," Environmental Science and Technology. Volume 35, Issue 7.

[26] Herzog, H. and D. Golomb. 2004. "Carbon Capture and Storage from Fossil Fuel Use," Contribution to Encyclopedia of Energy.

Drawing from a number of published case studies, research is available for carbon management practices used with conventional pulverized coal (PC) plants, natural gas-fired combined cycle (NGCC) plants, as well as coal-based integrated gasification combined cycle (IGCC) plants. The differences between the approaches that would be used with different types of power plants are notable. An EPA report notes that "it is generally accepted that the IGCC system, by removing most pollutants from the syngas prior to combustion, is capable of meeting more stringent emission standards than PC technologies."[27] The report further demonstrates that this technology results in a substantially reduced cost of carbon capture.

Geologic Sequestration. A recent report notes that " . . . potential deep geologic CO_2 storage sites exist around the world, although the distribution of these candidate storage sites is quite uneven."[28] The injection sites that are generally thought to have the greatest potential for geologic sequestration include depleted oil and gas reservoirs, unminable coal seams, and deep saline formations. The report by Dooley et al. estimates the potential global deep geologic CO_2 storage capacity to be nearly 11,000 $GtCO_2$ and, if other advanced energy technologies are developed and deployed, this potential capacity should be more than enough to meet global CO_2 storage needs for the 21st century.

Dooley et al. state that, in the United States, the potential for using CCS systems is large because 95% of the major CO_2 sources are within 50 miles of a candidate CO_2 reservoir. The Department of Energy is funding "more than 60 highly leveraged projects" on this technology. [29] Numerous CCS projects are already in place throughout the world or in the planning stage. Figure G.1. shows the status of planned or operational projects as of late-2005. The figure also displays the significant gap between the potential need for storage and the current status by showing the requirements of a single 1,000 MW IGCC power plant.

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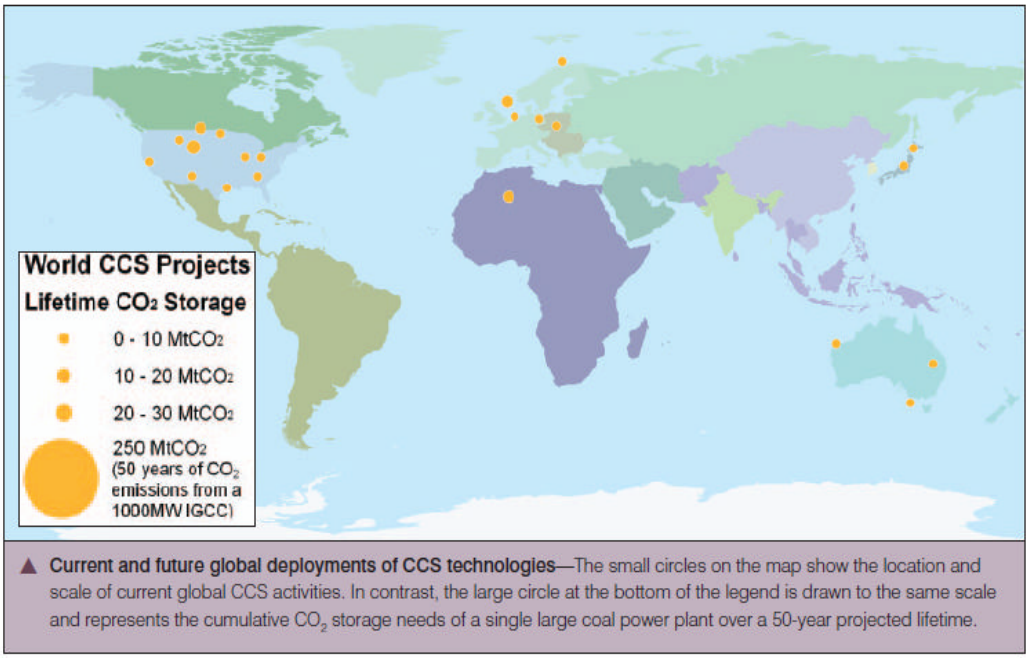
[27] United States Environmental Protection Agency (EPA), July 2006. Environmental Footprints and Costs of Coal-Based Integrated Gasification Combined Cycle and Pulverized Coal Technologies, EPA-430/R-06/006.

[28] Dooley, JJ, RT Dahowski, CL Davidson, MA Wise, N Gupta, SH Kim, EL Malone. 2006. Carbon Dioxide Capture and Geologic Storage. Global Energy Technology Strategy Program.

[29] U.S. Department of Energy (DOE). "Carbon Sequestration Research and Development." http://www.fe.doe.gov/programs/sequestration/cslf/sequestrationfactsheet_06_18.pdf

Figure G.1. Planned or Operational CCS Projects[30]



▲ **Current and future global deployments of CCS technologies**—The small circles on the map show the location and scale of current global CCS activities. In contrast, the large circle at the bottom of the legend is drawn to the same scale and represents the cumulative CO_2 storage needs of a single large coal power plant over a 50-year projected lifetime.

Carbon Capture and Storage Costs. Although numerous case studies exist, there are several issues that complicate the assessment of CCS costs. For one, the estimated costs are often for only part of the process (e.g., capture), and the results presented do not always clarify which parts are not included. Estimates are sometimes presented on a metric basis (per tonne, or 2,200 pounds) and other times on a short-ton (2,000 pounds) basis. Also, estimates are sometimes presented in terms of cost per unit of emissions removed and other times they are presented in terms of cost per unit of emissions avoided. The cost based on emissions avoided takes into account both the net emissions reduction and the incremental cost of generating electricity with the facility using the capture technology. Calculating capture costs using the avoided emissions approach appears to be the more comprehensive approach and can give results as much as 50% or more higher than calculated using the removal costs.

In addition to these complications, estimates of carbon capture costs are variable and subject to considerable uncertainty. According to a Union of Concerned Scientist's report, "Economic modeling studies are difficult to compare because of differing assumptions (such as discount rates or economic incentives to reduce emissions). Whatever cost estimates are available should thus be viewed as indicative of the order of magnitude rather than of presumed current cost."[31]

The EPA study cited earlier notes that, based on a review of several different plant types and technologies, "The costs per ton of CO_2 sequestration remain high for all cases, and the range of

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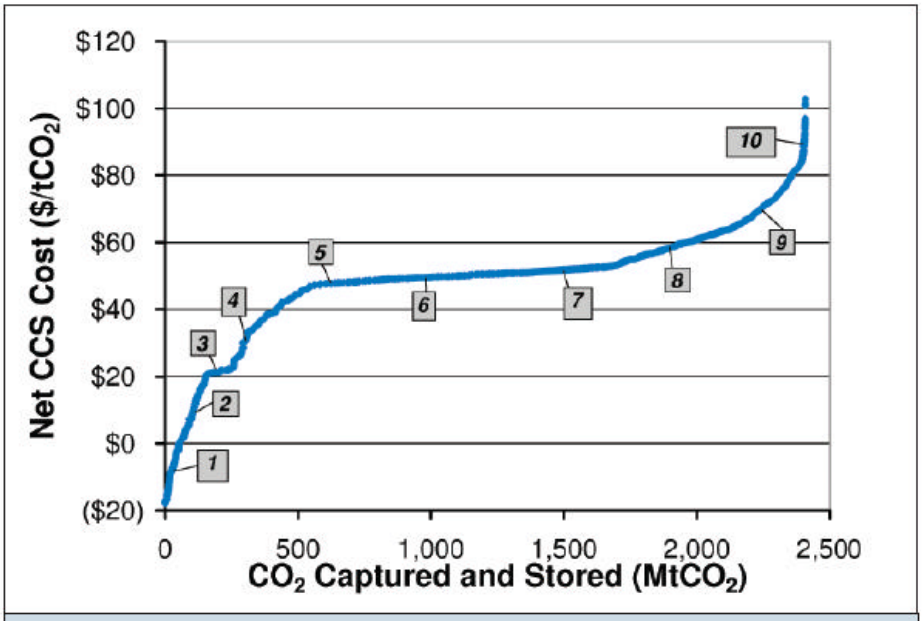
[30] Dooley, op. cit.

[31] Union of Concerned Scientists, 2001. Policy Context of Geologic Carbon Sequestration http://www.ucsusa.org/assets/documents/global_warming/GEO_CARBON_SEQ_for_web.pdf

estimates indicates a level of uncertainty that can only be reduced by the real-world construction of several plants." Dooley et al. presented levelized cost estimates for CCS applied to different types of sources as shown in Figure G.2. The costs relevant to handling emissions for power plants lie in the flat part of the curve, ranging from about $50 to more than $60 per ton. According to the authors, these costs reflect current technologies and they note that costs may come down as projects are implemented and technologies are improved. They also provided estimates of the net costs of the different components of the process. These are shown in Figure G.3 for the same ten generic projects identified in Figure G.2. Note that projects 1 through 3 have negative injection costs because they are defined to include the use of the injected CO_2 for enhanced oil recovery (EOR) or enhanced coal bed methane recovery (ECBM). These cost estimates are not based on the avoided emissions approach, so they do not include the incremental power generation costs. Given the fact that existing and planned storage projects are much smaller than the capacity needed to provide storage for a typical size fossil fuel power plant, it is difficult to assess the uncertainty of these cost estimates.

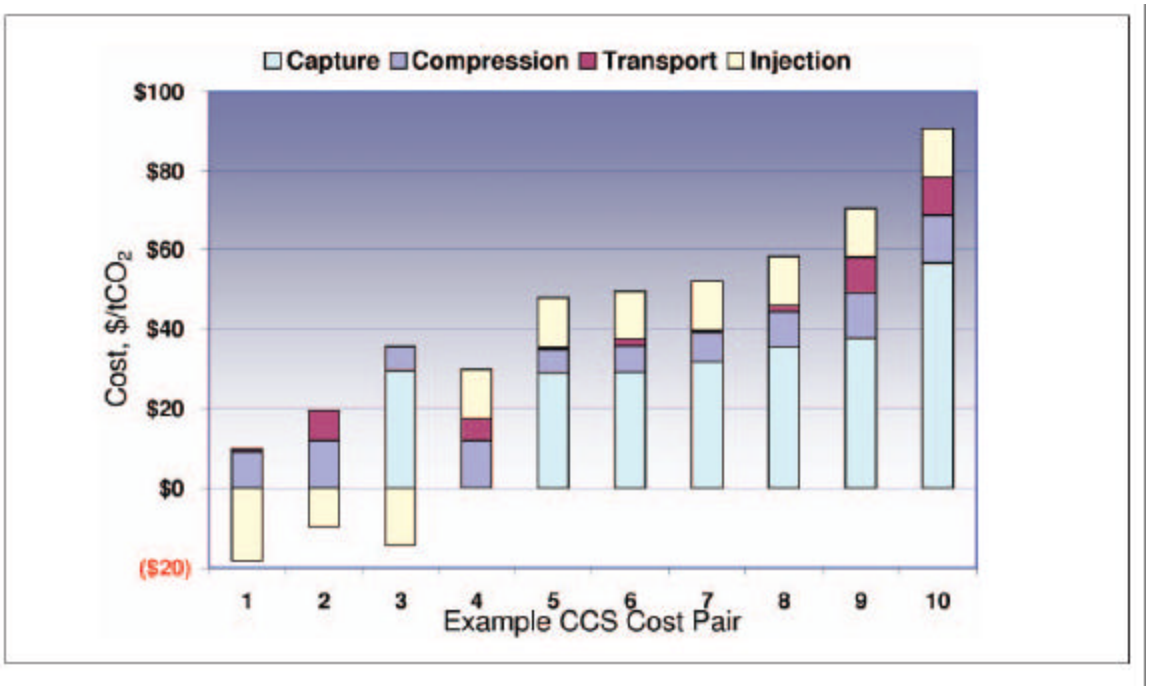
Figure G.2. Levelized Total CCS Net Costs for Million Tons per Year[32]



1	**High purity ammonia plant** / nearby (<10 miles) EOR opportunity
2	**High purity natural gas processing facility** / moderately distant (~50 miles) EOR opportunity
3	**Large, coal-fired power plant** / nearby (<10 miles) ECBM opportunity
4	**High purity hydrogen production facility** / nearby (<25 miles) depleted gas field
5	**Large, coal-fired power plant** / nearby (<25 miles) deep saline formation
6	**Coal-fired power plant** / moderately distant (<50 miles) depleted gas field
7	**Iron & steel plant** / nearby (<10 miles) deep saline formation
8	**Smaller coal-fired power plant** / nearby (<25 miles) deep saline basalt formation
9	**Cement plant** / distant (>50 miles) deep saline formation
10	**Gas-fired power plant** / distant (>50 miles) deep saline formation

[32] Dooley et al. op. cit. Note that Mt is million tons.

Figure G.3. Net Costs of CCS Process Components[33]



Issues and Concerns. According to one recent report: "The current understanding of science and technology for geological carbon sequestration supports these key conclusions:

- Sequestration can be executed safely
- In time, sequestration could effectively mitigate substantial emissions for many years
- Initial demonstration of sequestration, at scale, should be deployed with the highest priority.[34]

In a 2001 Union of Concerned Scientists report, however, multiple risks to humans and the environment were identified, some of which cannot be resolved through research.[35] These included:

- The potential for environmental risks to humans, such as catastrophic venting of CO_2, (i.e., the rapid re-release of stored gas in toxic concentrations from underground storage sites)
- The potential for potable aquifer contamination

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[33] Ibid.

[34] Herzog, H and J Katzer. 2006. The Future of Coal in a Greenhouse Gas Constrained World; Presented at the 8th International Conference on Greenhouse Gas Control Technologies, Trondheim, Norway, June 2006.

[35] Union of Concerned Scientists, 2001. *Policy Context of Geologic Carbon Sequestration* http://www.ucsusa.org/assets/documents/global_warming/GEO_CARBON_SEQ_for_web.pdf

- The possible risk of induced seismicity (earthquakes) due to underground movement of displaced fluid
- The yet-unknown permanence of underground carbon storage (i.e., the re-release of carbon dioxide), thus delaying, but ultimately not solving, the emission problem; given the energy penalty associated with carbon separation, if stored carbon is re-released to the atmosphere over time scales of years or decades, atmospheric carbon dioxide concentrations will increase
- The continued (and possibly increased) reliance on fossil fuels with the associated adverse environmental consequences at fossil-fuel extraction sites, particularly in ecologically sensitive areas
- The adverse environmental impacts associated with extensive expansion of pipeline facilities necessary for the transfer of CO_2 to deposition sites if implemented on a large scale
- The unknown impacts on the biological communities that live in deep saline formations and other storage sites

A lack of established regulations or standards for the sequestration of carbon results in a number of safety and legal uncertainties. According to a National Energy Technology Laboratory report,[36] the "two main legal and regulatory issues relating to the storage of CO_2 include how the CO_2 itself is defined or classified, which determines its legality and treatment under existing international treaties and national laws, and whether and how standards should be developed for well design at the storage site." The report goes on to say that:

> Standards for the measurement, monitoring, and verification (MMV) of injected CO_2 are crucial to any regulatory or legal framework for CCS (Carbon Capture Storage) because they provide for the collection of vital data on containment, reactivity of CO_2 with surrounding well materials, seismic activity, leakage, and long-term storage, which are necessary for establishing who is liable in the event of leakage or disruption.

Status of Policies and Programs for Addressing Externalities

Our overview of how externalities are being addressed was based on a review of the literature and telephone interviews with state utility regulatory staff. The most comprehensive studies of externalities were conducted in the early- to mid-1990s. Research into externalities, how to incorporate them in utility planning, and how to value them declined significantly once states started focusing on deregulating the electric utility sector in the mid-1990s.

Most recently, the emphasis has been on forecasting the market prices of air emission allowances under cap-and-trade type programs. Nevertheless, it is useful to review the earlier, as well as recent, literature and requirements to provide a full picture of how externalities have been addressed and how they might be treated in the future.

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[36] International Carbon Capture and Storage Projects Overcoming Legal Barriers, NETL, June 2006.

Past Analyses and Requirements

In 1995, the Energy Information Administration (EIA) published a comprehensive report summarizing the status of state externality requirements.[37] As of 1995, 32 states either had taken some steps toward incorporating consideration of externalities in law or regulations or had implemented specific requirements. Kansas was typical of those states where limited action had been taken; hearings were being held on proposed rules " . . . that require quantitative consideration to the extent feasible. Where externalities are not readily monetized . . . [the utility should] consider them on a qualitative basis."

For 19 states, there were requirements for quantitative assessment of externalities. The requirements ranged from using specific values to quantify the economic cost of specific externalities (California, Massachusetts, Minnesota, Nevada, New York, Oregon, and Wisconsin), to applying aggregate adders to generation costs and credits to energy efficiency (Vermont, Washington, Ohio, New Jersey, and Iowa), to specifying that some quantification was necessary, without setting specific values.

Other states required qualitative assessments, either instead of, or as an alternative to, quantification when it was not possible. These states included Delaware, Georgia, Hawaii, Illinois, North Carolina, and Wisconsin.

Another report published a little after the EIA report presented case studies of the treatment of externalities by utility commissions at the time, and summarized the status as follows:

> These case studies, as well as decisions from other jurisdictions, indicate that commission consideration of environmental externalities remains an incomplete and evolutionary process. To date, consideration of externalities has focused on the planning and/or acquisition of new generating capacity, unit life extensions, and DSM. A few states, such as Maine, Conn*ecticut, and Massachusetts, have begun to recognize the potential of market-based systems* of environmental regulation to achieve objectives that are both similar to and broader than that of commission externality considerations. Only limited attention, however, has been given to analyzing the best tools for internalizing environmental costs in utility resource planning and operations.[38]

As suggested earlier, the shift toward utility deregulation in the mid-1990s removed much of the basis for implementing integrated resource planning and, as a result, the avenue through which externalities had started to be considered in the resource planning process. One outcome was a refocusing on emissions regulations. By 2004, several states had enacted air emission regulations more stringent than federal regulations that would affect electricity generation, including Connecticut, North Carolina, Massachusetts, Maine, New Hampshire, New Jersey, New York,

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[37] Energy Information Administration (EIA). September 1995. Electricity Generation and Environmental Externalities: Case Studies. DOE/EIA-0598.

[38] Rose, K., P.A. Centolella, and B.F. Hobbs. June 1994. Public Utility Commission Treatment of Environmental Externalities. The National Regulatory Research Institute. NRRI-94-10.

and Oregon.[39] As of 2004, 16 states were considering proposed air emission regulations; most dealt with NO_x and SO_2, with greenhouse gas and Hg regulations emerging, including the following:[40]

- Connecticut: SO_2 (phased in) and NO_x emissions must meet pounds per million Btu input requirement and 90% of Hg must be removed by July 2008
- Maine: greenhouse gas emissions are required to decline over time
- Massachusetts: SO_2, NO_x, and CO_2 emissions must meet standards in pounds per MWh
- New Hampshire: SO_2, NO_x, and CO_2 emissions for existing fossil-fuel power plants are capped
- New Jersey: greenhouse gas emissions in terms of CO_2 must decline
- New York: SO_2 (phased in) and NO_x total emissions from power plants are capped
- New York's Environmental Board approved regulations in December 2006 requiring a 90% reduction in power plant mercury emissions by 2015
- North Carolina: existing coal-fired power plant total emissions of SO_2 (phased in) and NO_x are capped
- Oregon: CO_2 emissions for baseload gas plants, baseload gas plants with power augmentation, and non-baseload plants, must meet standards in pounds per kWh

In 2005, the Bush administration enacted the Clean Air Mercury Rules to cut mercury levels by 70% from 1999 levels. Toward that end, pollution levels would be cut from 48 tons/year today to 38 tons/year in 2010, to 15 tons in 2018. It would do this through a series of actions that include implementing a ceiling on emissions beginning in 2010 and establishing a cap-and-trade program.

At the national level, the Energy Policy Act of 2005 directed the National Academy of Sciences to conduct a comprehensive study,

> . . . to define and evaluate the health, environmental, security, and infrastructure external costs and benefits associated with the production and consumption of energy that are not or may not be fully incorporated into the market price of such energy, or into the Federal tax or fee or other applicable revenue measure related to such production or consumption.[41]

The information from this study could be directly useful in state and utility efforts to quantify externalities. However, this study has not received a funding appropriation, and it is uncertain when the funding will be appropriated.[42]

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39 Energy Information Administration. 2004. *Annual Energy Outlook 2004.*

40 Haq, Z. November 7, 2003. "Environmental Externalities and State Regulatory Initiatives," Energy Information Administration.

41 26 USC 41 note Sec. 1352.

42 Personal communication, December 5, 2006, Raymond Wassel, National Academy of Sciences.

There are six recent federal legislative clean air proposals that EPA has modeled. They include:[43]

1. Clean Air Planning Act (Carper, S.843 in 108th)
2. Clean Power Act (Jeffords, S.150 in 109th)
3. Clear Skies Act of 2005 (Inhofe, S.131 in 109th)
4. Clear Skies Act of 2003 (Inhofe/Voinovich at the Administration's request, S.485 in 108th)
5. Clear Skies Manager's Mark (of S.131 in 109th)
6. Clean Air Interstate Rule, Clean Air Mercury Rule, and the CleanAir Visibility Rule

Among other things, EPA modeled the future allowance prices for the pollutants covered. They cover a wide range depending on the legislative requirements. Representative values are presented in Table G. 1. and Table G.2. .

Current State Requirements

Information on current state requirements for the treatment of externalities was compiled from a variety sources. One excellent source of information was the reports produced by The Regulatory Assistance Project (RAP) (http://www.raponline.org). RAP surveys the states, and regularly updates their database of state policies for long-range utility planning. Within that survey, they ask a few questions specifically about the treatment of externalities. We supplemented this information through a review of other documents and telephone interviews with knowledgeable representatives from each of the states.

California. As of late 2005, California was addressing greenhouse gases (GHG) through the use of a GHG adder, which required utilities to assume an additional $8 per ton of carbon dioxide added to the bid price of all fossil fuels. The $8 was not charged, but was factored into the utility's decision-making process for portfolio planning and modeling, and in procurement bids for both supply-side and demand-side resources. The $8 per ton was expected to increase over time and was designed to reflect the cost of climate change to California, as well as reduce the risk associated with fuels likely to face increasingly stringent environmental regulation in the future. Other adders were being considered, but had not been implemented. Climate change and air pollution were being addressed through several mechanisms in place to discourage the use and dispatch of generation that produced these pollutants.

In 2006 and 2007, California took additional steps that affect GHG emissions. The Public Utilities Commission implemented an interim GHG emissions performance standard as a result of Senate Bill 1368, which prohibits load-serving entities (LSEs) from entering into a long-term financial commitment for baseload generation unless it complies with a GHG emissions performance standard. LSEs include investor-owned utilities, energy service providers, and

[43] The original internet reference is no longer available, but a cached versions is at: http://72.14.253.104/search?q=cache:2DOwoty_hVcJ:www.epa.gov/airmarkets/mp/index.html+multi-pollutant+legislative+protection+agency&hl=en&ct=clnk&cd=1&gl=us

community choice aggregators. The performance standard is set at the level produced by a combined cycle gas turbine plant.

As of September 2006, California began to implement a new approach. Through California's AB 32, which was adopted by statute, the state started the process of establishing statewide requirements that apply to the electric utility sector as well as others, designed to set ceilings on GHG emissions. The law does not limit the requirements to CO_2, but instead is intended to affect all GHG emissions wherever they are generated, based on their CO_2 equivalence as greenhouse effect contributors. California's law establishes a load-based cap approach for electric utilities, which caps emissions associated with the electricity sold by providers at the customer level and, consequently, targets emissions reductions regardless of where they are generated.

The law defines greenhouse gases to include methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, as well as CO_2. It also requires GHG emissions to be reduced to 1990 levels by 2020. The statute authorizes the Air Resources Board to adopt market-based compliance mechanisms defined as either of the following:

1. A system of market-based declining annual aggregate emissions limitations for sources or categories of sources that emit GHG.
2. GHG emissions exchanges, banking, credits, and other transactions, governed by rules and protocols established by the [Air Resources Board],[44] that result in the same GHG emission reduction, over the same time period, as direct compliance with a GHG emission limit or emission reduction measure adopted by the state board pursuant to this division.

The effect of this change will be to internalize the cost of reducing GHG emissions, rather than treating GHG as an externality in planning activities.

Hawaii. The incorporation of externalities has been discussed since the early 1990s in Hawaii, but a formal methodology for identifying or quantifying the values has not been established.

Hawaii's electric utilities are required to submit IRPs to the Public Utilities Commission under the IRP Framework adopted in 1992. The Framework instructs utilities to include consideration of indirect or external costs and benefits in their assessments. External costs and benefits include the impact on the environment, on people's lifestyles and cultures, and on Hawaii's economy. To the extent possible and feasible, these costs and benefits must be quantified and expressed in dollar terms. When it is neither possible nor feasible to quantify a cost or benefit, the cost or benefit must be addressed qualitatively.

Idaho. Idaho utilities are required to file IRPs every two years, but no specific externality requirements are set forth for the plans. Risks are assessed, however, and utilities typically consider the risks associated with carbon tax proposals. Other types of environmental risks are usually not addressed.

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[44] California Assembly Bill No. 32, Chapter 488, filed September 27, 2006.

Iowa. In Iowa, supply planning and energy-efficiency planning are conducted through two different processes. There is no requirement to consider externalities in the supply planning activity.

On the demand side, energy-efficiency planning is required on a regular basis. This planning is similar to an IRP, but supply-side resources are examined only to develop cost effectiveness thresholds by determining avoided costs. To address externalities a 10% adder is applied to supply costs. Specific environmental impacts are addressed in the siting process.

Minnesota. Starting in 1994, the Minnesota Public Utilities Commission began requiring utilities to include externalities in their resource plan analyses. Most utilities use present value of revenue requirements in evaluating various scenarios and they are required to take into account environmental cost values as determined by the PUC. Values were established for NO_x, CO, CO_2, lead, and particulates (PM10). Originally there was a value established for SO_2, but once the allowance trading program began the PUC decided that those costs had been internalized and no longer required an adder. The initial values were established based on damage costs and are updated annually.

Mercury and radioactive emissions are not assigned a value. Mercury has been treated qualitatively. Water, land, and socioeconomics are treated on an implicit basis. For power plants sited in-state, an environmental impact analysis is required and the full range of impacts can be considered in this process. Wind generators above 5 MW currently must be permitted at the state level, but the state is considering raising this threshold to 25 MW so that plants smaller than this would be subject to local siting processes.

Montana. The RAP report from September 9, 2005, summarized the Public Service Commission (PSC) requirements in Montana, and a phone interview with a PSC representative indicated that the requirements have not changed since. Two regulated electric utilities serve Montana and both are required to conduct long-range resource planning, though the requirements differ some for the two utilities (restructured utilities are subject to less explicit treatment of externalities and their planning process is referred to as portfolio planning).

The IRP rules require use of both the total societal cost test and total resource cost test, and an explicit quantification of environmental externalities. The objective is to minimize societal costs. Under the IRP rules, the one utility covered is required to adjust the cost for each resource to reflect externalities, but there are no rules or statutes setting the values to be used.

There has been one long-range plan completed since 2005, and the utility used two different values for CO_2 costs in its analysis. The PSC provided comments on this analysis suggesting that the utility use an approach more in line with that employed by the Northwest Power and Conservation Council that takes into account the probabilities of different values.

Nevada. No significant changes have occurred since the last RAP survey in May 2006. Utilities are required to file IRPs and to assess both the alternative options based on the present worth of revenue requirements (PWRR) and the present worth of societal cost. A study filed in 2006 provides forecasts of externality costs associated with three air emissions – CO_2, NO_2, and Hg –

under cap-and-trade market assumptions.[45] The two major electric IOUs in Nevada use specific values to quantify the environmental costs associated with SO_x, NO_x, CO, PM, and VOC.[46]

Other air emissions and externalities are not explicitly valued in the IRP process because there are considered to be too many uncertainties associated with them. These impacts, including land, water, and other air quality impacts, are typically addressed through state, federal, or local regulations as part of the siting process.

Oregon. Oregon established utility least-cost planning requirements in 1989. The latest activity by the Public Utility Commission (OPUC) noted that the term 'integrated resource planning' is being used now to describe the required process because it more clearly takes into account risks and uncertainties.[47]

The OPUC established the IRP requirements through Order No. 93-695, which included specific approaches and values for the assessment of CO_2, NO_x, SO_x, HG, and total suspended particulates (TSP). Utilities were directed to include compliance costs for these externalities in their base case and sensitivity analyses. The latest proceeding (Order No. 07-002) reiterated the requirement but eliminated the requirement to analyze TSP. The OPUC has very recently initiated a proceeding to address how CO_2 risk should be treated in the IRP process.[48]

At the executive policy level in Oregon, Governor Kulongoski established the Governor's Advisory Group on Global Warming, and adopted a goal of arresting the growth of greenhouse gas emissions by 2010, to reduce the greenhouse gas emissions to ten percent below 1990 levels by 2020, and to reduce them to levels 75 percent below 1990 emissions by 2050. The advisory group issued its report, *Oregon Strategy for Greenhouse Gas Reductions,* in late 2004 and one of its recommendations was that the "Governor create a special interim task force to examine the feasibility of, and develop a design for, a load-based allowance standard. This standard would reduce total amounts of CO_2 and other GHG emissions due to consumption of electricity, petroleum and natural gas by Oregonians in a deliberate, predictable, effective, equitable and verifiable manner." [49] On December 15, 2006, the task force issued its majority proposal, which called for a load-based approach similar to California's and a requirement that the "OPUC consider the IOUs' requirements to comply with the CO_2 cap in its rate-making decisions and integrated resource plan acknowledgments, including the prudency of IOU actions to comply with the cap." It is uncertain at this time how these recommendations will translate into policies and regulations, but they suggest the direction in which Oregon is likely to go.

Utah. Utah established an IRP process in 1992 (Docket No. 90-2035-01 in regards to PacifiCorp) and the associated IRP Standards and Guidelines require utilities to consider a range of demand forecasts as well as future uncertainties, including the risk of future internalization of

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[45] This information is available at http://pucweb1.state.nv.us/pucn in Docket 06-06051, Technical Appendix 2, vol. 2, item 17. *Environmental Costs and Economic Benefits of Electric Utility Resource Selection*, prepared by NERA Economic Consulting, June 2006.

[46] No information was available to clarify exactly which particulates (PM) werer specified.

[47] Oregon Public Utility Commission (OPUC) Order No. 07-002, UM 1056, January 8, 2007.

[48] Docket Number UM 1302, Investigation into the Treatment of CO_2 Risk in the IRP Process

[49] http://www.oregon.gov/ENERGY/GBLWRM/docs/CATF_Proposal.pdf

environmental costs. The utility must also identify who bears the risks under each scenario, the shareholders or the ratepayers. As part of this process, utilities are required to look at externalities and, if there are known costs associated with them, then they are required to submit those; however, if it is unknown whether or not legislation will be in place regarding a particular externality then it must be included on a risk assessment basis.

The Public Service Commission's (PSC) approach aims to balance concerns about externalities against those about increasing the costs of electricity to ratepayers from selecting resources that may have higher generation costs because they have less externalities. The PSC order noted above stated that, by applying their approach, "higher cost resources would be acquired when it is in the interests of [the utility] and its ratepayers to reduce the risks associated with future regulations." The PSC has provided no estimates of the values of externalities that should be included in utility studies.

Vermont. Externalities are addressed in both the Vermont IRP and transmission and distribution planning process (DUP). All projects are subject to Vermont Public Service Board (VPSB) approval, and externalities are reviewed qualitatively on a case-by-case basis. They can be used for screening of DSM projects and when evaluating supply resources. In the IRP process, a 5% adder is currently applied to all supply options other than energy efficiency and renewables. A value of $0.007/kWh is used to encompass externalities in the DUP, but this is a general figure and may not be used or appropriate for all projects. The cap-and-trade systems have complicated the issue of determining externalities, especially with regard to CO_2.

In a docket from 2002, the VPSB addressed the planning issues for Vermont distribution utilities, and provided a set of externality adjustments. In a memorandum of understanding from that proceeding,[50] specific externality and risk adjustments were presented; but the MOU allowed the parties to revisit these values over time and revise them as appropriate. In the MOU, a risk adjustment of negative ten percent for energy efficiency costs was specified and CO_2 emissions were valued at $19/ton (2002$). The MOU provided externality values for NO_x, SO_2, PM10, and CO as well.

Washington. Washington has had utility least-cost planning requirements in place for several years. In 2006, they made some modest changes to the requirements and extending them to public utilities, which had not been covered under the original requirements. Under current state regulations, both public utilities and IOUs are required to develop or update an IRP by September 1, 2008, and to provide complete updates at least every four years thereafter.[51] The IRP must be based on meeting current and projected needs at the "lowest reasonable cost" defined as,

> . . . the lowest cost mix of generating resources and conservation and efficiency resources determined through a detailed and consistent analysis of a wide range of commercially available resources. At a minimum, this analysis must consider

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[50] http://publicservice.vermont.gov/dockets/6290/6290MOU6%20-%20FINAL.PDF

[51] Revised Code of Washington. January 2007. RCW 19.280.030 Development of a resource plan – Requirements of a resource plan.

> resource cost, market-volatility risks, demand-side resource uncertainties, resource dispatchability, resource effect on system operation, the risks imposed on the utility and its ratepayers, public policies regarding resource preference adopted by Washington state or the federal government, and the cost of risks associated with environmental effects including emissions of carbon dioxide . . . . [52]

There are no specific requirements for how the environmental effects are to be taken into account. However, other regulations specifically require that owners of power plants now located in, or to be constructed in, Washington develop and submit approved carbon dioxide mitigation plans for site certification.[53] Legislation also has been proposed to extend a similar requirement to power obtained from a power plant located out-of-state.[54]

The carbon mitigation requirements can be met in one of three ways: (1) payment to a third party to provide mitigation, (2) direct purchase of carbon credits, or (3) investment in applicant-controlled carbon dioxide mitigation projects. The regulations establish a rate of $1.60/metric ton ($1.45/short ton) for payments to third-party mitigators, and the rate can be adjusted by the state as often as biennially, taking into account the current market price for CO_2.

Wyoming. Wyoming has no state utility resource planning requirement and, consequently, no process in place for valuing externalities. As of February 2007, the state legislature was considering establishing a resource planning requirement under HB 12. However, the Bill failed in the Senate after adverse amendments were adopted.

Regional Greenhouse Gas Initiatives

Western Regional Climate Action Initiative. In February 2007, the governors of five Western states announced a joint effort to reduce GHG emissions. The five states – Arizona, New Mexico, Oregon, Washington and California – agreed that, during the coming 18 months, they would devise a market-based program, such as a load-based cap-and-trade program to reach the target. The five states also agreed to participate in a multi-state registry to track and manage GHG emissions in their region.

The Western Regional Climate Action Initiative builds on existing greenhouse gas reduction efforts in the individual states as well as two existing regional efforts. In 2003, California, Oregon, and Washington created the West Coast Global Warming Initiative, and in 2006, Arizona and New Mexico initiated the Southwest Climate Change Initiative.

California already had a law establishing a comprehensive system of regulatory and market mechanisms to achieve its targets, and the regional agreement signaled an intent to create such a comprehensive system region-wide. The new agreement closely mirrors the Regional Greenhouse Gas Initiative (RGGI) discussed below.

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[52] Revised Code of Washington. January 2007. *RCW 19.280.020 Definitions*

[53] Revised Code of Washington. January 2007. RCW 80.70.020 Applicability of chapter—Carbon dioxide mitigation plan—Mitigation by a third party

[54] Washington House Bill 2156.

Regional Greenhouse Gas Initiative *(RGGI)*. One of the most noteworthy programs for addressing greenhouse gases is the RGGI. This was the first plan of its kind in the U.S. to order absolute reductions in carbon dioxide. Connecticut, New York, New Jersey, Delaware, Maine, New Hampshire, Vermont, and Massachusetts are participants in the initiative.

RGGI calls for its member states to cut CO_2 emissions from large electric power plants 10% by 2019 and to create a market through which permits to emit the gas will be traded like any commodity. RGGI caps power plant emissions at roughly present levels beginning in 2009, then lowers the cap. Plants exceeding their cap must buy extra permits or pay a penalty, while plants reducing emissions can sell their surplus permits. Each state must draft regulations to comply with the RGGI rules. A critical decision that has not been made yet is how each state will distribute its annual allotment of CO_2 permits, which could be worth more than $700 million.

The RGGI and California's approach appear to be at the cutting edge of efforts pursued by the states. They are likely to inform any federal approach that is developed in the future.

Externality Values

The treatment of externalities in the U.S. electricity sector has evolved over time. The initial approach was essentially to ignore externalities (basically, valuing them at $0) and to treat primarily direct environmental impacts during the siting or permitting process. This was followed by attempts to reflect externalities in resource planning by applying generic multipliers in the analysis process. In the mid-1990s, major attempts were made to quantify the economic value of externalities based on approaches such as the cost of damages or mitigation. These values were used by a few states in the process of assessing alternative resources, but the values were never incorporated in the price of electricity as real costs. The most recent trend is to begin internalizing at least some of the externalities through market mechanisms based on caps that decline over time.

Until market mechanisms are in place and actual market prices are known, it is useful to document the values that have been used in recent proceedings.[55] Based on a study in 2006, seven of 12 utilities in the western U.S. had included GHG risk in their last round of resource plans, representing 30% of the electricity supply in the region. In the next round, ten of the 12 will be required to include analysis of CO_2 in their plans, representing 42% of electricity supply.[56]

Estimates of the emission cost value for CO_2 vary widely. One recent presentation indicated reduction costs ranging from less than $2/ton of CO_2 (forestry and land use) to well over $50/ton (solar, nuclear, and sequestration).[57] This same source documented marginal cost and market

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[55] Note that we did not attempt to adjust the costs obtained from the literature to constant dollars because the final inflation rates that PacifiCorp will use in its next IRP were not available.

[56] Goldman, C. and N. Hopper. June 2006. *Review of Utility Resource Plans in the West*, Lawrence Berkeley National Laboratory, http://www.raponline.org/Slides/CGNH-IRPWest-06-06.pdf

[57] Swisher, J. 2005. "Status of CO_2 Emission Adders for Utility Planning in California and Other States." Rocky Mountain Institute. http://www.aceee.org/conf/05ee/05eer_jswisher.pdf

trading prices ranging from $5/ton to $69/ton, with a median value of $17/ton and a discounted present value of the stream of costs of about $8/ton in 2004.

Table G. 1. presents the values we compiled from a number of sources including RAP reports, state and utility documents, and interviews with state officials. The table indicates when the estimate was made, the year to which the price applies, and the reference year for the dollars quoted when this information was available. Note that, because of the various ways in which the values are reported and the frequent lack of detailed information on whether the values are constant or nominal dollars, it is difficult to compare the estimates on a consistent basis.

Table G. 1. CO_2 Emission Cost Values from Recent Sources[58]

Entity	CO_2 ($/ton)
States	
California	$8 (2005)
Nevada	See NERA study below
Oregon	$10 to $40 (OPUC) (1990$) $15 (Energy Trust of Oregon) (2005)
Washington	$1.45 (2007)
Minnesota	$0.36-$3.76 (2005)[a]
Vermont	$19 (2002)
Utilities	
Avista	$25 (2010); $62 (2023) (2010$)[59]
Idaho Power	$58 max.; $20 weighted avg. (2003$)[60]
Northwestern Energy	~$10 and ~$30 (2006)
PG&E	$0 to $9 (2005$)[61]
PGE	$53 max.; $4 weighted avg. (2003$)[62]
PSE	$11 max. (2003$)[63]
Xcel-PSCo	$9 (2010, escalate 2%/yr) (2005$)
Studies	
Federal Clean Power Act, Jeffords S.150[64]	$16 (2010); $27 (2020) (1999$)
NERA (for Nevada Power Co.)[65]	$6.08(2010); $7.63 (2020) (2006$)
Synapse[66]	2010: $0 low, $5 med., $10 high 2020: $10 low, $25 med., $40 high 2030: $20 low, $35 med., $50 high Levelized: $8.5 low, $19.6 med., $30.8 high (2005$)

[a] Value depends on location.

Table G.2. presents recent estimates of values for other externalities. Note that Oregon originally specified a value of $2,000 to $4,000 for TSP, but has eliminated this pollutant from consideration. As with the values for CO_2, there are considerable variations in the values that depend on the method used to derive them, when they were established, and the reference year.

58 Goldman, C. and N. Hopper. June 2006.

59 Johnston, L. et al. May 18, 2006. Climate Change and Power: Carbon Dioxide Emissions Costs and Electric ity Resource Planning. Synapse Energy Economics, Inc.

60 Goldman, C. and N. Hopper. June 2006.

61 Johnston, L. et al. May 18, 2006

62 Goldman, C. and N. Hopper. June 2006.

63 Goldman, C. and N. Hopper. June 2006.

64 Modeled by U.S. Environmental Protection Agency

65 Harrison, D. et al. June 2006. *Environmental Costs and Economic Benefits of Electric Utility Resource Selection*. Prepared for Nevada Power Co. by NERA Economic Consulting.

66 Johnston, L. et al. May 18, 2006.

Table G.2. Cost Values for Other Pollutants ($/ton)

Entity	SO_2	NO_x	Hg	Pb	PM10	CO
States						
Oregon[67]	- - -	$2,000-$5,000 (1990$)	- - -	- - -	- - -	- - -
Minnesota (2005)[a]	$0	$450-$1,187	- - -	$3,799-$4,702	$5,414-$7,793	$1.29-$2.75
Nevada	See NERA study below-		See NERA study below-	- - -	- - -	- - -
Vermont (2002)	$1,357	$5,747	- - -	- - -	$7,025	$766
Utilities						
Sierra Pacific[a 68]	$5.60-$65.75 (2003$ SO_x)	$5.60-$65.75 (2003$)	- - -	- - -	$5.60-$65.75 (2003$)	$0-$65.75 (2003$)
Studies						
Federal Clean Power Act, Jeffords S.150[69]	Assumed $0 as a result of CO_2 trading	Assumed $0 as a result of CO_2 trading	No trading assumed	- - -	- - -	- - -
Federal Clear Skies, Inhofe S.131[70]	$741 (2010) $1,246 (2020) (1999$)	$219 (2010) $368 (2020) West US (1999$)	$931 (2010) $1,567 (2020) (1999$)	- - -	- - -	- - -
NERA (for Nevada Power Co.)[71]	$640(2007) $1,039(2020) (2006$)	- - -	$1,716(2010) $2,637(2020) (2006$)	- - -	- - -	- - -

a Value depends on location.

67 These values are from OPUC Order No. 93-695, UM 424.

68 From filing to Nevada Public Utilities Commission.

69 Modeled by U.S. Environmental Protection Agency

70 Modeled by U.S. Environmental Protection Agency

71 Harrison, D. et al. June 2006.