CHAPTER IV. ELECTRIC AND NATURAL GAS CONSERVATION POTENTIAL ASSESSMENT

A. Overview

Developing reliable estimates of the magnitude, timing, and price of alternative energy-efficiency resources is a critical first step in a least-cost, integrated resource planning process. These estimates also help to guide and inform demand-side planning and inform conservation program development efforts.

This chapter summarizes the results of an assessment of technical and achievable electricity and natural gas conservation potentials in Puget Sound Energy's service area for the 2004-2023 planning horizon. The assessment was performed for PSE as a collaborative effort between the consulting firms of KEMA-XENERGY and Quantec LLC. (The consultants' complete report is appended to this document.) The principal goal of this study was three-fold:

1. Developing reasonable and reliable estimates of "technical" and "achievable" electricity and gas conservation potentials among the residential, commercial and industrial customers served by Puget Sound Energy (PSE);
2. Employing a simple, flexible, and transparent analytical approach consistent with the methods used by the Northwest Power and Conservation Council, and relying mainly on available data from secondary regional sources; and
3. Creating discrete "bundles" of conservation potential composed of homogeneous groups of conservation measures, and providing supply curves for each bundle in a manner which would allow energy conservation options to be directly evaluated and compared with supply options in PSE's integrated resource planning process.

Estimates of long-term conservation potentials provided in this report are based on standard analytical practices and methods in the utility industry, using the best available data. Studies such as this rely heavily on assumptions concerning the future. Changes in energy-efficiency technologies, market conditions, and consumer behavior are likely to affect these results. The results are also sensitive to changes in load forecasts. It is, therefore, inevitable that the findings in this report will have to be reconsidered periodically to take into account the impacts of emerging technologies and the changing dynamics of the energy markets.

B. Methodology

The overall approach in this study was based on the recognition that conservation potential comprises two distinct, yet interrelated, definitions widely used in resource planning: 1) "technical potential", and 2) "achievable potential." Technical potential assumes that all conservation measures are installed regardless of cost or market barriers. In deriving estimates of technical potential, we distinguish between "instantaneous" and "phased-in" definitions of technical potential. *Instantaneous technical potential* assumes immediate retrofit in existing buildings and full installation of efficiency measures at the time of new construction. *Phased-in technical potential* assumes system replacement only upon burnout or normal retirement of existing equipment. This distinction has important implications for the planning and timing of how conservation resources are acquired over time, as described in section E, below. It is important to note that, in the long run (such as with the 20-year plan developed by PSE), the two estimates of "technical potential" energy savings converge. Thus the 2023 technical potential estimates developed in this study can be viewed as either instantaneous or phased-in.

"Achievable potential" is defined as that portion of the potential that is likely to be available over the planning horizon under prevailing market barriers and administrative constraints that hamper delivery or implementation of energy-efficiency measures. In estimating the achievable potential, a 15% conservation program administration and delivery cost adder was applied to each measure/bundle combination, resulting in minor shifts of the price-quantity relationships (supply curves) within the technical potential bundles. This adder is consistent with past PSE program experience. Second, likely penetration rates, derived from industry literature, previous planning efforts conducted by KEMA-XENERGY and Quantec, and PSE's previous programmatic experiences as recorded in the company's tracking system, were used to derive estimates of achievable potential. These estimates take into account the company's ability to ramp up programs and customers' willingness to adopt measures assuming incentives fully cover all incremental conservation measure costs.

Estimates of technical potential for the residential and commercial sectors were derived using a "bottom-up" approach, an industry-standard methodology used widely both by energy utilities in the country and by the Northwest Power and Conservation Council. The "bottom-up" approach begins with compiling a comprehensive list of conservation measures applicable to each sector and end-use, calculating the savings potential for each measure, and aggregating measure-specific savings to derive total savings potential. For each measure, the approach integrates measure-specific data (per-unit costs, absolute and relative savings, impacts by time period) with baseline building-stock data (base-case fuel saturations, measure-applicability factors, current measure saturations) and baseline energy-use data to produce estimates of levelized costs per unit of energy saved.

Conservation potential in the industrial sector was analyzed using an alternative, “top-down” approach. This was due to the more complex nature of the industrial market, its end-uses, and its equipment, as well as the lack of reliable information on measure-specific saturations. The top-down approach involved two steps. First, total firm industrial loads were disaggregated into standard classes and major end-uses within each class, based on PSE’s latest sales data. Second, for each end use, we estimated potential savings and per-unit cost of the potential savings, relying on available data from a large number of industrial energy-efficiency programs in the Northwest and California, and on market information on PSE’s customers available from PSE industrial-accounts representatives.

An accurate assessment of conservation potential requires that base conditions closely approximate the historical sales and the load forecast. In this study calibration was achieved by (1) calibrating end-use estimates to PSE’s sector-level, weather-normalized, per-customer sales for the 2002 calendar year, and (2) by applying projections of customer counts through 2023, from the customer forecast in PSE’s April 30, 2003 Least Cost Plan. To the extent that the long-term forecast changes (e.g., changes in projected number of customers), the estimates of conservation potential will also change.

Appropriate treatment of fuel conversion, particularly with regard to space- and water-heating applications in the residential and commercial sectors, represents an additional consideration in the development of dual-fuel conservation potentials. This study did not explicitly take into account conservation potentials based on fuel conversion.

C. Data Sources

Implementation of the methodology described above required compilation of a large database of measure-specific technical and market data from both primary and secondary sources. Given the accelerated schedule for completion of this study, we relied mainly on data available from secondary regional and national sources. The main sources used in this study included, but were not limited to, the following:

- ***Puget Sound Energy*:** Loads and load forecasts, load shapes, economic assumptions, residential appliance saturation studies (RASS), 1994 commercial building survey, 2002 commercial building stock assessment.
- ***Pacific Northwest Studies*** by the Northwest Power and Conservation Council, Regional Technical Forum, Northwest Energy Efficiency Alliance, Tacoma Public Utilities, and the Northwest Energy Coalition; data elements included technical measure information, measure costs, measure savings, measure life, market saturations.
- ***California Studies*** sponsored by the California Measurement Advisory Council, which includes Pacific Gas and Electric, Southern California Edison, San Diego Gas and Electric, Southern California Gas under the auspices of the California Energy Commission and the California Public Utilities Commission; data elements included measure costs and savings, measure applicability factors, technical feasibility factors, etc.
- ***Other Data Sources*:** Including previous conservation potential and energy-efficiency market studies by KEMA-XENERGY, Quantec LLC, and others.

D. Summary of the Results

Technical conservation potentials in the residential and commercial sectors were derived from an analysis of 125 unique electric measures, and 60 unique gas measures. As a preliminary screen, only measures that were judged to be commonly available and based on well-understood technology were included in the analysis. Six residential segments (existing single-family, existing multi-family, existing manufactured homes, new single-family, new multi-family, new manufactured homes) and 20 commercial segments (10 building types within both the existing and the new structure segments) were considered. Since many conservation measures may be applied to multiple segments and building types, a total of 1,630 electric and 610 gas measure/structure combinations were included in the analysis. All major end uses in all 15 major industrial segments in PSE's service area were analyzed.

Based on the results of this study, cumulative 20-year technical conservation potentials in PSE's service area are estimated at 1,016 average megawatts (aMW) of electricity savings and 45,708,939 decatherms of natural gas savings, of which 328.3 aMW (32 percent) and 10,788,029 (24 percent) are expected to be achievable. The estimated achievable savings represent 10.8 percent of PSE's electric load and 9.3 percent of projected gas use over the

20-year planning period. Cumulative, long-run technical and achievable conservation potentials are shown in Exhibit IV-1 and Exhibit IV-2 for electricity and natural gas respectively.

As shown in Exhibit IV-1, the residential sector accounts for the largest share of achievable electricity savings (176 aMW), followed by the commercial sector's achievable savings potential of 143 aMW over 20 years. The industrial sector accounts for 9.2 aMW of achievable electricity savings during the same period.

Exhibit IV-1
Long-Run Electric Technical and Achievable Potential

Sector	Total 2023 Baseline Load[1] (aMW)	20-Year Cumulative Potential (aMW and % of Baseline)	
		Technical	Achievable
Residential	1,538	525.7	176.0
		34.2%	11.4%
Commercial	1,331	471.8	143.1
		35.4%	10.7%
Industrial	179	18.4	9.2
		10.3%	5.1%
Total	3,048	1,016.0	328.3
		33.3%	10.8%

Estimates of natural gas conservation potential by sector are reported in Table IV-2. The largest share of achievable natural gas potential appears to be in the residential sector, which accounts for nearly 76 percent of total achievable natural gas savings. The commercial and industrial sectors respectively account for 22 percent and 2 percent of the achievable potential.

[1]From PSE April 30, 2003 Least Cost Plan load forecast.

Exhibit IV-2
Long-Run Natural Gas Technical and Achievable Potential

Sector	Total 2023 Baseline Load[2] (Decatherms)	20-Year Cumulative Potential (Decatherms and % of Baseline)	
		Technical	Achievable
Residential	81,319,163	39,383,771	8,223,569
		48.4%	10.1%
Commercial	29,562,290	5,880,506	2,342,129
		35.4%	10.7%
Industrial	4,789,020	444,662	222,331
		9.3%	4.6%
Total	115,670,473	45,708,939	10,788,029
		39.5%	9.3%

Distributions of achievable electricity savings in the residential and commercial sectors by end use are shown in Exhibits IV-3 and IV-4. As can be seen, in the residential sector, upgrade and replacement of appliances with energy-efficient technologies provide the largest opportunity for acquisition of conservation resources. Savings in this end use represent approximately 42 percent of all achievable electricity savings in the residential sector. The results also show that about 32 percent of achievable savings in the residential sector may be obtained through the application of energy-efficient lighting technologies, primarily compact fluorescent light bulbs and fixtures. The remaining savings can be achieved through the implementation of water-heating measures (16 percent) and HVAC measures (10 percent)

In the commercial sector, lighting represents the largest potential for electricity savings. Nearly 74 percent of potential electricity savings in the commercial sector are attributable to the application of energy-efficient lighting. Retrofit, upgrade, and better operation and maintenance of HVAC equipment are also shown to be effective conservation measures, accounting for over 23 percent of the total electricity savings potential in this sector. Appliances (plug loads) and water heating measures together account for about 3 percent of total commercial-sector electricity savings.

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[2]From PSE April 30, 2003 Least Cost Plan load forecast.

As shown in Exhibit IV-5, expected savings in space heating is the largest component of the achievable natural gas conservation potential in the residential sector, accounting for nearly 67 percent of the gas savings potential. Upgrade of heating equipment with alternative, more energy-efficient equipment provides the main source for the potential savings. Study results also show that installation of more efficient water heaters and measures that improve the performance of existing water heaters account for over 39 percent of the gas conservation potential in the residential sector.

As Exhibit IV-6 illustrates, space heating, water heating and cooking conservation measures provide the largest potentials for gas savings in the commercial sector. These measures respectively represent 39.6 percent (space heating), 34 percent (water heating), and 25.8 percent (cooking) of the total achievable gas conservation potential in the commercial sector. Upgrade to miscellaneous gas appliances accounts for a relatively small share of the total gas savings potential in this sector.

Exhibit IV-3

Distribution of Achievable Electric Conservation Potential by End-Use Residential Sector

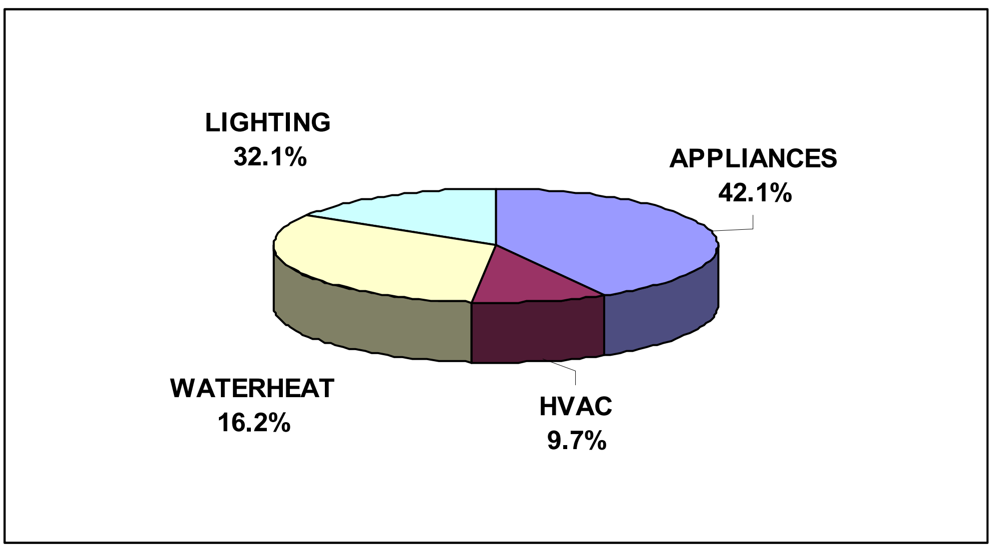


Exhibit IV-4
Distribution of Achievable Electric Conservation Potential by End Use
Commercial Sector

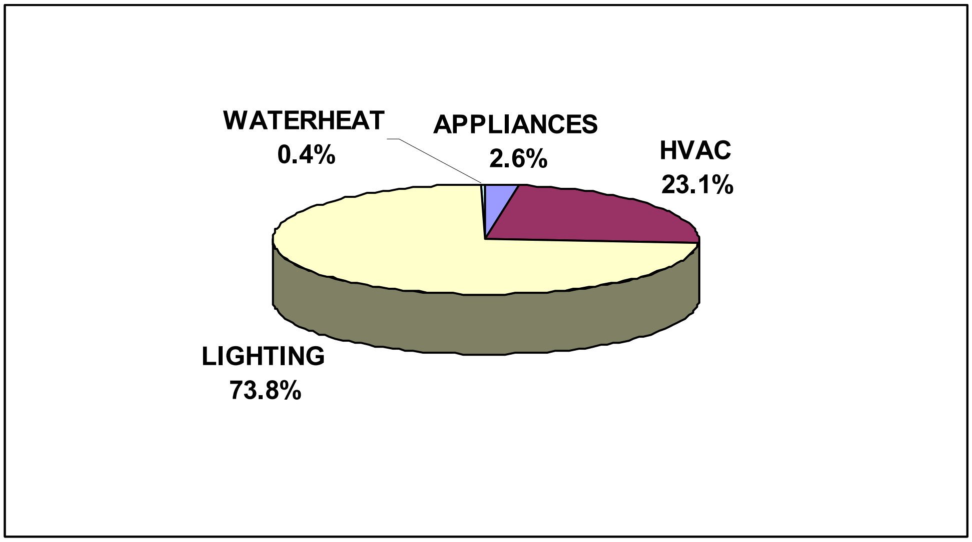
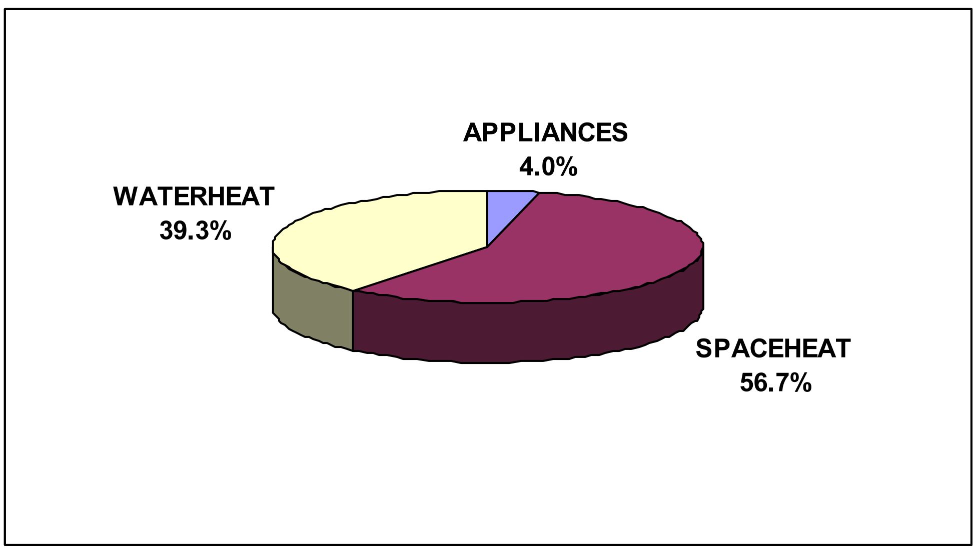


Exhibit IV-5
Distribution of Achievable Natural Gas Conservation Potential by End Use
Residential Sector

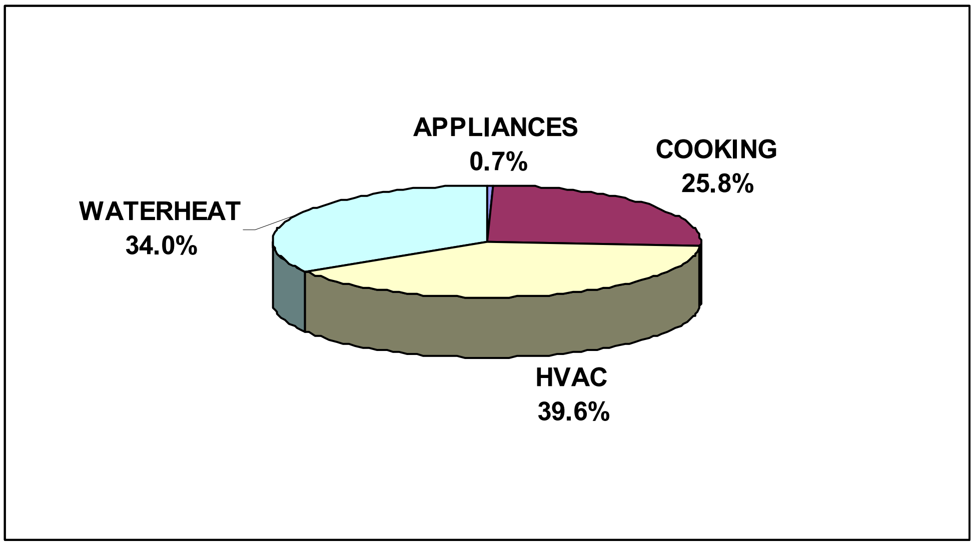


E. Conservation Resource Portfolios

While an accurate assessment of achievable conservation potential was an important objective of this study, an equally paramount consideration was to construct portfolios of electric and natural gas conservation resource options that could be compared with and evaluated against supply options on a balanced and consistent basis.

To facilitate the incorporation of the results of this study into PSE's least-cost, integrated resource planning process, estimates of electricity and natural gas conservation potential for each sector were disaggregated into distinct cost-based "bundles" of conservation resource. Four "bundles" were created for each fuel by grouping together conservation measures with similar cost and load-shape characteristics. For each fuel and sector, up to five resource cost categories were considered.

Exhibit IV-6
Distribution of Achievable Natural Gas Conservation Potential
Commercial Sector



Electric and gas measures with costs above the thresholds of $0.11/kWh or $1/therm were not considered economic or achievable. The composition of electric and natural gas resource portfolios and their associated cost ranges are shown in Exhibits IV-7 and IV-8. A more detailed breakdown of the electricity and natural gas conservation resource bundles by market segment is presented in Exhibits IV-9 and IV-10.

As shown in Exhibit IV-7, nearly 56 percent of achievable electricity savings in the residential sector, 33 percent of the achievable savings in the commercial sector, and all potential savings in the industrial sector fall in the lowest cost category, Cost Level A. With respect to natural gas, conservation potentials are more evenly distributed across the four cost categories, particularly in the residential sector (see Exhibit IV-8). Again, a significant portion of potential conservation in the residential (32.6 percent) and commercial (52.4 percent) sectors and all potential savings in the industrial sector fall in the low-cost resource category (Cost Level A).

Exhibit IV-7
20-Year Cumulative Technical and Achievable Electric Potential by Sector and Cost Groups

	Residential 20-Year Potential (aMW/Cost Group as % of Total)		Commercial 20-Year Potential (aMW/Cost Group as % of Total)		Industrial 20-Year Potential (aMW/Cost Group as % of Total)		Total 20-Year Potential (aMW/Cost Group as % of Total)	
	Technical	**Achievable**	**Technical**	**Achievable**	**Technical**	**Achievable**	**Technical**	**Achievable**
Cost Level A	225.4	97.8	105.4	46.6	18.4	9.2	349.3	153.7
(</=$0.03/kWh)	53.5%	55.6%	34.9%	32.6%	100.0%	100.0%	47.1%	46.8%
Cost Level B	33.9	2.0	89.1	39.6	-	-	123.1	41.6
($0.03-0.045/kWh)	8.1%	1.1%	29.5%	27.7%	0.0%	0.0%	16.6%	12.7%
Cost Level C	21.2	24.1	61.2	33.7	-	-	82.3	57.8
($0.045-0.06/kWh)	5.0%	13.7%	20.3%	23.6%	0.0%	0.0%	11.1%	17.6%
Cost Level D	70.9	40.0	25.3	15.4			96.3	55.4
($.06 - .085/kWh)	16.8%	22.8%	8.4%	10.7%	0.0%	0.0%	13.0%	16.9%
Cost Level E	69.7	12.0	20.7	7.8	-	-	90.4	19.8
($0.085-0.11/kWh)	16.5%	6.8%	6.9%	5.5%	0.0%	0.0%	12.2%	6.0%
Total Up to $0.11/kWh	421.1	176.0	301.7	143.1	18.4	9.2	741.3	328.3

Exhibit IV-8
20-Year Cumulative Technical and Achievable Natural Gas Potential by Sector and Cost Groups

	Residential 20-Year Potential (Decatherms/Cost Group as % of Total)		Commercial 20-Year Potential (Decatherms/Cost Group as % of Total)		Industrial 20-Year Potential (Decatherms/Cost Group as % of Total)		Total 20-Year Potential (Decatherms/Cost Group as % of Total	
	Technical	**Achievable**	**Technical**	**Achievable**	**Technical**	**Achievable**	**Technical**	**Achievable**
Cost Level A	5,116,161	2,681,181	2,627,962	1,227,305	444,662	222,331	8,188,785	4,130,817
(</=$0.3/therm)	33.2%	32.6%	54.8%	52.4%	100.0%	100.0%	39.6%	38.3%
Cost Level B ($0.3-	2,341,164	1,445,086	1,054,087	300,781	-	-	3,395,251	1,745,867
.45/therm)	15.2%	17.6%	22.0%	12.8%	0.0%	0.0%	16.4%	16.2%
Cost Level C ($0.45-	2,181,009	1,503,636	866,307	729,379	-	-	3,047,316	2,233,015
.65/therm)	14.1%	18.3%	18.1%	31.1%	0.0%	0.0%	14.7%	20.7%
Cost Level D ($0.65-	5,794,673	2,593,666	249,538	84,664	-	-	6,044,211	2,678,330
1.00/therm)	37.5%	31.5%	5.2%	3.6%	0.0%	0.0%	29.2%	24.8%
Total Up to $1 / therm	15,433,008	8,223,569	4,797,894	2,342,129	444,662	222,331	20,675,564	10,788,029

Exhibit IV-9
Achievable Electricity Conservation Potentials by Resource Bundle and Segment
(Cumulative aMW 2004-2023)

Bundle/Segment	**Cost Level A** *(<=$0.03/kWh)*	**Cost Level B** ($0.03-0.045/kWh)	**Cost Level C** ($0.045-0.06/kWh)	**Cost Level D** ($0.06-0.085/kWh**)**	**Cost Level E** ($0.085-0.11/kWh**)**	**Total Achievable Potential**
Res. Ex. Const. – Appliances	29.2	-	18.2	19.9	0.1	67.4
Res. Ex. Const. – HVAC	8.4	1.8	2.0	3.2	0.8	16.2
Res. Ex. Const. – Lighting	32.7	-	-	-	0.3	32.9
Res. Ex. Const. – Water Heat	4.7	-	-	12.5	0.5	17.7
Res. New Const. – Appliances	-	-	1.2	3.5	2.0	6.7
Res. New Const. – HVAC	-	-	0.2	0.6	-	0.8
Res. New Const. – Lighting	23.0	0.2	-	0.3	-	23.5
Res. New Const. – Wtr. Heat	-	-	2.5	-	8.4	10.8
Subtotal Residential	97.8	2.0	24.1	40.0	12.0	176.0
Com. Ex. Const. – HVAC	7.0	2.9	6.0	5.6	2.9	24.4
Com. Ex. Const.- Lighting	28.2	32.3	24.1	6.9	3.2	94.8
Com. Ex. Const. – Plug Loads	1.7	0.2	0.4	0.3	0.3	2.9
Com. Ex. Const. – Water Heat	0.2	0.1	0.1	0.1	0.0	0.4
Com. New Const. – HVAC	2.3	1.1	1.9	2.0	1.4	8.7
Com. New Const. – Lighting	6.7	2.9	1.1	0.3	0.0	10.9
Com. New Const. Plug Loads	0.5	0.1	0.1	0.1	0.0	0.8
Com. New Const. – Wtr. Heat	0.1	0.0	0.0	0.0	0.0	0.2
Subtotal Commercial	46.6	39.6	33.7	15.4	7.8	143.1
Ind. Existing Const. – General	9.2	-	-	-		9.2
Total All Sectors	153.7	41.6	57.8	55.4	19.8	328.3

Exhibit IV-10
Achievable Gas Conservation Potentials by Resource Bundle and Segment
(Cumulative Decatherms 2004-2023)

Bundle/Segment	**Cost Level A** (</=$0.3/ therm)	**Cost Level B** ($0.3-0.45/therm)	**Cost Level C** ($0.45-0.65/therm)	**Cost Level D** ($0.65-1.00/therm)	**Total Achievable Potential**
Res. Existing Construction - Appliances	-	-	-	199,062	199,062
Res. Existing Construction - HVAC	2,292,015	485,777	17,933	1,319,257	4,114,982
Res. Existing Construction - Water Heat	389,166	402,822	753,004	227,488	1,772,480
Res. New Construction - Appliances	-	-	-	127,193	127,193
Res. New Construction - HVAC	-	-	-	550,215	550,215
Res. New Construction - Water Heat	-	556,487	732,699	170,452	1,459,638
Subtotal Residential	2,681,181	1,445,086	1,503,636	2,593,667	8,223,570
Com. Existing Const. - Appliances	10,310	-	-	3,187	13,497
Com. Existing Construction - Cooking	279,629	-	267,348	11,376	558,353
Com. Existing Construction - HVAC	417,348	228,400	121,530	28,069	795,347
Com. Existing Const. - Water Heat	379,030	22,996	230,898	16,025	648,949
Com. New Construction - Appliances	1,743	-	-	-	1,743
Com. New Construction - Cooking	462	24,138	21,162	426	46,188
Com. New Construction - HVAC	68,300	1,023	41,106	21,212	131,641
Com. New Construction - Water Heat	70,483	24,224	47,335	4,369	146,411
Subtotal Commercial	1,227,305	300,781	729,379	84,664	2,342,129
Ind. Existing Construction – General	222,331	-	-	-	222,331
Total All Sectors	4,130,817	1,745,867	2,233,015	2,678,331	10,788,030

F. Electric Conservation Resource Acquisition Cases

In assessing long-run conservation resource potentials, the timing of how conservation resources are acquired over time has significant ramifications for the integrated resource planning process. Since a large portion of conservation potential – especially savings from retrofit and replacement opportunities – may be considered a finite resource, the amount of conservation available in any given time period depends on how much of the resource was acquired in earlier periods. The timing for the acquisition of conservation resources must also take into account practical administrative and logistical considerations, as well as potential market barriers.

In this analysis, we considered three cases for acquisition of achievable electric conservation resources:

- Case 1: Constant Rate of Acquisition Case. This case assumes that electric conservation resources would be acquired in equal annual proportions over the 20-year planning horizon, which for PSE equates to 16.4 aMW per year across all achievable potential cost categories.

- Case 2: Accelerated Lighting Case. Under the accelerated lighting case, we assume that conservation resource acquisition for residential and commercial lighting retrofit measures would be accelerated through a two-year ramp-up, continue at 22.8 aMW per year during years three to ten, then gradually ramped down during years eleven and twelve to a level of 10 aMW per year for years thirteen through twenty. All savings associated with applicable measures would be acquired with aggressive marketing during the first twelve years of the plan. It is important to note that only the retrofit portion of the existing customer potential may be subject to accelerated acquisition. In Case 2, the residential administrative-cost adder is increased from 15% to 50%, and the commercial administrative-cost adder is increased from 15% to 30%.

- Case 3: Accelerated All Retrofit Case. Under the accelerated all retrofit case, we assume that conservation resource acquisition for all residential and commercial electric retrofit measures – including lighting, HVAC, water heating, and appliances – would be accelerated via the same ramp-up / ramp-down strategy as Case 2, with the same administrative-cost adders. In Case 3, the acquisition of conservation potential ramps up to 25.5 aMW per year for years three to 10, then down to 7.1 aMW per year for years thirteen to twenty.

The results of these three cases are shown graphically in Exhibits IV-11 and IV-12.

Exhibit IV-11
Conservation Resource Acquisition Cases, Cumulative aMW

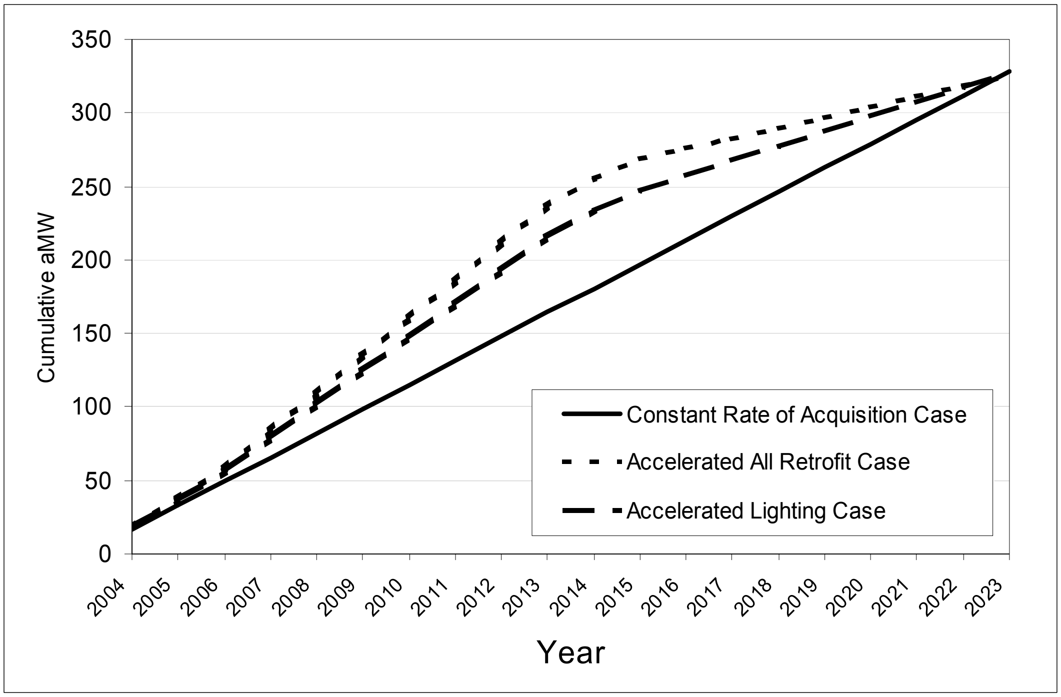


Exhibit IV-12
Conservation Resource Acquisition Cases, Incremental aMW