NW Natural 2018
Energy Efficiency Plan

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1 SUMMARY

The following plan outlines how NW Natural plans to save 365,145 therms across its energy efficiency programs. These savings are expected to cost $2,664,405.

2018 EE Plan Summary		Annual Therms Goal	Annual Cost
Incentive Program	Commercial Program	160,000	$918,575
	Residential Programs	199,880	$1,335,690
Low Income	WA-LIEE	5,265	$109,091
Market Transformation	NEEA	N/A	$141,049
Pilots	Pilots	N/A	$70,000
Evaluation	Evaluation	N/A	$90,000
Efficiency Offerings Total		**365,145**	**$2,664,405**

2 PART I – Background

2.1 History

Northwest Natural, dba NW Natural ("NW Natural" or "Company"), began offering its current energy efficiency programs to Washington customers on October 1, 2009. The Washington Utilities and Transportation Commission's ("WUTC's") Order No. 04 in the Company's 2008 rate case, docketed as UG-080546, directed the Company to create and begin offering a program.

The Company's energy efficiency programs were developed and continue to evolve under the direction and oversight of the Energy Efficiency Advisory Group ("EEAG") which is comprised of interested parties to the Company's 2008 rate case.

The Company began using Energy Trust of Oregon ("Energy Trust") as the delivery arm for its Oregon energy efficiency incentive program in 2003. Since the Company's Washington service territory is contiguous with its Oregon territory, it made sense in 2009 to have Energy Trust extend the boundaries of the Oregon incentive program offerings into Washington.

As agreed to in UG-080546, Energy Trust implemented the Company's incentive program for one pilot year. During this time, the EEAG monitored the program's performance and assessed whether Energy Trust should be the ongoing incentive program implementer. On May 25, 2011, NW Natural made a compliance filing in UG-080546 wherein it stated the EEAG's opinion to allow Energy Trust to continue delivering the Company's energy efficiency incentive programs in Washington. On June 8, 2011, Public Counsel separately filed a letter supporting this decision.

2.2 Oversight

The EEAG includes representatives from NW Natural, Energy Trust of Oregon ("Energy Trust"), Washington Utilities and Transportation Commission ("WUTC") Staff, Public Counsel, Northwest Industrial Gas Users ("NWIGU"), The Energy Project, and the NW Energy Coalition.

2.3 Program Delivery

The Company's programs are currently delivered to customers through partnerships and contracts with third parties.

The incentive program is offered through Energy Trust. Energy Trust is an independent, nonprofit organization dedicated to helping utility customers save electric and gas energy. Energy Trust was formed in 2002 in response to Oregon legislation that restructured electric utilities[1] for multiple reasons, including allowing non-residential

[1] SB 1149, codified as ORS 757.612, mandated the creation of an independent entity capable of providing demand side management services to utility customers.

customers to purchase their electricity from providers other than the utility and reassigning the responsibility for demand side management from utility operations to Energy Trust.

The Washington Low Income program (WA-LIEE) including outreach and delivery is provided through local community action agencies. The local community action agencies are Clark County Community Action Agency serving Clark County and Washington Gorge Action Programs serving Klickitat and Skamania Counties.

Market Transformation efforts are a regional collaborative effort administered by the Northwest Energy Efficiency Alliance ("NEEA") with funding from multiple utilities. The Company's funding is provided indirectly through Energy.

2.4 Energy Efficiency Programs Offered

2.4.1 Incentives Program

2.4.1.1 Residential Program Description

Residential programs in southwest Washington acquire cost-effective gas savings by engaging with builders and homeowners. This program engages with builders to increase energy efficiency of newly constructed homes through incentives, education, trade and program ally support and quality assurance. For single-family and small multifamily homeowners, incentives are available for the following energy saving efforts:

- efficient space heating and controls
- water heating
- insulation
- windows
- water conservation and behavioral actions
- education
- trade ally support
- financing with repayment through utility bills
- market interventions

Specific measure offerings and details are as listed in Appendix 1 and Appendix 2.

There are four tracks within the Residential Incentive program, Standard, Multifamily, Mid-stream and New Homes.

2.4.1.2 Residential Standard Track (Existing Homes)

Residential customers with gas heated homes are offered incentives for cost-effective weatherization measures and certain efficient gas appliances. On-line home energy reviews are available wherein an energy use estimation tool identifies incentives and qualifying insulation and weatherization measures that could be installed to improve the efficiency of customers' homes.

2.4.1.3 Residential Multifamily Track

Residential customers in multifamily buildings are offered a specialized subset of the Residential Standard Track incentives. Due to the usage profile of Multifamily buildings, there are unique measures within this sub sector. Condos, townhomes, duplexes, triplexes and fourplexes and stacked units qualify for incentives for the approved measures.

2.4.1.4 Residential Mid-stream (Supply Chain) and Products Track

Mid-stream focuses efforts and incentives toward distributors to encourage them to promote the sale of efficient equipment to residential customers. Products strategy focuses on retail engagement to promote efficient natural gas appliance and fixtures.

2.4.1.5 EPS New Homes Track

The EPS New Homes program encourages builders to construct homes to an energy efficiency standard that is at least 10% better than Washington building code. The Company offers an energy performance score that rates the efficiency of a home and measures it against similar-sized homes built to 2015 Washington State Residential Energy Code. Qualifying new homes must also meet new construction Best Practice criteria established by the New Homes Program. The compliance of all new homes is verified through an inspection process and homes are issued a scored, called an EPS, upon completion.

2.4.1.6 Commercial Program Description

The Commercial program provides natural gas energy-efficiency solutions for existing commercial buildings. Commercial customers of NW Natural in Washington can receive incentives for qualifying energy-efficient upgrades and retrofits. The program incentivizes select measures in existing and new commercial buildings, including office buildings, restaurants and other foodservice buildings, dormitory and assisted living facilities, greenhouses and multifamily structures. Specific measure offerings and details are as listed in Appendix 1 and Appendix 2.

The Washington Existing Buildings program consists of two tracks, custom and standard.

2.4.1.7 Commercial Custom Track

The Custom Track acquires gas savings through incentivizing energy efficient capital projects and operations and maintenance upgrades in complex and non-standard situations. Program Management Contractor account managers and engineering firms identify and promote customer opportunities. The custom track also pursues opportunities in retrocommissioning, which features targeted incentives for operations and maintenance improvements such as controls or HVAC adjustments.

2.4.1.8 Commercial Standard track

The Commercial Standard track provides incentives for standard measures with predetermined savings for buildings of all sizes and across all commercial market

sectors. The program promotes measures through customer outreach and cultivation of trade ally contractors.

2.4.2 Low Income

Under NW Natural's low-income energy efficiency program, agencies administering the program leverage other funding sources with WA-LIEE dollars to provide whole-house weatherization services to qualifying customers. Program details are available in the Company's Schedule I, "Washington Low Income Energy Efficiency Program (WA-LIEE)."

2.4.3 Market Transformation

The Company views the regional gas market transformation initiative led by the Northwest Energy Efficiency Alliance (NEEA) as a necessary investment in the future of gas demand side management (DSM) and as an enduring component of regional power planning. NEEA's primary work on behalf of the Pacific Northwest is focused on two strategic goals: 1) bring energy efficient emerging gas technologies to market, and 2) create the market conditions that will accelerate and sustain the market adoption of energy efficient emerging gas technologies. NEEA uses a stage-gate approach to manage its work. Below are the six phases that a technology would go through to fully achieve the two goals and result in a sustained market change that provides gas savings.

Prior to the market development phase, NEEA works on:

- Scanning for new technologies (shown in the graphic above as "scanning and concept identifications")
- Researching and assessing both the market and technology conditions and savings potential (through the concept opportunity assessment and market and product assessment stages)
- Developing and testing the market intervention strategy for the technology and developing cost effectiveness models which produce long term cost effectiveness metrics and energy savings forecasts (both part of strategy testing and finalization)

The purpose of these phases is to develop additional efficiency measures and strategies over the long-term that will further the cost-effectiveness and reliability of savings and programs by acquiring savings at market scale. At each stage, the assessment of the potential for long-term cost-effective savings is refined**.** NEEA does not typically forecast savings associated with these earlier phases. These first four phases (of the graphic) are

where most of the activity has been in the early years of the NEEA gas collaborative. Significant savings begin in the fifth stage, Market Development.

2.4.4 Pilots

The company may offer pilots from time to time to test and evaluate new program opportunities. Pilots should have defined objectives or purposes and will be limited in duration. Pilot plans should follow the same EEAG review process as new measures.

2.5 Cost Effectiveness Standards

2.5.1 UCT: Utility Cost Test

The Company utilizes the UCT to evaluate the cost effectiveness of the incentive program. The UCT measures the present value of the energy savings in relation to the net costs incurred by the incentive program, including incentive costs and excluding any net costs incurred by the participant. The UCT measures utility benefits divided by utility costs where each is defined as follows:

Utility Benefits are:

The value of gas energy saved based on the Company's avoided costs. The Company's avoided costs include the following values:

- Gas Price Forecasts
- Supply and Distribution Capacity Costs
- Washington State Carbon Policy Adder
- Risk Reduction Value
- 10% Power Act Credit

Utility Costs are:

- Incentives paid to, or for the benefit of, the participant;
- Administrative costs; and
- Evaluation, verification, and monitoring.

2.5.2 TRC: Total Resource Cost Test

The Company will continue to monitor and report how the portfolio fares using the Total Resource Cost (TRC) Test. The TRC includes all quantifiable costs and benefits regardless of who accrues them. This includes participant and others' costs. The TRC Test a calculation of total present value of total resource benefits divided by total resource costs when each is defined as follows:

Total Resource Benefits include:

- The value of gas energy saved based on the Company's avoided costs. The Company's avoided costs include the following values:
    - Gas Price Forecasts
    - Supply and Distribution Capacity Costs
    - Washington State Carbon Policy Adder

  - Risk Reduction Value
  - 10% Power Act Credit
- Non-energy benefits as quantified by a reasonable and practical method; and
- The 10% credit for the benefits of conservation in addressing risk and uncertainty as well as unquantified environmental benefits.

Total Resource Costs are:

- Incentives paid to the participant;
- Administrative costs;
- Evaluation, verification, and monitoring; and
- The participant's remaining out-of-pocket costs for the installed cost of the measures after incentives and Federal tax credits.

2.5.3 NSPM: National Standard Practice Manual

The Company may investigate the opportunities provided by NSPM methodology which is "intended to provide a comprehensive framework for assessing the cost-effectiveness of energy efficiency resources." Any change to Cost Effectiveness test will be vetted through the EEAG process.

2.5.4 Levelized Cost Metric

The levelized cost is the present value of the total net cost of a measure over its economic life, converted to equal annual payments. The levelized cost calculation starts with the incremental capital cost of a given measure or package of measures. The total cost is amortized over an estimated measure lifetime using the discount rate established in the Company's most current IRP. The annual net measure cost is then divided by the annual net energy savings (therms) from the measure application (again relative to a standard technology) to produce the levelized cost estimate in dollars per therm saved, as illustrated in the following formula.

$$Levelized\ Cost = \frac{Net\ Annual\ Cost\ (\$)}{Net\ Annual\ Savings}$$

The levelized cost of an energy efficiency measure is cost-effective if it is less than the average levelized costs of other supply-side options. A cost-effective threshold is established in the Company's most current IRP and further refined through the BCR test.

2.5.5 Avoided Cost

The avoided cost calculation from the 2017 EE Plan included a new natural gas price forecast (as outlined in the 2016 Integrated Resource Plan[2]) and captured the hedge value of demand side management as well as supply and distribution capacity avoided costs. The avoided costs also include: 1) expected impact to natural gas customers from

[2] The relevant pages are 4.8-4.13 and all of Chapter 5.

national carbon policy and 2) expected impact of incremental carbon policy from Washington State. Avoided cost for 2018 measure and program planning remained the same as those used in 2017. Avoided costs may be updated in 2018 for 2019 measure and program planning. The most recent avoided costs are used to retroactively review the cost-effectiveness of the current program year.

The Company will adaptively manage and make improvements to the avoided cost calculation methodology as necessary. Continuing work on the avoided cost calculation further refines the true avoided cost for Washington customers by identifying how energy savings on peak help avoid or delay investment in capacity resources.

2.6 Program Evaluation, Monitoring and Verification

2.6.1 Impact Evaluations

Annual savings reported by the Company are based on the assumed gross savings for each measure. The assumed savings is consistent with the most current impact studies performed on the programs and measures. The company or third parties are utilized to perform impact studies wherein customers' energy usage data is analyzed before and after a measure is installed. The savings from all measures are evaluated on a frequency as deemed appropriate by the Company based on accepted practice, program activity, staff resources and evaluation priorities (unless sample sizes based on participation rates are not statistically significant.) From the impact evaluation, a determination is made by the Company if evaluated savings are consistent with assumed savings. If they are not, the claimed savings are "trued-up" by the program implementer to reflect the relevant evaluation findings. A link to the true up report as well as a short summary of the results will be provided in the quarterly report following the report's release.

2.6.2 Process Evaluations

The Company or program delivery contractor may, as appropriate, contract with a third party to perform process evaluations on a subset or all energy efficiency programs, WA-LIEE, pilots and other efforts offered. The third party studies and reports on the processes employed for each program with recommendations for improvement. A link to annual process evaluations, as well as a short summaries of the results, will be provided in quarterly reports following the report's release.

2.7 Process for Program Changes

The Company considers if incentive program year changes are needed when reviewing Unit Energy Savings (UES) Measure List (Appendix 1) prior to filing the Plan each year. If the UES Measure List needs an offering added, changed, or removed, the Company will revise this Plan to make requested program modifications when it makes its annual advice filing, submitted no later than December 1, to revise the performance metrics and budget that are also included in this Plan. This does not preclude the Company from filing to revise Schedule G or its EE Plan or Appendices at any time during the year. Advice filings revising or adding measures will include:

1) A benefit-cost ratio ("BCR") calculation as outlined in Section 2.5 "Cost Effectiveness"; and

2) For new measures, a summary of the vetting of a measure before it is introduced as a program offering. The EEAG will be given the opportunity to review all tariff filings before they are filed. The Company will generally give the EEAG ten business days to review a draft filing. The EEAG's review process will not be less than five business days.

3) New programs proposed mid-cycle will include a program-specific plan addressing the possible need for program-specific metrics.

4) For Pilots previously budgeted or with no additional budget impact, no filing will be required. The EEAG will be given the opportunity to review the offering before implementation if not previously outlined in the "Pilot Program" section. The Company will include summary notes in the appropriate report following the completion of any Pilots.

Not all advice filings must include the EE Plan. The EE Plan will only be included when it is being revised.

The Company will work to resolve issues with EEAG members before filing. If the EEAG cannot agree and recommend approval of a filing, the Company may still choose to make the filing with the WUTC with the understanding that EEAG members may intervene in that public proceeding.

2.8 Annual Schedule for Program Planning

By November 15 of each year, the Company will provide the EEAG with the following proposals for the next program year, which will subsequently be filed with the WUTC in a new docket. The Company will file to this docket all the required reporting for the program year, including a link to the Purchased Gas Adjustment (PGA) filing wherein program costs are recovered.

Budget

The Company provides in this plan a total estimated budget for the program year. The budget presents expected expenditures by program and customer class. The budget component comprised of incentives and direct customer benefit shall be considered a soft cap and may be exceeded in order to achieve available cost effective savings. Notification should be made to the EEAG prior to exceeding incentive targets.

The budget forecast is based on the best information available at the time of filing. As the year progresses, budgeted dollars may be reallocated among the various programs and/or measures and/or new offerings that are submitted to the WUTC.

The Company may provide the necessary funding for program administration and delivery as appropriate, including reserves. The amounts dispersed in one year are the sum of all funds forecasted to be needed for that program year, adjusting for any unspent or uncommitted funds previously dispersed.

Metrics

The Company proposes performance metrics each year that will address the following:

- Total program costs
- Projected therm savings consistent with most recent IRP
- Average levelized cost for measures
- Projected homes to be weatherized in the WA-LIEE program

The Company expects that Utility Cost Test (UCT) at the portfolio level should be greater than 1.0 and will report compliance to this in the Annual Report.

The Company will present the EEAG with the next year's budget and performance metrics before making a tariff filing with the WUTC to modify this plan so that it incorporates the next year's projected costs and metrics accordingly. This filing will be made annually not later than December 1 for a January 1 effective date.

2.8.1 Reporting Schedule

2.8.1.1 Program Year Schedule

January 1	Start of program year
April 25	Annual report for previous program year is filed.
Second Quarter	NW Natural check in with County agencies regarding WA-LIEE progress and performance. Understand any necessary changes and report to EEAG.
May 25	Q1 report on January 1 through March 31 of current year
August 25	Q2 report on April 1 through June 30 and YTD
October 1	Tariff filing submitted for program cost recovery.
November 1	Requested effective date of program cost recovery filing.
November 15	Share next year's budget range, funding schedule, and proposed performance metrics with EEAG no later than this date
November 25	Q3 report on July 1 through September 30 and YTD
November 30	Latest date to file EE Plan for next program year
January 1	Start of next program year; new EE Plan effective

Quarterly
The Company will report on its program on a calendar year basis. Quarterly reports will be provided to the EEAG and filed with the WUTC

Annual
An annual report will be due annually by the following April 25th after the end of the program year.

EEAG Review
The EEAG will meet either in person or by teleconference to review the annual report and as requested if additional meetings are needed.

2.9 Content of Reports

The quarterly reports will include:

1. Quarterly progress toward annual program metrics
2. A breakdown of costs by program and customer sector
3. A reporting on percentage of program costs spent on customer incentives
4. The funding paid to date by the Company
5. A status report on market transformation efforts, spending, and activity
6. The 2Q report will include a 6 month check in on WA-LIEE
   - program year costs,
   - homes served,
   - estimated total therms saved per home, and
   - total therm savings to-date
7. The quarterly report following the annual release of the impact and process report will include a link to that report and a short summary of the findings (if evaluations were performed)

The annual report will include the following:

1. Budget compared to actual results by program
2. Cost-effectiveness calculations results as defined in Section 2.5 and outlined by Program in Part II of this plan
3. Measure level participation (units installed and savings) under the incentive program
4. Reporting on achievement of metrics
5. A status report on market transformation efforts, spending, and activity
6. An overview of the Company's year-end review of program delivery expenses and transactions.
7. Evaluation results (if performed)
8. Pilot results (if performed)
9. WA-LIEE program results including:
   - total program year costs

- homes served
- estimated total therm savings, and
- average therms saved per home

2.10 Annual Program Budget Guidelines

Budgets

Forecasted program costs for the next calendar year will be reviewed annually in November when metrics are also proposed for the following program year.

Actual Costs

Each year, the Company will file its annual report by April 25 which will detail costs and acquisitions for the previous program year. This filing will trigger the EEAG's review of the energy efficiency program including Incentive, WA-LIEE, Market Transformation, Pilots, and other program expenses.

2.11 Cost Recovery

Incentive program, Market Transformation, Low Income, Pilot, Evaluation and all other Energy Efficiency expenses are deferred and later amortized for recovery from applicable customers on an equal cents per margin basis as established annually in the temporary rate adjustments, Schedules 215 and 230, respectively. The Company will annually submit a stand-alone filing concurrent with its PGA filing, for cost recovery of its energy efficiency program expenses for the prior calendar year. That annual filing will include the following information:

- Background on the Company's energy efficiency programs and cost recovery
- A copy of the prior program year's annual report as outlined in section 2.9 "Content of Reports" of this Plan
- The total dollar amount the Company is seeking to recover
- The total incremental dollar impact that the proposed rate change will have on average residential and commercial customer monthly bills
- Total average monthly bill of proposed rate for applicable customers
- Work papers demonstrating the analysis behind the collection rate

The Company also includes a message on applicable customers' monthly bills stating how much of their current monthly bill represents costs collected to pay for the residential and commercial energy efficiency programs.

3 PART II – 2018 Plan

3.1 Current-Year Program Drivers

With the success of the Company's incentive program efforts in 2017, the 2018 strategy will continue with a few additional offerings and enhancements.

Residential: The Existing Homes Program will include new measures and outreach for residential multifamily structures including small multifamily, condos, and townhomes. The New Homes Program is expected to remain successful in 2018 due to a thriving housing market in SW Washington. To support the program's growth and increase in market participation, the associated incentive and delivery budget increased 50%. This is the largest contributor to the overall increase in the incentive program budget.

The Residential program will also be increasing focus and involvement with distributors to influence the supply chain and to ensure efficient products are being offered to HVAC, water heater, and gas fireplace dealers. This approach is a cost effective and efficient way to introduce and promote efficient equipment in to the market.

The Residential program will introduce a multifamily program in 2018. Anticipated savings in the first half of the year are based on a small set of multifamily measures; gas hearth, gas furnace, thermostat controls, and water heating. Condos, townhomes, duplexes, triplexes and fourplexes will be the housing stock targeted initially, however stacked units will qualify for incentives for the approved measures. Measure analysis and updating residential measure approval documents will also be a focus in the first half of 2018 in an effort to expand the multifamily measure list and continue to strive to serve customers that reside in this housing stock. A mid-year filing will like be executed to introduce additional Residential Multifamily measures.

Existing Buildings: The Commercial program is now benefitting from a maturing pipe line of custom projects as a result of the programs' prior years' outreach to building managers and owners. The extension of standard measure offerings to New Buildings have brought in more savings opportunities and will continue to be a part of the portfolio in 2018. The commercial program will also be increasing the number of measures available for commercial Multifamily application, which will help to diversify the portfolio and potentially create more collaboration opportunities between Commercial and Residential outreach.

Low Income: The Company's Low Income program has been impacted by its partner's funding challenge, which has slowed project delivery. In 2018 the Company plans to continue to adaptively manage the program for growth and future success.

3.2 Incentive Program Metrics and Budget

The 2018 Incentive Program Metrics are: Total Cost, Levelized Cost, UCT and total therm savings.

- The **total costs:** Costs estimated to achieve all cost effective therms for the incentive programs being offered as determined in the Company's 2016 Integrated Resource Plan ("IRP").

The program's primary goal is to meet system demand with the least cost conservation as required per WAC 480-90-238(1). The therm savings target is aligned with the demand-side management targets for the programs offered as identified in the Company's 2016 IRP. From a quarterly perspective, savings are anticipated as follows: Q1: 10%; Q2: 10%; Q3: 25%; and Q4: 55% of the annual total.

- **Average levelized cost** for the incentive program portfolio of measures will not exceed $0.65 per therm.

This metric is unchanged from last year. The profile of the Company's Washington service territory makes it harder to reduce the averaged levelized cost per therm than it would be in an area with more industrial customers since therm savings are acquired more cost effectively for bigger customers than for residential customers.

- The **UCT** at the incentive program portfolio level is greater than 1.0.

The UCT shall be calculated as prescribed in Section 2.5. A value greater than 1.0 demonstrates that the benefits received are greater than the costs. This test is applied at the portfolio level.

- The **total therms** at the incentive program portfolio level is 359,880 therms.

3.2.1 Therm Savings by Incentive Program

Incentive Program		Annual Therms Goal
Commercial Programs	Standard Track	110,000
	Custom Track	50,000
	Commercial Total	160,000
Residential Programs	Existing Homes	89,961
	Products and Mid-stream	36,410
	Multifamily	11,744
	New Homes	61,765
	Residential total	199,880
	Incentive Programs Total	**359,880**

3.2.2 Expenses by Incentive Program

Incentive Program		Budget
Commercial Programs	Commercial - Standard	$ 558,306
	Existing Buildings - Custom	$ 318,775
	Commercial administration	$ 41,494
	Commercial Total	$ 918,575
Residential Programs	Existing Homes	$ 502,930
	Products and Mid-stream	$ 59,941
	Multifamily	$ 57,213
	New Homes	$ 655,322
	Residential Administration	$ 60,284
	Residential total	$ 1,335,690
	Total Expenditures	$ **2,254,265**

3.2.3 Incentives by Incentive Program

Incentive Program		Expenditure	Percent Incentives
Commercial Programs	Standard Track	$ 268,400	47%
	Custom Track	$ 187,000	54%
	Commercial Total	**$ 455,400**	50%
Residential Programs	Existing Homes	$ 216,321	40%
	Products and Mid-stream	$ 41,946	59%
	Multifamily	$ 27,250	45%
	New Homes	$ 367,039	54%
	Residential total	**$ 652,556**	49%
	Total Incentives	**$ 1,107,956**	49%

3.2.4 Incentive Program Cost Effectiveness

The goal of the Company's incentive program is to acquire cost-effective gas therm savings. The portfolio of energy efficiency Incentive programs will be deemed cost-effective if, at the end of the program year, the program portfolio passes the Utility Cost Test (UCT) by having a benefit-to-cost ratio of one or more.

3.3 Low Income Metrics and Budget

The WA-LIEE program will strive to weatherize **13** homes. A breakout of costs and therm savings estimates is reflected in table 2 below:

3.3.1 Low Income Performance Targets

WA-LIEE		Annual Therm Savings
WA-LIEE	WA-LIEE total @ 13 homes	5265
	Total Low Income savings	**5,265**

3.3.2 Low Income Budget

WA-LIEE		Budget	
WA-LIEE @ 13 homes	WA-LIEE Measures	$	79,040
	WA-LIEE Agency Administration (15%)	$	11,856
	Health / Safety	$	13,000
	WA-LIEE application processing admin (5% cap)	$	5,195
	WA-LIEE Total	**$**	**109,091**

The WA-LIEE 2018 goal is in line with expected 2017 performance due to lack of matching funding from state and federal agencies. As outlined in Schedule I, in 2018 there is a measure funding cap per home of $6,080 with an additional 15% allowable for agency administrative costs plus a $1,000 cap on heath/safety work. The Company is allowed up to 5% for processing administration.

The Company is exploring pilots and engaging in outreach to other eligible agencies to drive additional program participation in 2018.

3.3.3 Low Income Cost Effectiveness

The goal of the Low Income program is primarily to address underserved markets and customers that do not access to the energy efficiency incentive programs. WA-LIEE leverages funds provided by other state, federal and local agencies. Those leveraged funds also utilize Savings to Investment (SIR) tests.

3.4 Gas Market Transformation Metrics and Budget

The Company will continue its participation with NEEA in 2018. The increase in the NEEA budget from $94,134 in 2016 to $108,564 in 2017 was on track with the 5 year business plan. Efforts include increasing market research for hearth products, a shift in timing of combination space and water heating system work, and acceleration of rooftop HVAC work.

3.4.1 Market Transformation Budget

Market Transformation			Budget
NEEA	NEEA Commercial	$	36,358
	NEEA Residential	$	98,303
	NEEA Administration	$	6,388
	NEEA Total	**$**	**141,049**

3.4.2 Market Transformation Energy Savings

Given the nature of Market Transformation work, there is high investment in the beginning and the bulk of the savings are delivered in the long-term, this is true for NEEA's electric portfolio as well. The bulk of the natural gas technologies NEEA is exploring that have high savings opportunities are pre-commercialized and therefore will not be market ready for quite some time. Much of NEEA's work is focused on bringing them to market faster, but this is yet another reason why the energy savings are a few years away.

There are no savings forecasted for the Natural Gas Business Plan (2015-2019). The Company would hope and expect to see savings from a continued NEEA effort beyond 2019.

3.4.3 Market Transformation Cost Effectiveness

NEEA programs will be tracked and any associated savings will be reported separately. It has been discussed with the EEAG that these programs are not likely or expected to contribute savings this early in development. The Company acknowledges that this practice of excluding market transformation from total cost effectiveness analysis is in no way precedent setting, and should the Company make any future requests for the unique treatment of costs and savings, such requests will be evaluated by the EEAG and WUTC at that time, and on a case-by-case basis.

3.5 Pilots Metrics and Budgets

In 2018 the Company plans to investigate and initiate opportunities to further strengthen the suite of offerings through a number of pilot projects.

3.5.1 Pilot Budget

Pilot Programs		Budget	
Pilots	Low Income Furnace Tune Ups	$	15,000
	School New Construction	$	30,000
	Pilot Placeholder – to be reviewed with EEAG	$	25,000
	Pilots Total	**$**	**70,000**

3.5.2 Pilot Energy Savings

Pilot programs will be tracked and any associated savings will be reported separately. It has been discussed with the EEAG that these programs may not all contribute savings.

3.5.3 Pilot Cost Effectiveness

Pilots will generally be excluded from total cost effectiveness but project by project test may be performed. The Company acknowledges that this practice of excluding pilot costs from total cost effectiveness analysis is in no way precedent setting, and should the Company make any future requests for the unique treatment of costs and savings, such requests will be evaluated by the EEAG and WUTC at that time, and on a case-by-case basis.

3.6 Loans and On-The-Bill Repayment Services

The Company will continue to provide access to a low-interest, unsecured financing offer to residential homeowners who heat their homes with natural gas. The program lender will originate loans granted for the purposes of purchasing and installing conservation and energy efficiency measures incented by the existing homes program, and the Company will provide billing and remittance services to the program lender by placing the loan repayment fee on the participating customers' monthly gas bill. Customers who obtain a loan with on-the-bill repayment services will receive a loan repayment charge itemized as "Energy Upgrade Loan" on their monthly bill for natural gas service. This will be reflected for the term of the loan or until the loan has been paid off, transferred, or otherwise discharged or removed from the bill in accordance with the terms and conditions of the Company's service agreement. The Company will lead and manage the coordination of activities between the program lender, the program management contractor, and the Company. More information can be found in Appendix 5.

3.7 Evaluation Activities and Budget

In 2010 the Company hired Navigant for a two part study on the Company's Washington Energy Efficiency program. The first part was a benchmark study to evaluate how the

pilot program compared to other programs in Washington and the second part was an evaluation of how the Company should proceed with turning the pilot into a full-fledged program. Over the past 6 years the Company's program, as well as the other Washington programs, have evolved and matured. The Company plans to hire a third party to perform a three part study in 2018. Phase one will provide another benchmark the program. Phase two will look at areas for enhancement within the Company's current program offering. Phase three will investigate opportunities to grow the Company's Energy Efficiency efforts through new program offerings, sectors or other efforts.

The Company will utilize a bid process and submit a proposed Scope of Work for the three phases mentioned above to the EEAG for feedback.

3.7.1 Evaluation Budget

Evaluation Work		Budget	
Evaluation	Program baseline	$	30,000
	Areas of enhancement	$	30,000
	Program growth opportunities	$	30,000
	Evaluation Total	**$**	**90,000**

4 PART III – Appendices

These Appendices are for reader reference and additional background or context unless specifically referenced in the body of the Company's Plan.

4.1 Appendix 1: UES Measure Lists

Measure List

Mid-year Filing Change	PROGRAM CODE	Measure Group	Measure Code	Measure Description	Load Profiles	Measure Life	Incentive per Quantity	Incremental (TRC) Cost per Quantity	Savings (Therms) per Quantity	2017 WA-Only GAS AC per measure	Estimated Max Incentive (2017 AC)	Notes	NPV of NEBs per Quantity	UCT BCR (2017 AC)	TRC BCR (2017 AC)	2017 Levelized Cost (5.09% Discount Rate)	MAD #
new savings	Existing Homes	AERATOR	BYOKAER10BG14	Build Your Own Kit, 1.0 gpm Bath Aerator Gas 2014	RESDHWG	15	$1.35	$ 1.35	3.4	$15.56	$1.35		$67.47	11.53	61.51	$0.04	27
new savings	Existing Homes	AERATOR	BYOKAER15KG14	Build Your Own Kit, 1.5 gpm Kitch Aerator Gas 2014	RESDHWG	15	$1.85	$ 1.85	6.1	$30.21	$1.85	New 2018 MAD	$130.91	16.33	87.09	$0.03	27
	Existing Homes	AIRSEALING	SFAIRSEALG13	SF Air Sealing, $150 Gas 2013	GEXSPHT	20	$150.00	$ 150.00	25.53	$204.46	$150.00		$0.00	1.36	1.36	$0.48	36
	Existing Homes	BOILER	HEGBLRINST	SF Gas Boiler	GEXSPHT	25	$200.00	$ 1,100.00	44.44	$417.05	$417.05		$0.00	2.09	0.38	$0.32	196
	Existing Homes	CEILINGINSULATE	SFINSCEILGZ114	SF Attic Insulation/SQFT, Gas Heat, Zone 1 2014	GEXSPHT	45	$0.25	$ 0.83	0.052	$0.67	$0.67		$0.00	2.67	0.80	$0.27	36
new UCT BCR	Existing Homes	THERMOSTAT	SMARTTSTATG	Smart Thermostat Gas Forced Air Furnace	1GHNACG	13	$50.00	$ 100.00	25	$110.00	$100.00	New 2018 MAD	$0.00	1.40	1.50	$0.17	153
	Existing Homes	THERMOSTAT	SSFURNACE	Seasonal Savings	1GHNACG	1	$3.00	$3.00	18	$7.04	$3.00	New 2018 MAD Pilot measure, v	$0.00	2.35	2.35	$0.18	173
	Existing Homes	DUCTINSULATE	SFINSDUCTG	SF Duct Insulation, Gas Heat	GEXSPHT	45	$100.00	$ 100.00	12.3	$157.88	$100.00		$0.00	1.58	1.58	$0.46	63
	Existing Homes	FLOORINSULATE	SFINSFLRGZ114	SF Floor Insulation/SQFT, Gas Heat, Zone 1 2014	GEXSPHT	45	$0.30	$ 1.60	0.04	$0.51	$0.51		$0.00	1.71	0.32	$0.43	36
	Existing Homes	GASDVENT	HEGASFURNDV	SF Direct Vent Gas Heater	GEXSPHT	18	$100.00	$ 100.00	47.54	$340.95	$100.00		$0.00	3.41	3.41	$0.18	210
new savings	Existing Homes	GASFIRE	GASHRTH7074	Gas Hearth 70-74 FE	GEXSPHT	20	$150.00	$ 0.01	51.4	$408.00	$150.00	New 2018 MAD Savings reduced	$0.00	2.72	40,800.00	$0.21	29
new savings	Existing Homes	GASFIRE	GASHRTH75PLUS	Gas Hearth 75+ FE	1GHNACG	20	$250.00	$ 47.00	63.2	$502.50	$47.00	Savings reduced as does not inc	$0.00	2.01	10.69	$0.27	29
	Existing Homes	GASFURNACE	HEGASFURN9094	Gas Furnace SW WA 90-94%+ AFUE	1GHNACG	25	$100.00	$ 500.00	60.7	$590.39	$500.00		$0.00	5.90	1.18	$0.12	23
	Existing Homes	GASFURNACE	HEGASFURN95PLUS	Gas Furnace SW WA 95%+ AFUE	1GHNACG	25	$200.00	$ 950.00	80.7	$784.92	$784.92		$0.00	3.92	0.83	$0.18	23
	Existing Homes	KNEEINSULATE	SFINSKWGZ114	SF Knee Wall Insulation/SQFT, Gas Heat, Zone 1 2014	GEXSPHT	45	$0.30	$ 1.39	0.05	$0.64	$0.64		$0.00	2.14	0.46	$0.34	106
	Existing Homes	LWK	LWKFALLGWA16	Living Wise Kits - SW WA Gas DHW	RESDHWG	15	$18.99	$ 18.99	11.5	$52.63	$18.99		$312.41	2.77	19.22	$0.16	30
new savings	Existing Homes	SHOWERHEAD	BYOKSHWR175G14	Build Your Own Kit, 1.5 gpm Showerhead Gas 2014	RESDHWG	15	$5.00	$ 5.00	13	$74.14	$5.00	New 2018 MAD	$282.13	14.83	71.25	$0.04	27
new savings	Existing Homes	Drag	BYOKSHWR175G14	Build Your Own Kit, 1.75 gpm Showerhead Gas 2014	RESDHWG	15	$5.00	$ 5.00	9.8	$57.21	$5.00	New 2018 MAD	$217.93	11.44	55.03	$0.05	27
new savings	Existing Homes	SHOWERWAND	n/a	Build Your Own Kit, 1.5 gpm Shower wand Gas 2016	RESDHWG	15	$10.00	$ 10.00	14.9	$69.21	$10.00	New 2018 MAD	$320.65	6.92	38.99	$0.07	27
new savings	Existing Homes	SHOWERWAND	n/a	Build Your Own Kit, 1.75 gpm Shower wand Gas 2016	RESDHWG	15	$10.00	$ 10.00	9.8	$45.45	$10.00	New 2018 MAD	$217.93	4.55	26.34	$0.10	27
new mad	Existing Homes	WINDOWS	WINDOWS27G	Windows - GAS - U <=.27	GEXSPHT	45	$4.00	$ 4.36	0.48	$6.41	$4.36	New 2018 MAD	$0.00	1.60	1.47	$0.52	28
new mad	Existing Homes	WINDOWS	WINDOWS2830G	Windows - GAS - U .28-.30	GEXSPHT	45	$1.75	$ 1.11	0.2	$2.68	$2.68	New 2018 MAD	$0.00	1.53	2.41	$0.32	28
	New Homes & Products	EPS	SWWAEPS1	SW WA EPS Path 1 - 2017	1GHNACG	34	$250.00	$ 869.00	53	$627.27	$627.27	New 2018 MAD New measure -	$501.02	2.51	1.30	$1.02	145
	New Homes & Products	EPS	SWWAEPS2	SW WA EPS Path 2 - 2017	1GHNACG	39	$450.00	$ 2,701.00	111	$1,406.86	$1,406.86	New 2018 MAD New measure -	$539.48	3.13	0.72	$1.45	145
	New Homes & Products	EPS	SWWAEPS3	SW WA EPS Path 3 - 2017	1GHNACG	41	$650.00	$ 7,557.00	161	$2,083.38	$2,083.38	New 2018 MAD New measure -	$804.66	3.21	0.38	$2.75	145
	New Homes & Products	EPS	SWWAEPS4	SW WA EPS Path 4 - 2017	1GHNACG	42	$850.00	$ 8,970.00	199	$2,594.61	$2,594.61	New 2018 MAD New measure -	$826.07	3.05	0.38	$2.62	145
new 2018 MAD	New Homes & Products	EPS	SWWAEPS1	SW WA EPS Path 1 - 2018	1GHNACG	34	$250.00	$ 869.00	80	$949.00	$949.00	New 2018 MAD New measure -	$774.31	3.80	1.98	$0.68	145
new 2018 MAD	New Homes & Products	EPS	SWWAEPS2	SW WA EPS Path 2 - 2018	1GHNACG	39	$450.00	$ 2,701.00	142	$1,806.00	$1,806.00	New 2018 MAD New measure -	$809.21	4.01	0.97	$1.13	145
new 2018 MAD	New Homes & Products	EPS	SWWAEPS3	SW WA EPS Path 3 - 2018	1GHNACG	41	$650.00	$ 7,557.00	258	$3,378.00	$3,378.00	New 2018 MAD New measure -	$820.75	5.20	0.56	$1.71	145
new 2018 MAD	New Homes & Products	EPS	SWWAEPS4	SW WA EPS Path 4 - 2018	1GHNACG	42	$850.00	$ 8,970.00	293	$3,866.00	$3,866.00	New 2018 MAD New measure -	$826.07	4.55	0.52	$1.78	145
	New Homes & Products	SHOWERHEAD	WASHW15	NWNWA 1.5 gpm Retail Showerhead	RESDHWG	15	$7.00	$ 8.50	12.28	$56.20	$8.50		$235.73	8.03	34.35	$0.07	156
	New Homes & Products	SHOWERHEAD	WASHW16	Washington Retail Showerhead, 1.6 gpm	RESDHWG	15	$7.00	$ 8.50	11.77	$53.87	$8.50		$230.06	7.70	33.40	$0.07	156
	New Homes & Products	SHOWERHEAD	WASHW175	NWNWA 1.75 gpm Retail Showerhead	RESDHWG	15	$7.00	$ 8.50	10.05	$46.00	$8.50		$196.30	6.57	28.51	$0.08	156
	New Homes & Products	SHOWERHEAD	WASHW20	NWNWA 2.0 gpm Retail Showerhead	RESDHWG	15	$7.00	$ 8.50	7.64	$34.97	$8.50		$149.37	5.00	21.69	$0.11	156
mid-year 2017	Existing Homes	GASFIRE	GASHRTHPLELE25	Gas hearth-Electronic Ignition $25, retailer/distributor incent	1GHNACG	20	$25.00	$ 100.00	42.2	$334.80	$100.00	New 2018 MAD Electronic igniti	$0.00	3.10	3.35	$0.19	29
mid-year 2017	Existing Homes	GASFIRE	GASHRTHPLELE30	Gas hearth-Electronic Ignition $30, retailer/distributor incent	1GHNACG	20	$30.00	$ 100.00	42.2	$334.80	$100.00	New 2018 MAD Electronic igniti	$0.00	3.10	3.35	$0.19	29
mid-year 2017	Existing Homes	TANKISSDHW	HEGASDHW7016	Tankless Water Heater, Gas .82 $125, 2016	RESDHWG	20	$200.00	$ 1,834.00	74.2	$444.04	$444.00		$0.00	2.20	0.24	$2.00	197
mid-year 2017	Existing Homes	TANKDHW	HEGASDHW67100	Water Heater, Gas .67-.69 $100 - distributor	RESDHWG	13	$100.00	$ 200.00	25.3	$101.55	$101.55		$5.56	1.02	0.54	$0.85	102
mid-year 2017	Existing Homes	TANKDHW	HEGASDHW70100	Water Heater, Gas .70 $125 - distributor	RESDHWG	13	$125.00	$ 430.00	31.5	$126.43	$126.43		$5.56	1.01	0.31	$1.46	102
NEW	Multifamily	THERMOSTAT	SMARTTSTATG	Smart Thermostat Gas Forced Air Furnace	1GHNACG	13	$50.00	$ 100.00	25	$110.00	$100.00	New 2018 MAD	$0.00	2.20	1.10	$0.17	153
NEW	Multifamily	GASFURNACE	HEGASFURN9094	Gas Furnace SW WA 90-94%+ AFUE	1GHNACG	25	$100.00	$ 500.00	60.7	$590.39	$500.00		$0.00	5.90	1.18	$0.12	23
NEW	Multifamily	GASFURNACE	HEGASFURN95PLUS	Gas Furnace SW WA 95%+ AFUE	1GHNACG	25	$200.00	$ 950.00	80.7	$784.92	$784.92		$0.00	3.92	0.83	$0.18	23
NEW	Multifamily	GASFIRE	GASHRTH7074	Gas Hearth 70-74 FE	GEXSPHT	20	$150.00	$ 0.01	51.4	$408.00	$150.00	New 2018 MAD Savings reduce	$0.00	2.72	40,800.00	$0.21	29
NEW	Multifamily	GASFIRE	GASHRTH75PLUS	Gas Hearth 75+ FE	1GHNACG	20	$250.00	$ 47.00	63.2	$502.50	$250.00	New 2018 MAD Savings reduce	$0.00	2.01	10.69	$0.27	29
NEW	Multifamily	TANKISSDHW	HEGASDHW7016	Tankless Water Heater, Gas .82 $125, 2016	RESDHWG	20	$200.00	$ 1,834.00	74.2	$444.04	$444.00		$0.00	2.20	0.24	$0.22	197
NEW	Multifamily	WINDOWS	WINDOWS27G	Windows - GAS - U <=.27	GEXSPHT	45	$4.00	$ 4.36	0.48	$6.41	$4.36	New 2018 MAD	$0.00	1.60	1.47	$0.48	28
NEW	Multifamily	WINDOWS	WINDOWS2830G	Windows - GAS - U .28-.30	GEXSPHT	45	$1.75	$ 1.11	0.2	$2.68	$2.68	New 2018 MAD	$0.00	1.53	2.41	$0.50	28
NEW	Midstream	MIDGASWH	TBD	Energy Star Gas Water Heater		13	100	$215	25.7	$104.39	$104.39	New 2018 MAD - midstream tar	4.71	1.04	0.68	0.42	102

				total Incentive w/ bonus		Forecasted additional units resulting from bonus	Savings (Therms) per Quantity	Forecasted additional savings resulting from bonus
New	Bonus	TANKLESSDHW	TANKLESSBONUS	$300.00		12	74.2	890
New	Bonus	EPS	LowIncome_VERF	Varies - bonus amount = $250		20	Varies	Varies

Measure	Sub-sector	Load Profile		Measure Life	Savings		Incremental	Non-Energy Benefits (Annual $)	Maximum	Utility BCR at	TRC BCR	Water NEBs	kWh NEBs	Total NEBs	PV @ 5.09%
		Electric	Gas		kWh	therms									
1.0 GPM Bath Aerator - WA Gas DHW - All Housing Types	Not applicable	Res Wate	DHW	15	2	3.4	$1.35	$6.36	$1.35	11.61	60.14	$6.36	$0.18	$6.54	$67.47
1.5 GPM Kitchen Aerator - WA Gas ONLY DHW - All Housing Types	Not applicable	Res Wate	DHW	15	4	6.6	$1.85	$12.34	$1.85	16.44	85.15	$12.34	$0.35	$12.69	$130.91
1.5 GPM Showerhead - WA Gas ONLY DHW - All Housing Types	Not applicable	Res Wate	DHW	15	9	16.2	$5.00	$26.59	$5.00	14.82	69.60	$26.59	$0.76	$27.35	$282.13
1.75 GPM Showerhead - WA Gas ONLY DHW - All Housing Types	Not applicable	Res Wate	DHW	15	7	12.5	$5.00	$20.54	$5.00	11.44	53.77	$20.54	$0.59	$21.12	$217.93
1.5 GPM Shower Wand - WA Gas ONLY DHW - All Housing Types	Not applicable	Res Wate	DHW	15	11	18.4	$5.00	$30.22	$5.00	16.84	79.11	$30.22	$0.86	$31.08	$320.65
1.75 GPM Shower Wand - WA Gas ONLY DHW - All Housing Types	Not applicable	Res Wate	DHW	15	7	12.5	$10.00	$20.54	$10.00	5.72	26.88	$20.54	$0.59	$21.12	$217.93

Change	Measure Code	Measure Description	Load Profile	Measure Life	Incentive per Quantity	Incremental (TRC) Cost per Quantity	Savings (Therms) per Quantity	2017 WA-Only GAS AC per measure	Estimated Max Incentive (2017 AC)	Engineer's Notes	NPV of NEBs per Quantity	UCT BCR (2017 AC)	TRC BCR (WA-only AC)	2017 Levelized Cost (5.53% Discount Rate)	MAD #
	AERATORGONLY0P5	Aerator - Gas Hot Water - Bathroom 0.5 GPM or less	RESDHWG	10	$ 3.00	$ 8.66	19.1	$60.53	$8.66		$538.06	$ 20.18	$ 69.12	$0.02	1
	AERATORGONLYK1P5	Aerator - Gas Hot Water - Kitchen 1.5 GPM or less	RESDHWG	10	$ 3.00	$ 8.66	7.9	$25.04	$8.66		$221.56	$ 8.35	$ 28.47	$0.05	1
	BESHWNDGWA15	ShowerWAND - gas 1.5GPM or less	RESDHWG	10	$ 10.00	$ 35.00	7.7	$24.40	$24.40		$284.86	$ 2.44	$ 8.84	$0.17	77
	BESTEAMTRAP	Steam Traps - laundry and K-12 schools:Effective January 1, 2016 Schools Only.	GEXPRO	6	$ 250.00	$ 157.35	111.7	$210.31	$157.35	The max fo	$0.00	$ 0.84	$ 1.34	$0.45	42
new incentive amnt	BEWASHGASPART	Commercial Clothes Washer-Gas Water Heat - commercial laundry	GEXPRO	7	$ 65.00	$ 355.00	32	$70.29	$70.29		$726.64	$ 1.08	$ 2.24	$0.36	89
	COMBOOVGASWA	Gas Combination Ovens	GNEWPRO	12	$ 750.00	$ 1.00	290	$1,069.99	$1,069.99	The Energy	$0.00	$ 1.43	$ 1,069.99	$0.30	101
	GASSTEAMCOOK	Steam Cooker - Gas	GNEWPRO	12	$ 2,600.00	$ 870.00	1308	$4,826.01	$870.00	The Energy	$ 10,769.04	$ 1.86	$ 17.93	$0.23	101
	GFBOIL2500	Boiler > 2,500 kBtuh input	GEXSPHT	35	$ 8.00	$ 10.00	2.85	$32.96	$10.00		$0.00	$ 4.12	$ 3.30	$0.18	88
	GFBOIL300	Boiler < 300 kBtuh input	GEXSPHT	35	$ 10.00	$ 16.00	2.85	$32.96	$16.00		$0.00	$ 3.30	$ 2.06	$0.23	88
	GFBOIL3002500	Boiler ≥ 300, ≤ 2,500 kBtuh input	GEXSPHT	35	$ 9.00	$ 13.00	2.85	$32.96	$13.00		$0.00	$ 3.66	$ 2.54	$0.21	88
	GREENIRPOLY	Infrared (IR) polyethylene greenhouse cover	GEXSPHT	4	$ 0.32	$ 0.10	0.23	$0.35	$0.10	For greenl	$0.00	$ 1.10	$ 3.52	$0.40	104
	GREENTHCUR	Thermal Curtains Installed on Greenhouses	GEXPRO	10	$ 0.30	$ 1.17	0.41	$1.29	$1.17	For greenl	$0.00	$ 4.29	$ 1.10	$0.10	104
	GREENUNDERBENCH	Under-bench heating Green house	GEXSPHT	12	$ 1.05	$ 2.19	1.25	$5.83	$2.19	For greenl	$0.00	$ 5.55	$ 2.66	$0.10	104
	GRNCNTRL	Greenhouse controllers	GEXSPHT	15	$ 0.10	$ 0.58	0.28	$1.66	$0.58	For greenl	$0.00	$ 16.57	$ 2.86	$0.04	103
	INSATTICGWA	Attic Insulation - Gas heating	GEXSPHT	30	$ 0.60	$ 0.90	0.25	$2.69	$0.90		$0.00	$ 4.48	$ 2.99	$0.17	68
	INSROOFGR5R20	Roof Insulation R-5 to R-20 gas heat	GEXSPHT	30	$ 0.30	$ 0.64	0.09	$0.97	$0.64		$0.00	$ 3.23	$ 1.51	$0.23	68
	INSROOFGWA	Roof Insulation - Gas heating	GEXSPHT	30	$ 0.60	$ 0.64	0.25	$2.69	$0.64		$0.00	$ 4.48	$ 4.20	$0.17	68
	INSWALLGWA	Wall Insulation - Gas heating	GEXSPHT	30	$ 0.60	$ 1.41	0.16	$1.72	$1.41		$0.00	$ 2.87	$ 1.22	$0.26	68
	MFSTEAMTRAPWA	Multifamily Steam Traps	GEXPRO	6	$ 100.00	$ 100.00	99	$186.40	$100.00		$0.00	$ 1.86	$ 1.86	$0.20	40
	NCBVD	Boiler Vent Damper	GEXSPHT	12	$ 1,000.00	$ 1,500.00	270	$1,258.50	$1,258.50	The MAD	$0.00	$ 1.26	$ 0.84	$0.43	86
	NCCONVOVENWA	Convection Oven - Gas - Full Size	GEXPRO	12	$ 600.00	$ 1.00	302	$1,114.26	$1,114.26	The Energy	$0.00	$ 1.86	$ 1,114.26	$0.23	101
	NCDHWCONDMF	MF Domestic Tank Water Heaters	GEXPRO	18	$ 2.50	$ 4.91	2.21	$11.81	$4.91	Water hea	$0.00	$ 4.72	$ 2.41	$0.10	21
	NCDHWCONDWA	Domestic Tank Water Heaters	GEXPRO	18	$ 4.00	$ 5.04	1.37	$7.32	$5.04	Water hea	$0.00	$ 1.83	$ 1.45	$0.26	21
	NCHVACUNCON	HVAC Unit Heater	GEXSPHT	18	$ 3.00	$ 5.23	1.05	$7.53	$5.23		$0.00	$ 2.51	$ 1.44	$0.25	11
	NCIRGASFRY2014	Gas Fryer	GEXPRO	12	$ 800.00	$ 1,120.00	569	$2,099.39	$1,120.00	For fryers,	$0.00	$ 2.62	$ 1.87	$0.16	101
	NCIRGASGRI	Gas Griddle	GEXPRO	12	$ 500.00	$ 1,492.00	147	$542.37	$542.37	The Energy	$0.00	$ 1.08	$ 0.36	$0.40	101
	NCWHEL	Domestic Tankless Water Heaters - Coin Op Laundries	GEXPRO	15	$ 2.00	$ 5.00	2.58	$11.65	$3.00	The MAD	$0.00	$ 5.83	$ 2.33	$0.08	72
	NCWHEL	Domestic Tankless Water Heaters - Food service	GEXPRO	15	$ 2.00	$ 3.95	0.57	$2.57	$3.00	The MAD	$0.00	$ 1.29	$ 0.65	$0.35	72
	NCWHEL	Domestic Tankless Water Heaters - Lodging	GEXPRO	15	$ 2.00	$ 5.00	1.11	$5.01	$3.00	The MAD	$0.00	$ 2.51	$ 1.00	$0.18	72
	NEW	Greenhouse condensing unit heaters	GEXSPHT	12	$ 5.00	$ 11.18	6.29	$29.32	$11.18		$0.00	$ 5.86	$ 2.62	$0.09	134
	NEW	Modulating Boiler Burner installed on Hot Water Boiler (condensing or non-condensing type) or on steam boiler.	GEXSPHT	20	$ 2.00	$ 4.02	0.8	$6.41	$4.02		$0.00	$ 3.20	$ 1.59	$0.21	142
	NEW	Showerhead or Showerwand 1.50gpm Any Commercial Building Except Fitness Center Gas Water Heating Direct Install	GEXPRO	10	$ 12.00	$ 35.00	9.9	$31.07	$31.07		$284.86	$ 2.59	$ 9.03	$0.16	77
	NEW	Showerhead or Showerwand 1.50gpm Fitness Center Gas Water Heating Direct Install	GEXPRO	10	$ 12.00	$ 35.00	92.8	$291.21	$35.00		$5,404.39	$ 24.27	$ 162.73	$0.02	77
	PIPEINSLN	Pipe Insulation - Hot water - Pipe Diameter > 1.5"	GEXPRO	15	$ 2.00	$ 18.40	4	$18.07	$18.07	The MAD	$0.00	$ 9.03	$ 0.98	$0.05	91
	PIPEINSLN	Pipe Insulation - Hot water - Pipe Diameter ≤ 1.5"	GEXPRO	15	$ 2.00	$ 18.40	4	$18.07	$18.07	The MAD	$0.00	$ 9.03	$ 0.98	$0.05	91
	PIPEINSLN	Pipe Insulation - Low-Pressure Steam (< 15 psig) - Pipe Diameter > 1.5"	GEXPRO	15	$ 4.00	$ 18.40	9.3	$42.01	$18.40	The MAD	$0.00	$ 10.50	$ 2.28	$0.04	91
	PIPEINSLN	Pipe Insulation - Low-Pressure Steam (< 15 psig) - Pipe Diameter ≤ 1.5"	GEXPRO	15	$ 4.00	$ 18.40	9.3	$42.01	$18.40	The MAD	$0.00	$ 10.50	$ 2.28	$0.04	91
	PIPEINSLN	Pipe Insulation - Med-Pressure Steam (15–200 psig) - Pipe Diameter > 1.5"	GEXPRO	15	$ 6.00	$ 14.57	5	$22.59	$14.57	The MAD	$0.00	$ 3.76	$ 1.55	$0.12	91
	PIPEINSLN	Pipe Insulation - Med-Pressure Steam (15–200 psig) - Pipe Diameter ≤ 1.5"	GEXPRO	15	$ 6.00	$ 14.57	5	$22.59	$14.57	The MAD	$0.00	$ 3.76	$ 1.55	$0.12	91
	RADHEATMODWA	Radiant Heater, Modulating	GEXSPHT	20	$ 10.00	$ 48.50	11.2	$89.70	$48.50	The MAD	$0.00	$ 8.97	$ 1.85	$0.07	117
	RADHEATNONMODWA	Radiant Heater, Non-Modulating Infrared Natural Gas-Fired Radiant Heater	GEXSPHT	20	$ 6.50	$ 21.61	4.3	$34.44	$21.61	The MAD	$0.00	$ 5.30	$ 1.59	$0.13	117
	STCONHITEMPGASWA	Dishwasher - Single Tank Conveyor - gas high temp	RESDHWG	20	$ 900.00	$ 3,000.00	508	$3,040.08	$3,000.00		$2,003.22	$ 3.38	$ 1.68	$0.15	35
	STCONLOTEMPGAS	Dishwasher - Single Tank Conveyor - gas low temp	RESDHWG	20	$ 900.00	$ 3,000.00	520	$3,111.89	$3,000.00		$2,055.25	$ 3.46	$ 1.72	$0.15	35
	STDRUPLOTEMPGAS	Dishwasher - Single Tank Door/Upright - gas low temp	RESDHWG	15	$ 900.00	$ 2,000.00	554	$2,535.54	$2,000.00		$1,804.24	$ 2.82	$ 2.17	$0.16	35
	STDUPHITEMPGASWA	Dishwasher - Single Tank Door/Upright - gas high temp	RESDHWG	15	$ 900.00	$ 2,100.00	405	$1,853.60	$1,853.60		$1,320.96	$ 2.06	$ 1.51	$0.22	35
	THERMRADVAL	Thermostatic Radiator Valves (TRVs), central hydronic or steam systems only (MF only)	GEXSPHT	15	$ 100.00	$ 215.00	55	$325.41	$215.00		$0.00	$ 3.25	$ 1.51	$0.18	45
	UCHITEMPGASWA	Dishwasher - Under counter - gas high temp	RESDHWG	10	$ 600.00	$ 1,000.00	217	$687.71	$687.71		$522.24	$ 1.15	$ 1.21	$0.37	35
new incentive amnt	NEW	Multifamily Commercial Clothes Washer Common Areas	RESDHWG	11	$ 65.00	$ 355.00	24	$65.00	$93.00		$775.68	$ 1.00	$ 2.37	$0.34	89
	New (No code yet)	Cooler Doors	GEXSPHT	15	$ 100.00	$ 375.00	45	$203.27	$ 375.00		$0.00	$ 2.03	$ 0.54	$0.22	47
	New (No code yet)	Manufacturer-Installed Rooftop Unit Controls - Demand Control Ventillation controls on new RTUs, All New and Existing Buildings on Commercial Rate, including Multifamily	GEXSPHT	15	$ 29.00	$ 38.00	21	$124.25	$ 38.00		$0.00	3.32	3.69	$0.13	195
	New (No code yet)	Multifamily HVAC Hot Water Condensing Gas Boilers <300 kbtu/h	GEXSPHT	35	$ 10.00	$ 16.00	4.1	$47.41	$ 16.00		$0.00	3.08	2.91	$0.15	147
	New (No code yet)	Multifamily HVAC Hot Water Condensing Gas Boilers ≥300 kbtu/h, ≤2,500 kbtu/h	GEXSPHT	35	$ 9.00	$ 13.00	4.1	$47.41	$ 13.00		$0.00	3.79	3.58	$0.14	147
	New (No code yet)	Multifamily HVAC Hot Water Condensing Gas Boilers >2,500 kbtu/h	GEXSPHT	35	$ 8.00	$ 10.00	4.1	$47.41	$ 10.00		$0.00	4.92	4.66	$0.12	147
	New (No code yet)	Existing Multifamily - Residential Bathroom Faucet Aerator, 1.0	RESDHWG	15	$ 3.00	$ 8.66	8.08	$36.98	$ 8.66		$219.00	4.27	258.36	$0.04	51
	New (No code yet)	New Multifamily - Residential Bathroom Faucet Aerator, 1.0	RESDHWG	15	$ 3.00	$ 8.66	5.57	$25.49	$ 8.66		$151.00	2.94	178.09	$0.05	51
	New (No code yet)	Existing Multifamily - Residential Kitchen Faucet Aerator, 1.5	RESDHWG	15	$ 5.00	$ 8.66	6.76	$30.94	$ 8.66		$183.00	3.57	215.83	$0.07	51
	New (No code yet)	New Multifamily - Residential Kitchen Faucet Aerator, 1.5	RESDHWG	15	$ 5.00	$ 8.66	3.25	$14.87	$ 8.66		$88.00	1.72	103.80	$0.15	51
	New (No code yet)	Existing Multifamily - Low flow showerheads, 1.5 GPM or less flow	RESDHWG	15	$ 10.00	$ 28.00	13.1	$59.96	$ 28.00		$30.00	2.14	14.41	$0.07	157
	New (No code yet)	Existing Multifamily - low flow showerwand, 1.5 GPM or less flow	RESDHWG	15	$ 10.00	$ 28.00	5.5	$25.17	$ 25.17		$13.00	1.00	6.09	$0.18	157
	New (No code yet)	Multifamily Condensing Tankless Water Heater ≤199 kbtu/h	RESDHWG	15	$ 300.00	$ 320.00	82	$375.30	$ 320.00		$0.00	1.18	1.18	$0.35	196
New	New (No code yet)	New Refrigerated Cases with Doors in Convenience Stores/Small Grocery	GEXSPHT	15	$ 35.00	$ 206	18.9	$118.72	$ 118.72	Convenien	$214.98	3.39	1.62	$0.18	201
New	New (No code yet)	New Refrigerated Cases with Doors in Medium Grocery	GEXSPHT	15	$ 35.00	$ 206	36.8	$229.69	$ 206.25	Convenien	$152.98	6.56	1.86	$0.09	201
New	New (No code yet)	New Refrigerated Cases with Doors in Large Grocery	GEXSPHT	15	$ 35.00	$ 206	33.7	$206.97	$ 206.25	Convenien	$395.88	5.91	2.92	$0.10	201

4.2 Appendix 2: Measure Approval Documents

I. Commercial
   a. Commercial Aerators
   b. Commercial Condensing Boiler Measure
   c. Commercial Condensing Tankless
   d. Commercial Dishwashers
   e. Commercial Furnaces
   f. Commercial Insulation
   g. Commercial Pipe Insulation
   h. Commercial and Industrial RTU Controls
   i. Commercial Showerheads
   j. Condensing Tank Water Heaters
   k. Condensing Unit Heaters in Greenhouses
   l. Condensing Unit Heaters
   m. Cooler Doors
   n. Direct Install Showerheads and Showerwands
   o. Food Service Cooking Measures
   p. Greenhouse Controller
   q. Greenhouse Measures
   r. MF Condensing Boiler Measure
   s. MF Steam Traps
   t. Modulating Boiler Burners
   u. Multifamily 199kBTU Condensing Tankless WH
   v. Radiant Infrared Heat
   w. Residential Aerator
   x. Steam Trap Update
   y. Thermostat Radiator Valves

II. New Commercial for 2018
   a. Commercial Clothes Washers
   b. Multifamily Clothes Washers
   c. New Refrigerated Cases with Doors

III. Residential
   a. Direct Vent Heaters
   b. Knee Wall Insulation
   c. Living Wise Kit
   d. MF Condensing Boiler
   e. Multifamily Duct Insulation 4 or fewer living units
   f. Prescriptive air sealing with attic insulation
   g. Residential Aerator
   h. Retail Showerheads and Showerwands
   i. Retail Showerwands at 1.75 and 2.0gpm
   j. Single Family Insulation Retrofit

IV. New Residential for 2018

a. Automated Thermostat Optimization
b. Energy Saver Kit
c. Gas Fireplaces
d. Gas Furnace in Washington
e. Gas Storage Water Heat
f. New Homes EPS WA
g. Res Tankless Water Heaters in SW WA
h. Residential High Performance Windows
i. Retail Web Enabled Thermostat

Measure Approval Document for Commercial Clothes Washers

Valid Dates

1/1/2018 – 12/31/2020

Program Applicability

Based on the referenced analysis and associated cost-effectiveness screening, the measures described below are approved on a prospective basis for use in the following programs:

- Existing Buildings
- New Buildings
- New Multifamily
- Existing Multifamily
- Residential (where residential serves small multifamily with shared laundries)

Within these programs, the measure is expected to be primarily in:

- Commercial facilities with laundry loads such as lodging and hospitals
- Laundromats
- Multifamily with shared laundry rooms

Within these programs, the measure is applicable to the following cases:

- New
- Replacement

Purpose of Re-Evaluating Measure

Update for new expiration dates, avoided costs and water rates and maximum incentives. Savings are updated based on Energy Trust's 2017 value for the embedded energy in water savings.

Cost Effectiveness

Table 1 Cost Effectiveness Calculator Oregon

Measure	Measure Life (years)	Savings (kWh)	Savings (therms)	Incremental Costs ($)	Non-Energy Benefits (Annual $)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR	% Electric Allocation	% Gas Allocation
Commercial laundry ≥ MEF 2.2	7	460	26	$425	$152	$209	1.00	2.62	75%	25%
Commercial laundry ≥ MEF 2.2 - Electric only	7	1,027	0	$425	$152	$347	1.00	2.94	100%	0%
Commercial laundry ≥ MEF 2.2 - Gas only territory	7	0	32	$425	$180	$67	1.00	2.68	0%	100%
Multifamily clothes washer in common area ≥ MEF 2.2	11	624	5	$425	$106	$354	1.00	2.98	95%	5%

Multifamily clothes washer in common area ≥ MEF 2.2 - Electric only	11	752	0	$425	$106	$405	1.00	3.10	100%	0%
Multifamily clothes washer in common area ≥ MEF 2.2 - Gas only territory	11	0	24	$425	$126	$78	1.00	2.75	0%	100%

Table 2 Cost Effectiveness Calculator Washington

Measure	Measure Life (years)	Savings (kWh)	Savings (therms)	Incremental Costs ($)	Non-Energy Benefits (Annual $)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR	% Electric Allocation	% Gas Allocation
Commercial laundry ≥ MEF 2.2 - Gas only territory	7	0	32	$425	$169	$71	1.00	2.43	0%	100%
Multifamily	11	0	24	$425	$108	$80	1.00	2.23	0%	100%

clothes washer in common area ≥ MEF 2.2 - Gas only territory										

Requirements

- ENERGY STAR (v7.1) front load commercial clothes washer
- Hot water fuel must be provided by an Energy Trust utility

Details

Commercial clothes washers are soft mount, generally 30 pounds of capacity or less. They wash many loads per day as they are in a commercial setting, or they are in the common areas of multifamily buildings and used by several families. Commercial clothes washers are rated by their Modified Energy Factor (MEF) which is an efficiency metric with units of ft^3/kwh/cycle. It combines mechanical energy used by the washer, water heating, and energy required to remove moisture content after the spin cycle. Another efficiency metric used by ENERGY STAR is the Water Factor (WF), which is the gallons of water per cycle per unit volume of laundry. ENERGY STAR commercial clothes washers have MEF ≥ 2.2 and WF ≤ 4.5.

Savings and Baseline

The baseline is shown in Table 3.

Table 3 Baseline Washer Categories

Washer Category	**Market Share**
Top Load MEF 1.60 to 2.19	71.6%
Top Load MEF 2.20 and greater	0%

Front Load MEF 2.00 to 2.19	3.6%
Front Load MEF 2.20 and greater	24.9%

While this measure requires that hot water fuel must be provided by an Energy Trust participating utility, the savings are weighted assuming the fuel splits in Table 4, which shows the percentage of equipment that is assumed to be electric. Laundromat, lodging, and hospital fuel splits are based on 2012 CBSA: Regional Building Characteristics Summary (Table A6) and the total number of commercial dryers in the database. Multifamily fuel splits are based on 2011 RBSA.

Table 4 Assumed percentage of electric water heat and electric dryers in full and partial service territories

	Dual Fuel Territory		**Gas Only Territory**		**Electric Only Territory**	
	Water heat	**Dryer**	**Water heat**	**Dryer**	**Water heat**	**Dryer**
Commercial	22%	77%	0%	77%	100%	100%
Multifamily	87%	74%	0%	74%	100%	100%

All savings are due to reduced water usage and reduced dryer energy. The washer itself does not use less electricity per cycle than a standard washer. Savings are based on the following assumptions:

- 1,095 cycles per year are used for multifamily and 1,497 cycles per year are used for the commercial sector referenced from 2014 US DOE Technical Support Document (TSD) for commercial clothes washers.
- Electric water heating efficiency is 98% and gas water heating efficiency is 75% in agreement with DOE TSD.
- Per TSD, average washer load is 13.50 lbs of dry clothes per load
- 50% of fresh water remains in moisture content of clothes per Bevan study “Two Case Studies Describe Significant of Energy Embedded in Water”

Cost

Incremental costs are referenced from the 2014 US DOE TSD for commercial clothes washers.

Comparison to RTF or other programs

Analysis is heavily based on RTF Commercial Clothes Washer v4.4 measure.

Measure Life

Measure life is taken from RTF analysis which uses 7 years for commercial applications and 11 years for multifamily applications. The RTF references the 2014 U.S. DOE TSD for commercial clothes washers.

Non Energy Benefits

Non-energy benefits due to water savings are determined using most recent Energy Trust rates, net of embedded electricity which is included as electricity savings.

In gas only territory, electric bill savings (from electric dryers) and electric embedded water savings are included as non energy benefits.

A maintenance cost ($19 and $30) is included as a negative non-energy benefit corresponding to RTF assumptions regarding regular maintenance of commercial washing machines.

Incentive Structure

The maximum incentives listed in Table 1 and Table 2 are for reference only and are not suggested incentives. Incentives will be structured per clothes washer.

Follow-Up

This measure should be updated following any changes to federal standards or ENERGY STAR specifications. Maintaining alignment with the RTF is preferred. Costs should be updated at the next revision. Consider splitting measure by water heating fuel rather than by territory at next revision.

Supporting Documents

The cost effective screening for these measures is attached and can be found along with supporting documents at:

I:\Groups\Planning\Measure Development\Commercial and Industrial\Commercial Appliances\clothes washer

Commercial Clothes Washer CEC.xlsx

References

U.S. DOE's 2010-01-19 Commercial Clothes Washers Final Rule Technical Support Document: Chapter 8. Life-Cycle Cost and Payback Period Analysis http://www.regulations.gov/#!documentDetail;D=EERE-2012-BT-STD-0020-0036

RTF Commercial Clothes Washers https://rtf.nwcouncil.org/measure/clothes-washers

Version History and Related Measures

Energy Trust has been supporting commercial clothes washers for many years. This measure predates our current measure approval and record retention policies. Table 5 may be incomplete, particularly for activities prior to 2013.

Table 5 Version History

Date	Version	Reason for revision
6/27/2005	x	Approve commercial clothes washers for multifamily and laundromats. MEF>1.8
12/08/2006	x	Change incentives
3/09/2007	x	Update measure to MEF>2.0
3/06/2009	x	Update measure to align with CEE tier II specifications. MEF ≥ 2.0 WF ≤ 6.0. Blend Multifa savings

3/10/2009	x	Add partial territory clarifications and correct errors
11/06/2015	89.x	Update for ENERGY STAR 7.1. Split analysis for multifamily and commercial settings, add commercial building types. Weights water and dryer fuels. MEF >2.2.
1/22/2016	89.1	Adds residential new homes small multifamily as applicable program
9/19/17	89.2	Update water NEBs and embedded energy, maximum incentives.

Table 6 Related Measures

Measures
Multifamily in-unit clothes washers

Approved & Reviewed by

Jackie Goss, PE

Sr. Planning Engineer

Mike Bailey PE

Engineering Manager Planning

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Measure Approval Document for Multifamily In-Unit Clothes Washers

Valid Dates
January 1, 2018 – December 31, 2018

Description
“In-unit” clothes washers sold to the multifamily market. This measure is offered as both a buydown and standard incentive.

Program Applicability
Based on the referenced analysis and associated cost-effectiveness screening, the measures described below are approved on a prospective basis for use in the following programs:

- New Multifamily
- Existing Multifamily

Within these programs, the measure is applicable to the following cases:

- New
- Retrofit
- Replacement

Purpose of Re-Evaluating Measure
This MAD is updated to reflect new NEBs for water savings. Savings are unchanged from MAD 152.1.

A new ENERGY STAR specification (8.0) has been finalized and is effective February 5, 2018. *The savings for the new specification are not included here*. The program has historically honored a grace period of 6 months when ENERGY STAR specifications change to allowed for retailer sell-through and newly specified products to hit the sales floor. The savings for this measure are based on RTF's last analysis (approved April 2015). The measure will be updated to reflect 8.0 specification prior to September 1, 2018. Savings for the new specification are expected to be higher, so if any 8.0 are sold using this measure savings will be conservative. It is unknown at this time when RTF will complete an updated analysis that reflects the 8.0 specification, if RTF work will not be completed in time, the program will provide the analysis.

Cost Effectiveness
Table 1 Cost Effectiveness Calculator Oregon

Measure	Measure Life (years)	Savings (kWh)	Savings (therms)	Incremental Costs ($)	Non-Energy Benefits (Annual $)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR	% Electric Allocation	% Gas Allocation
MF Clothes Washers - Electric DHW	14	255	0	$209	$52.09	$157	1.10	3.41	100%	0%
MF Clothes Washers - Gas DHW	14	117	6	$209	$52.09	$157	0.66	3.08	75%	25%
MF Clothes Washers - Gas only Territory	14	0	6	$209	$66.00	$157	0.16	3.39	0%	100%
MF Clothes Washers - Weighted DHW	14	224	1.35	$209	$52.09	$157	1.00	3.33	96%	4%

Exceptions
The OPUC provided an exception on September 2, 2015 for higher incentives on clothes washers in gas service territory that are not cost-effective on the basis of the established exceptions listed in UM-551, Criteria C: “The measure is included for consistency with other demand side management (DSM) programs in the region.” The OPUC directed Energy Trust to consider cost-effectiveness for clothes washer measures based on efficiency rating as a group, rather than separating them into different incentives based on territory. The weighting is based on program data which shows that 78% of multifamily clothes washer participants have electric DHW while 22% multifamily clothes washer participants have gas DHW.

Requirements
- Residential front-loading clothes washers
- 2.38 or higher Integrated Modified Energy Factor (IMEF)
- At least 2.5 cubic feet tub capacity
- Water heating fuel must be provided by an Energy Trust participating utility
- Oregon Only

Details
Two metrics are used in discussion of clothes washer efficiency. Integrated Modified Energy Factor (IMEF) is a measure of washer efficiency considering the volume of the washer, the mechanical energy used by the washer, water heating, and energy required to remove moisture content remaining after the spin cycle. A higher IMEF indicates higher energy efficiency. Integrated Water Factor (IWF) is the gallons of water per cycle per unit volume of laundry. A lower WF indicates higher water efficiency. ENERGY STAR 7.0 requires residential clothes washers above 2.5 cubic feet to have IMEF ≥ 2.38 and IWF ≤ 3.7.

Savings and Baseline
The methods and values in this measure analysis are uniformly those used by the RTF in their v5.4 workbook approved 4/15/15.

Baseline
The baseline characterization for this measure are based on MF sales data provided by a distributor in 2015, which is taken to be representative of the multifamily (in-unit) market. There are two distinct categories of washers in this data set:

- Federal standard top-loaders (85% of sales)
- High efficiency front-loaders (15% of sales)

Consistent with the baseline method for Energy Trust’s residential clothes washer measure (MAD ID 4) and with the RTF’s baseline method, a combined top & front loader baseline representing current practice for the multifamily “in-unit” market is calculated for determining energy savings. Calculating savings with respect to a combined baseline in this way assumes that customers who would have bought top-loading clothes washers are able and willing to purchase front-loaders instead. Since the multifamily washer baseline included efficient front-loaders, no free-ridership multipliers should be applied to this measure.

Washing Machine Energy
Energy use are determined from the energy used per cycle multiplied by 273 cycles per year. Energy per cycle is a function of configuration (front vs top load) and IMEF and calculated using DOE methods modified by the RTF. ENERGY STAR washers use more electricity in than market baseline washers do. The energy penalty is an increase of 13 kWh per year, which is more than made up for in decreased dryer energy and hot water savings.

Dryer Energy
Dryer savings are determined by the difference in Rated Remaining Moisture Content (RMC) between the efficient and baseline washing machines. This difference in moisture content is multiplied by the annual cloth weight and typical dryer energy usage per pound of moisture to determine the annual dryer energy savings. For electric dryers, this is a savings of 130 kWh. All dryers are assumed to be electric in in-unit multifamily settings.

DHW Energy
Domestic Hot Water (DHW) savings are the reduction in energy used to heat DHW based on the lower amount of water used by machines with lower IWF. For electric water heaters, a water heater efficiency of 100% is assumed. For gas DHW, a water heater efficiency of 75% is used. The energy savings for electric DHW is 138 kWh. The savings for gas DHW is 6.3 therms.

Comparison to RTF and other programs
This measure is based on RTF analysis. While the RTF specifies savings for various combinations of dryer fuel, DHW fuel and efficiency tiers, Energy Trust uses only assumptions appropriate to the multifamily market for this measure.

Energy Trust's offing for residential clothes washers is based on the same basic analysis but uses a different market baseline more appropriate for that sector.

Measure Life
A measure life of 14 years is used, consistent with the RTF's residential clothes washer measure.

Cost
All baseline and incremental costs are taken from the multifamily sales data. A combined and weighted top and front-loader baseline is used, with incremental cost representing the difference in cost between the baseline and ENERGY STAR efficiency front-loaders.

Non Energy Benefits
Annually, an ENERGY STAR front-loading clothes washer is expected to save 3,918 gallons of water in a multifamily setting. A non-energy benefit is water and wastewater savings, resulting in lower water bills and embedded electricity savings within the water system for reduced transportation of water. The non-energy benefit from water savings is $52.09.

In gas-only territory, customer electric bill savings are a non-energy benefit because the electric energy savings are not claimed.

Incentive Structure
The maximum incentives listed in Table 1 are for reference only and are not suggested incentives. Incentives will be structured per clothes washer. The maximum incentive is based on the expected mix of electric and gas DHW and is not cost effective for gas DHW, but has an exception from the OPUC.

Follow-Up
This MAD will be updated with new analysis for ENERGY STAR 8.0 specification as soon at that information is available and that will replace this approval on or before December 31, 2018.

Supporting Documents
The cost effective screening for these measures is attached and can be found along with supporting information at:
I:\Groups\Planning\Measure Development\Residential\Res Appliances\clothes washer\multifamily clothes washers

MF Clothes Washers CEC.xlsx

References
- ResClothesWashersSF_v5_4.xlsm https://rtf.nwcouncil.org/measure/clothes-washers-0

Version History and Related Measures
Energy Trust has been supporting and incenting clothes washers for many years. Past measures predate our approval and records retention processes. Table 2**Error! Reference source not found.** may be incomplete, especially for measures approved before 2013.

Table 2 Version History

Date	Version	Reason for revision
7/9/04	x	Residential Clothes washer measure for 1.26 and 1.42 MEF.
1/14/05	x	Residential Clothes washer measure for MEF 1.8.
2006	x	Residential Clothes washer measure for MEF 1.8, updated federal standard.
6/27/07	x	Residential Clothes washer measure for MEF 2.0.
12/3/07	x	Products program clothes washers for tiers at 2.0 and 2.2 MEF.
11/24/10	4.x	Differentiates baseline and savings between single family and multifamily applications. Weighted dryer fuel type. Tiers at 2.2 and 2.46 MEF.
11/21/12	4.x	Multifamily applications removed from MAD 4. Other changes to residential washer requirements.
10/29/15	152.x	Multifamily Clothes washer measures for IMEF 2.74. Cost update. Distributor buy-down only.
11/11/15	152.1	Align with ENERGY STAR specification, IMEF 2.38
8/25/2017	152.2	Update non-energy benefits. Clarifies delivery channel.

Table 3 Related Measures

Measures	MAD ID
Residential clothes washers	4
Commercial clothes washers (coin-op laundry, commercial laundry, multifamily shared laundry)	89

Approved & Reviewed by

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Sr. Planning Engineer

Mike Bailey PE
Engineering Manager Planning

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Measure Approval Document for New Cooler Cases with Doors

Valid Dates
1/1/2018-12/31/2020

Description
Installation of new vertical medium-temperature grocery display cases with doors, instead of open cases.

Program Applicability
Based on the referenced analysis and associated cost-effectiveness screening, the measures described below are approved on a prospective basis for use in the following programs:

- Existing Buildings
- New Buildings

Within this market segment, applicability to the following building types are expected:

- Convenience Stores
- Grocery Stores
- Big Box Retail Stores with Grocery Sections

Measures are approved as cost-effective for use in the following segments:

- New
- Replacement

Cost Effectiveness
Table 1 Cost Effectiveness Calculator Oregon

Measure	Measure Life (years)	Savings (kWh/lf)	Savings (therms/lf)	Incremental Costs ($/lf)	Non Energy Benefits ($/lf)	Maximum Incentive ($/lf)	UCT BCR at Max Incentive	TRC BCR	% Electric Allo-cation	% Gas Allo-cation
Cooler Doors in Convenience, Electric Heating	15	412	0	$206		$206	1.41	1.41	100%	0%
Cooler Doors in Medium Grocery, Electric Heating	15	458	0	$206		$206	1.56	1.56	100%	0%
Cooler Doors in Large Grocery, Electric Heating	15	733	0	$206		$206	2.50	2.50	100%	0%
Cooler Doors in Convenience, Gas Heating	15	277	18.9	$206		$206	1.46	1.46	65%	35%
Cooler Doors in Medium Grocery, Gas Heating	15	196	36.8	$206		$206	1.68	1.68	40%	60%
Cooler Doors in Large Grocery, Gas Heating	15	494	33.7	$206		$206	2.61	2.61	65%	35%
Cooler Doors in Convenience, Gas Heating, Gas only	15		18.9	$206	$21.89	$106	1.00	1.67	0%	100%
Cooler Doors in Medium Grocery, Gas Heating, Gas only	15		36.8	$206	$15.48	$206	1.01	1.82	0%	100%
Cooler Doors in Large Grocery, Gas Heating, Gas only	15		33.7	$206	$38.96	$190	1.00	2.98	0%	100%

Table 2 Cost Effectiveness Calculator Washington

Measure	Measure Life (years)	Savings (kWh/lf)	Savings (therms/lf)	Incremental Costs ($/lf)	Non Energy Benefits ($/lf)	Maximum Incentive ($/lf)	UCT BCR at Max Incentive	TRC BCR	% Electric Allo-cation	% Gas Allo-cation
Cooler Doors in Convenience, Gas Heating	15		18.9	$206	$21.37	$114	1.00	1.59	0%	100%
Cooler Doors in Medium Grocery, Gas Heating	15		36.8	$206	$15.11	$206	1.08	1.81	0%	100%
Cooler Doors in Large Grocery, Gas Heating	15		33.7	$206	$38.02	$203	1.00	2.83	0%	100%

Requirements

- This measure is applicable to the purchase of new remote commercial refrigerated medium temperature display cases with doors in new construction or existing buildings when additional cases are added or existing cases are replaced.
- Self-contained condensing unit display cases are not eligible for this measure.
- Refurbished cases are not eligible for this measure.

Details

Warm air and moisture from the sales floor (infiltration) are responsible for 70-80% of the refrigeration load on open vertical refrigerated display cases. Adding doors greatly reduces this infiltration, thereby reducing the load on the refrigeration system resulting in energy savings. In addition to refrigeration savings, there are interactive effects with the store's heating and cooling systems leading to heating savings, and a cooling penalty.

Measure Analysis

The baseline is a new vertical medium temperature remote commercial refrigerated display case without doors.

Savings were calculated to include savings/penalties associated with the following components: decreased load on refrigeration system due to decrease in infiltration from the sales floor, interactions with the building heating, and interactions with building cooling.

The infiltration savings is calculated as the difference between the case load without doors and with doors multiplied by the estimated full load refrigeration hours based on building type and region divided by the code minimum EER (12.85) for a medium temperature remote commercial refrigeration display case[i]. The EFLH hours estimates were derived using hourly reports produced using the GrocerSmart eQUEST models. Hourly reports were generated for the building refrigeration load, heating load, and cooling load. The sum of all hourly loads was divided by the peak annual load to determine the annual equivalent full load hours. Separate models were used representing Convenience Stores, Small Grocery, Medium Grocery, and Large Grocery. Cases with doors are assumed to have 75% lower infiltration loads and 55% lower conduction loads than cases without doors, resulting in overall loads for cases with doors, 27% of those for cases without doors[ii].

The building heating savings is calculated as the difference between the case load without doors and with doors multiplied by the estimated full load heating hours based on building type and region divided by the code minimum heating efficiency for either a gas fired furnace or an electric heat pump system.

The building cooling penalty is calculated as the difference between the case load without doors and with doors multiplied by the estimated full load cooling hours based on building type and region divided by the code minimum air conditioner efficiency.

Savings were reported separately based on the following categories:

1. Building type: convenience stores and small grocery stores (modeled to represent <14,000 SF), medium grocery stores (≥14,000 SF, <75,000 SF), and large grocery stores (≥75,000 SF with non-grocery spaces)
2. Type of building heat: electric or natural gas
3. Energy Trust region: Portland, Eugene, Astoria, Medford, and Pendleton.

Savings calculations are included in the workbook called: "NB Medium Temperature Case Doors Calculator_07252017.xlsx".

Self-contained refrigerated cases were excluded from this analysis. A leading display case manufacturer informed the program that due to the new 2017 DOE energy efficiency requirements for refrigerated cases, they do not currently offer a self-contained medium temperature case that has doors.

Savings are reported separately for different store sizes/types, as the savings between different store types showed relatively high variation. Savings are averaged across different weather locations, as the savings between different locations showed relatively low variation. The combined savings and analysis of differences between store sizes and locations can be found in the "NB Medium Temperature Case Doors Sorted Savings_07252017.xlsx" spreadsheet. Final savings are shown in Table 1.

Comparison to RTF or other programs

The RTF's cooler door retrofit measure of doors onto existing cases is currently inactive.

Energy Trust's Existing Buildings program has a cooler door retrofit measure (MAD ID 47) based on the RTF's now-inactive measure (workbook v1.0)[iii]. Both costs and savings are expected to be lower for new cases than for retrofits. The lower savings are partially due to differences in calculation methods, and partially due to the assumption of higher efficiency refrigeration equipment. Energy Trust's retrofit measure does not differentiate by store type.

Measure Life

The measure life is 15 years, consistent with other standard grocery refrigeration measures in Energy Trust and RTF programs.

Cost

A leading display case manufacturer was surveyed and it was estimated that the average incremental cost of purchasing a remote commercial medium temperature vertical case with doors compared to one without doors was $206.25/linear foot of case.

Non Energy Benefits

In Energy Trust's gas-only territory, where Energy Trust cannot incent or claim electric savings, electric bill savings experienced by customers are calculated as non-energy benefits.

Incentive Structure

The maximum incentives listed in Table 1 and Table 2 are for reference only and are not suggested incentives. Note that in gas-only territory, maximum incentives are lower than in full-service or electric-only territory and differ by grocery size and between Oregon and Washington. This measure is applicable to the grocery Market Solutions offering. New Buildings incentives must be set such that projects receiving a the highest Market Solutions bonus do not exceed the maximum incentives.

Incentives will be structured per linear foot of case.

Follow-Up

Minimum efficiency for commercial refrigeration equipment is defined by federal standards, documented in 10 CFR 431.66. This measure should be revised when commercial refrigeration equipment standards are revised.

Supporting Documents

The cost effective screening for these measures is attached and can be found along with other supporting documents at:
I:\Groups\Planning\Measure Development\Commercial and Industrial\Grocery\cooler doors\New coolers

NB Medium Temperature Case D

Version History and Related Measures

Table 3 Version History

Date	Version	Reason for revision
8/11/17	201.1	Approve cooler doors for new cases.

Table 4 Related Measures

Measures	MAD ID
Cooler Door Retrofits	47
Grocery Market Solutions	161

Approved & Reviewed by

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Sr. Planning Engineer

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Engineering Manager - Planning

Disclaimer

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[i] DOE federal standard electronic code of federal regulations Subpart C 2017 references AHRI standard 1200 (I-P)-2010 for the EER of remote commercial display cases.

[ii] Faramarzi, Ramin T., B.A. Coburn and R. Sarhadian, 2002. *Performance and Energy Impact of Installing Glass Doors on an Open Vertical Deli/Dairy Display Case*. ASHRAE Transactions, AC-02-7-2, pp 673-679.

[iii] https://rtf.nwcouncil.org/measure/walk-inreach-door-retrofit

Measure Approval Document for Automated Thermostat Optimization – Winter Seasonal Savings

Valid Dates
November 10, 2017 – December 31, 2020

Description
Seasonal Savings is an offering of Nest Labs. It is a service that Nest Labs provides to utility programs on a fee for service basis. Existing Nest users are recruited via messages on the Nest Thermostat and via e-mail requesting they sign for a free energy saving service. There are two enrollment periods each year, summer and winter. These messages can be cobranded. Once enrolled, Nest Labs applies a series of algorithms over a three-week period that seeks to deploy consumer acceptable adjustments to the thermoset settings. This occurs during occupied hours as well as unoccupied times. The changes in interior temperature are minor, less than 1.5 degrees Fahrenheit in all cases. The measure reduces heating and cooling run time by lowering the average temperature difference between indoors and outdoors.

Program Applicability
Based on the referenced analysis and associated cost-effectiveness screening, the measures described below are approved on a prospective basis for use in the following programs:

- Residential

Purpose of Re-Evaluating Measure
Transition from pilot to standard measures. Incorporates evaluation findings from the 2016 pilot. Limits offering to winter season only.

Cost Effectiveness
Table 1 Cost Effectiveness Calculator Oregon

Measure	Measure Life (years)	Savings (kWh)	Savings (therms)	Incremental Costs ($)	Non-Energy Benefits (Annual $)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR	% Electric Allocation	% Gas Allocation
Forced Air Furnace - Winter Seasonal Savings	1	33	16	$3	$0.16	$6.54	1.1	2.5	27%	73%
Heat Pump - Winter Seasonal Savings	1	121	0	$3		$6.54	1.0	2.2	100%	0%

Table 2 Cost Effectiveness Calculator Washington

Measure	Measure Life (years)	Savings (kWh)	Savings (therms)	Incremental Costs ($)	ELE Bill Savings NEB (Annual $)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR	% Electric Allocation	% Gas Allocation
Forced Air Furnace - Winter Seasonal Savings	1	35	16	$3	$2.86	$6.26	1.0	3.0	0%	100%

Requirements
- Participant to have a web connected Nest thermostat with primary heating fuel provided by participating Energy Trust's Oregon utility.
- Home heated with air source heat pump or forced air furnace in Oregon
- Home heated with forced air furnace in Washington
- Winter Seasonal Savings only. Summer seasonal savings are not approved.

Savings and Baseline
Savings are based on a heating system runtime reduction model. Table 3 provides the 2017 impact evaluation results specifically for gas forced air furnaces and heat pumps for the winter seasonal savings offer.[1]

Table 3 Evaluated Winter Seasonal Savings Findings for Gas Furnaces and Heat Pump Opt-in Participants

Equipment	Runtime Reduction (Hours)	Fuel	Equipment Capacity Assumption	Per Device Savings
Gas Furnace	27	Natural Gas	65 kBtu/hour	17.8 therms
		Electricity (Fan)	0.56 kW	15.3 kWh
Heat Pump	40	Electricity (Heat Pump)	3 kW	120.9 kWh

Heat pump savings estimates of 121 kWh are taken directly from the pilot evaluation.

Savings for participants with forced air furnaces are more complex. The pilot evaluation looked at savings from gas heated forced air furnaces in the sample. However, the actual fuel source for furnaces cannot be determined remotely by Nest Labs, so some participants will have forced air furnaces with other fuel sourced, necessitating a weighted distribution of fuel savings.

Runtime hour reduction and fan kW and fan savings are assumed to be equivalent across furnace types. Electric furnace kW capacity is estimated using an RTF formula used in their weatherization savings modeling based on dwelling calculated UA and heating zone.[2] To estimate a climate zone weighted kW capacity the 2011 Residential Building Stock Data for electric furnace forced air furnaces in Oregon used and resulted in a population weighted estimate of 7.2 kW across heating zones one and two.[3] With runtime reduction of 27 hours, electric furnace heating savings are 196 kWh.

Table 4 Gas and Electric Furnace Runtime Reductions, Equipment Size and Unweighted Savings Estimates

Heating Fuel	Runtime Reduction (Hours)	Savings Source	Equipment Capactiy (Kbtu/hr or kW)	Per Device Savings
Gas Furnace	27	Heating Energy	0.65	17.8 therms
		Fan Energy	0.56	15.3 kWh
Electric Furnace		Heating Energy	7.15	196 kWh
		Fan Energy	0.56	15.3 kWh

The following assumptions were used to weight savings between gas and electric furnaces.

[1] Energy Trust of Oregon Nest Seasonal Savings Evaluation
[2] Residential Single Family Existing HVAC and Weatherization – February 2016
[3] Residential Building Stock Assessment – Single Family Database

- Survey findings in the 2017 seasonal savings evaluation found approximately 1% of non-heat pump systems were fueled by either propane or oil. Savings from these homes are not included in this analysis.
- Of the 99% of furnaces that do not use propane or oil, the weighting between gas and electric fuel is based on Energy Trust program participation recorded distribution of incented Nest furnace installations, which is 90% gas and 10% electric.
- Fan savings for gas fueled furnaces are de-rated 10% based on Project Tracker data identifying devices installed in Energy Trust gas-only territory in Oregon. The non-energy benefit section describes how these values are treated.

Table 5 and Table 6 summarize the weightings used to estimate savings for the forced air furnace measures.

Table 5 Weighted Furnace Savings Calculation Oregon

Heating Fuel	Savings Source	Savings per Furnace (therm or kWh)	Furnace Fuel Split	Weighted Savings (therm or kwh)	Participating Fuel Territory	Weighted participating Therms	Weighted Participating kWh	Unclaimable kWh
Gas Furnace	Heating Energy	17.8	89.1%	16	100%	16		
	Fan Energy	15.3		13.7	90%		12.3	1.4
Electric Furnace	Heating Energy	196	9.9%	19.4	100%		19.4	
	Fan Energy	15.3		1.5			1.5	
Oregon Furnace Weighted Seasonal Savings						**16**	**33**	**1**

Table 6 Weighted Furnace Savings Calculation Washington

Heating Fuel	Savings Source	Savings per Furnace (therm or kWh)	Furnace Fuel Split	Weighted Savings (therm or kwh)	Participating Fuel Territory	Weighted Participating Therms	Weighted Participating kWh	Unclaimable kWh
Gas Furnace	Heating Energy	17.8	89.1%	16	100%	16		
	Fan Energy	15.3		13.7	0%			13.7
Electric Furnace	Heating Energy	196	9.9%	19.4	0%			19.4
	Fan Energy	15.3		1.5				1.5
Washington Furnace Seasonal Savings						**16**		**35**

These factors result in a weighted forced air furnace savings estimate in Oregon per participating device of 16 therms and 33 kWh, and 16 therms in Washington.

Measure Life

The current estimated measure life is one year, as persistence of savings beyond one heating season have not been evaluated at this time.

Cost

Costs are $3 per customer device opt-in per season as of the 2017-2018 heating season. It is unknown how frequently the cost for this service will change or if the cost will trend up or down. The measure is cost effective up to $6.54 in Oregon and $6.26 in Washington.

Non Energy Benefits

A benefit of $0.16 per Oregon participant to account for fan kWh savings for 10% of the existing gas furnace Nest installation base falling outside Energy Trust served electric utility territory. This was calculated using Energy Trust's assumed residential electric rates.

In Washington, the full 35 kWh electric furnace and fan savings estimate are converted to a NEB in the cost effectiveness calculation in Table 2.

Incentive Structure

The maximum incentives listed in Table 1 and Table 2 are for reference only and are not suggested incentives. Incentives will be structured per customer device opt-in per season and paid to the service provider. The maximum listed in the table is the highest cost effective incentive, rather than capping at the actual 2018 costs to allow for the potential of cost increases over time without re-approval.

Follow-Up

Nest randomly assigns eligible devices to treatment and control groups and will conduct a savings evaluation based on the methods outlined in Energy Trust's 2017 third party evaluation. A 70% treatment 30% control assignment allows for significant savings acquisition while maintaining a control sample for statistically valid savings estimates. The cost of this analysis is covered in Nest's administrative fee. If findings from this analysis challenge the measure's assumptions, the measure should be reanalyzed.

Evaluation of the 2017 winter offering may result in identification of persistence of savings beyond one year. If that is the case, the measure and MAD could be updated to change the measure life.

There is ongoing research regionally and nationally regarding smart thermostats. Any relevant findings should be considered at the next major update.

Supporting Documents

The cost effective screening for these measures is attached and can be found along with supporting documentation at:
I:\Groups\Planning\Measure Development\Residential\Res HVAC\thermostat\web enabled thermostat\seasonal savings

Automated Thermostat Optimiz

Version History and Related Measures

Table 7 Version History

Date	Version	Reason for revision
6/2/2016	173.1	Pilot approval. Winter and summer offerings.
11/10/2017	173.2	Transition from pilot to standard measure. Winter only. Savings update based on pilot evaluation.

Table 8 Related Measures

Measures	MAD ID
Contractor installed thermostats on new heat pumps (includes Nest)	19
Contractor installed thermostats of existing heat pumps (includes Nest)	148
Retail web enabled thermostats (includes Nest)	153

Approved & Reviewed by

Jackie Goss, PE
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Mike Bailey PE
Engineering Manager Planning

Disclaimer

Measure Approval Document for Energy Saver Kits

Valid Dates
January 1, 2018 – December 31, 2018

End Use
Energy Saver Kits (ESK)

Scope
Measures listed below are approved as cost-effective for use in the Existing Homes Program to be distributed via mail to single family, manufactured and multifamily residences.

Program Applicability
Based on the referenced analysis and associated cost-effectiveness screening, the measures described below are approved as cost-effective on a prospective basis for use in the Existing Homes program.

Cost Effectiveness

Table 1 Cost Effectiveness Calculator Oregon

Measure	Measure Life (years)	Savings (kWh)	Savings (therms)	Incremental Costs ($)	Non-Energy Benefits (Annual $)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR	% Electric Allocation	% Gas Allocation
Mail by request LED General Purpose, Dimmable, and Three-Way 250 to 1049 lm	12	8	0	$3.50	$1.02	$3.50	1.4	4.1	100%	0%
Mail by request LED Reflectors and Outdoor 250 to 1049 lm	12	12	0	$5.50	$1.56	$5.50	1.3	4.0	100%	0%
1.75 GPM Showerhead - Electric DHW - All Housing Types	15	212	0	$5.00	$19.29	$5.00	31.2	73.3	100%	0%
1.75 GPM Showerhead - Gas DHW - All Housing Types	15	5	9.2	$5.00	$19.29	$5.00	9.4	51.4	8%	92%
1.75 GPM Showerhead - OR Gas ONLY DHW - All Housing Types	15	0	9.2	$5.00	$19.72	$5.00	8.6	51.5	0%	100%
1.5 GPM Showerhead - Electric DHW - All Housing Types	15	282	0	$5.00	$25.59	$5.00	41.5	97.2	100%	0%
1.5 GPM Showerhead - Gas DHW - All Housing Types	15	7	12.3	$5.00	$25.59	$5.00	12.4	68.1	8%	92%
1.5 GPM Showerhead - OR Gas ONLY DHW - All Housing Types	15	0	12.3	$5.00	$26.17	$5.00	11.4	68.4	0%	100%
1.75 GPM Shower Wand - Electric DHW - All Housing Types	15	212	0	$10.00	$19.29	$10.00	15.6	36.6	100%	0%
1.75 GPM Shower Wand - Gas DHW - All Housing Types	15	5	9.2	$10.00	$19.29	$10.00	4.7	25.7	8%	92%
1.75 GPM Shower Wand - OR Gas ONLY DHW - All Housing Types	15	0	9.2	$10.00	$19.72	$10.00	4.3	25.8	0%	100%
1.5 GPM Shower Wand - Electric DHW - All Housing Types	15	323	0	$10.00	$29.37	$10.00	23.8	55.8	100%	0%
1.5 GPM Shower Wand - Gas DHW - All Housing Types	15	8	14.1	$10.00	$29.37	$10.00	7.1	39.1	8%	92%
1.5 GPM Shower Wand - OR Gas ONLY DHW - All Housing Types	15	0	14.1	$10.00	$30.03	$10.00	6.5	39.2	0%	100%
1.5 GPM Kitchen Aerator - Electric DHW - All Housing Types	15	134	0	$1.85	$13.70	$1.85	53.3	133.9	100%	0%
1.5 GPM Kitchen Aerator - Gas DHW - All Housing Types	15	4	5.8	$1.85	$13.70	$1.85	16.1	96.7	10%	90%
1.5 GPM Kitchen Aerator - OR Gas ONLY DHW - All Housing Types	15	0	5.8	$1.85	$14.01	$1.85	14.6	97.0	0%	100%
1.0 GPM Bath Aerator - Electric DHW - All Housing Types	15	75	0	$1.35	$7.64	$1.35	40.7	102.3	100%	0%
1.0 GPM Bath Aerator - Gas DHW - All Housing Types	15	2	3.2	$1.35	$7.64	$1.35	12.3	73.9	9%	91%
1.0 GPM Bath Aerator - OR Gas DHW - All Housing Types	15	0	3.2	$1.35	$7.81	$1.35	11.1	74.1	0%	100%

Table 2 Cost Effectiveness Calculator Washington

Measure	Measure Life (years)	Savings (therms)	Incremental Costs ($)	Non-Energy Benefits (Annual $)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR
1.75 GPM Showerhead - WA Gas ONLY DHW - All Housing Types	15	9.8	$5.00	$16.68	5.00	9.1	42.5
1.5 GPM Showerhead - WA Gas ONLY DHW - All Housing Types	15	13.0	$5.00	$22.13	5.00	12.1	56.4
1.75 GPM Shower Wand - WA Gas ONLY DHW - All Housing Types	15	9.8	$10.00	$16.68	10.00	4.5	21.3
1.5 GPM Shower Wand - WA Gas ONLY DHW - All Housing Types	15	14.9	$10.00	$25.40	10.00	6.9	32.4
1.5 GPM Kitchen Aerator - WA Gas ONLY DHW - All Housing Types	15	6.1	$1.85	$11.85	1.85	15.4	79.6
1.0 GPM Bath Aerator - WA Gas DHW - All Housing Types	15	3.4	$1.35	$6.61	1.35	11.8	60.8

Purpose of Re-Evaluating Measure

New avoided costs for 2018. Lighting update for 2018 in concert with other Energy Trust lighting measure updates.

Program Requirements

The maximum number of products distributed in each kit shall be determined by program staff in consultation with Energy Trust Planning.

Savings for showerheads and aerators must match the water heating fuel type. In gas only service territory, showerheads and aerators should only be distributed to customers with gas water heating. Lighting products should not be distributed in gas only service territory. In electric only service territory, showerheads and aerators should only be distributed to customers with electric water heat.

Each household should not receive a kit more often than once every two years, with reasonable and agreed upon exceptions, such as residency changes or alterations or additions in kit product content.

Savings and Baseline

Installation Rates

Kit product installation rates are taken from a combination of the Existing Homes 2013 and 2016 Process Evaluations. These studies asked energy saver kit recipients about both the products they already installed as well as the products they intend on installing in the future. At the time of the 2013 study, recipients could choose any quantity of lighting and water devices up to a maximum amount. The 2016 process evaluation findings are based on recipients having less choice over the quantities of products received, resulting in lower reported installation rates.

Table 3 Existing Homes Process Evaluation Installation Rates

	Received (Confirmed by Respondent)	Net Installed (Installed - Removed)	Net Install Rate	Installed and Planned within 6 Months	Installed and Planned within 12 Months	Projected 2017 Install Rates
A-lamps	1421	1053	74.1%	-	91.3%	**91.3%**
Reflectors	419	247	58.9%	-	90.7%	**90.7%**

Showerheads (2016 Process Evaluation)	261	127	48.7%	59.8%	-	54.3%
Showerheads (2013 install and planned install rates)	-	-	62.0%	86.0%	-	74.0%
Blended 2017 projected installation rate						**64.2%**
Kitchen Aerators (2016 Process Evaluation)	221	69	31.2%	40.7%	-	36.0%
Kitchen Aerators (received at least one)	153	61	39.9%	47.1%	-	43.5%
Blended 2017 projected installation rate						**39.8%**
Bath Aerators	244	113	46.3%	60.2%	-	**53.3%**

For LED light bulbs we assume everyone will install their LED bulbs within 4 years and that bulbs not installed immediately will be, on average, installed in 2 years. This combination accounts for storage of bulbs and later replacement upon failure of the existing bulbs. The initial installation rates for LEDs are 74.1% for A-lamps and 58.9% for Reflectors.

Showerhead installation rates uses a blend of the 2013 average of installation and planned installation within six months and the 2016 process evaluation findings. Updates to the order form logic in Q2-3 of 2017 allows for more consumer choice over the number of water devices included in their kits, leading to the use of the 2013 'build your own' installation rates. The intention is for fewer people who did not want showerheads or shower wands to receive them, thus increasing installation rates. These rates for showerheads are also being applied to shower wands as they have not previously been included as an option in kits and mail order installation rates are unknown for Energy Trust territory.

As the maximum number of kitchen aerators included in each kit is now 1, installation rates are based on a blend of the projected 2017 rates and a different analysis from the on 2016 process evaluation. The new rates are based on recipients who received and installed, or plan to install within six months, at least one kitchen aerator, resulting in slightly higher rates than the previous figures based on 2016 results.

Bath aerators use the 2016 findings as no substantive alterations have been made to the number of devices a consumer can order. Averaging the net installation and planned to install within six months results in a rate of 53.5% for savings estimates.

LED Measure Analysis

Energy Trust uses the basic principles and supporting data developed by the Regional Technical Forum (RTF) for analysis of these measures. In depth description of the measure and methods of analysis are available from the RTF website for the August 18, 2015 meeting at which the measures were approved: http://rtf.nwcouncil.org/meetings/2015/08/. The basis of the analysis for 2018 is a modified version of the RTF workbook (v5.1) updated with lighting market data from 2016.

2016 Northwest Residential Lighting Market Data Summary

The basis for market information, costs, and market share is a dataset provided to Energy Trust by NEEA. The initial market summary was developed for BPA, by Cadeo and Navigant, as part of BPA's 2015-2016 residential lighting market characterization study. NEEA is now the primary steward of this data set, relying on shelf survey data from the end of 2016 and Nielsen data for in Oregon, Washington, Idaho and Western Montana. The primary analyst, Cadeo, uses those data sources (weighted by retailer presence) to determine regional average lumens, watts, and cost, as well as market share, by lamp application, technology, and lumen bin.

Previously the BPA/NEEA data set included utility incentives in cost calculations. This year NEEA made an effort to remove the incentives from the calculations in an attempt to better capture the price a customer would have paid in the absence of utility programs.

Baseline

Because the retail lighting market is changing so rapidly, we use a market baseline calculation methodology with weighted averages of energy use for each lumen bin and lamp style for all four technology types (incandescent, halogen, CFL, and LED) based on sales percentages. As the online form for ordering an ESK is set such that LEDs are only provided to customers who indicate a high number of inefficient bulbs, it is assumed that the LEDs are replacing a blend of incandescent and halogen bulbs.

Savings Calculation Method

RTF's res lighting workbook v5.1 was changed in such a way that it is much easier to update the input data and adjust the assumptions around the impact of the 2020 Federal efficiency standard (known as EISA) in 2020. As a result, Energy Trust has transitioned back to using a modified version of the RTF workbook. The main benefits of this transition are more robust analysis and alignment with regional best practices. The primary methodological change between analysis for 2017 and 2018 is the use of a baseline replacement model, which Energy Trust had used in 2015 and 2016 but did not use in 2017 due to inability to adapt the prior version of RTF workbook in time for our program budget deadlines.

The basic savings analysis is outlined as follows:

- Compile sales data to compare each individual lamp type and lumen bin across each technology.
- Calculate baseline watts for each lamp type (Decorative and Mini-Base, Globe, etc.).
    - This is a weighted average wattage of each technology and lumen bin based on sales share for that lamp type.
    - The market baseline includes all 4 technology types, not just the inefficient types.
    - This includes normalizing wattage based on actual lumen output.
- Calculate weighted hours of use for each lamp type using 2011 RBSA lighting data.
- Using hours of use, calculate raw lighting savings for each lamp type using the baseline replacement model. The baseline replacement model assumes that for each bulb that burns out in any given year, half will be replaced with bulbs of the same type and half will be replaced with bulbs based on the current market mix of bulbs. Further discussion of the intricacies of methodology can be found in the RTF presentation on res lighting on June 16, 2015.
- Calculate an HVAC adjustment factor for each lamp type. This factor adjusts lighting savings for impact on heating and cooling loads, as has been done for retail lighting since the inception of such programs. It is based on the residential HVAC fuel and technology mix in the NW.
- Using HVAC adjustment factor, installation and removal rates, calculate adjusted savings.

The major changes in analysis, both from last year and changes to the RTF workbook, include:

- Storage rate for LEDs is based on ESK survey results, as discussed above.
- Removal rate is included in storage rate, and is set to 0%.
- The RTF workbook has been modified to make no assumptions about EISA, to make no cost projections and to keep all dollar figures in 2016, the year they were collected.

Aerator Measure Analysis

The aerator savings analysis follows the methodology used to calculate savings for the 2015 Energy Saver Kits with updated daily usage duration based on a Showerhead and Faucet Aerator Meter Study. Daily use for kitchen aerators is 4.6 minutes and bath aerators are 1.6 minutes per faucet per day at 50% of the maximum flow and a 75˚F difference between inlet and outlet water temperature is assumed. Aerator occupancy rates of 350 days annually have been aligned with showerhead and wand assumptions from the RTF.

Water from the faucet is assumed to be delivered at 104°F on average, which implies 68% hot water. Baseline flow rates were collected by CSG, during on site Home Energy Reviews. The existing stock of kitchen aerators averaged 2.71 gpm in single family homes and 2.8 gpm in multifamily buildings. Manufactured homes, representing 4% of kit recipients, have an unknown baseline kitchen aerator flow rates with 2.71 gpm from single family measurements used as a proxy. Weighted average kitchen aerator gpm is 2.74.

Bath aerator blended single/multifamily flow rates were 2.48 gpm. Manufactured home bath aerators are assumed to have identical flow rates to single/multifamily units.

Savings for both aerators and showerheads are affected by the number of occupants in a household. The average number of occupants in Oregon as determined by the 2015 American Community Survey is 2.74 for Single Family, 2.3 for multifamily and 2.44 in manufactured housing, resulting in a weighted average occupancy of 2.59 persons per home using a 64% single family/31% multifamily/4% manufactured housing split based on 2016 process evaluation ESK survey recipients. NW Natural territory in SW Washington occupancy for utility gas heated housing are 2.98 for Single Family, 2.34 for multifamily and 2.13 in manufactured housing resulting in a weighted average of 2.74 occupants based on the 2016 ESK survey.

Measure life is 15 years, consistent with past Energy Saver Kit analysis for aerators.

Avoided water system pumping from these low flow devices creates additional energy savings at a rate of 3.68 kWh/1000 gallons according to the RTF, in accordance with the 7th Power Plan. For installations outside Energy Trust electric service territory the embedded energy cost is not removed and the non-energy benefits are based on the full incremental sewer rates.

Table 5 Avoided water pumping kWh savings Oregon/Washington

Device	Rated Flow (gpm)	Oregon avoided water system pumping kWh	Washington avoided water system pumping kWh (converted to NEB in CE tool)
Showerhead	1.75	5.3	5.6
Showerhead	1.5	7.1	7.5
Shower wand	1.5	5.3	5.6

Device	Rated Flow (gpm)	Oregon avoided water system pumping kWh	Washington avoided water system pumping kWh (converted to NEB in CE tool)
Shower wand	1.5	8.1	8.6
Kitchen Aerator	1.5	3.8	4
Bath Aerator	1	2.11	2.23

The RTF uses a blended water and sewer rate from regional cities and towns to calculate the non-energy benefit of reducing water consumption, which Energy Trust follows. The rate is $13.09/1000 gallons for Oregon water utilities and $10.49 for Washington, after removing the portion of the rate attributable to water system pumping. The change in water volume annually includes both cold and hot water and is calculated by multiplying the change in flow rate, the minutes of device use and the installation rate.

Showerhead Measure Analysis

This memo follows the methodology used to calculate showerhead savings for the 2015 Energy Saver Kits, including some updated assumptions to align more closely with the RTF's showerhead analysis and a showerhead and aerator metering study.

The average number of occupants assumed here is the same as aerators; 2.59 persons per home on average across single family, multifamily and manufactured homes in Oregon (64%/31%/4%). Washington occupancy is 2.74 across all housing types using the same distribution as Oregon.

The average shower length remains at 7.84 minutes, and it is assumed that there are 0.46 showers per person per day, with a 350 day/year occupancy rate.

The change in water flow for showerheads and wands is calculated using an updated baseline flow rate assumption of 2.36 gpm for single family households that comes from the 2011 RBSA and 2.29 gpm for multifamily, based on a 2016 field study, weighted using the 2016 process evaluation and 2.41 gpm for manufactured homes from the 2011 RBSA, for a blended average flow rate of 2.34 gpm. The new flow rate is as assumed to be 90% of the showerhead's rated flow rate, called an *in-situ* flow rate, per the RTF and 81% of the 1.5 gpm shower wand's flow rated flow rate based on field observations.

Table 6 Rated and In-situ flow rates

Device	Rated GPM	In-situ measuring method	In-situ rate as percent of rated	As installed (GPM)
Showerhead	1.5	RTF de-rating	90%	1.35
Showerhead	1.75	RTF de-rating	90%	1.58
Shower wand	1.5	Field measured	81%	1.22
Shower wand	1.75	RTF de-rating	90%	1.58

Average water heater efficiency assumptions are taken from the RTF; 75% and 98% for gas and electric water heaters, respectively. A reduction in the cost of the water to the participant is attributed to non-energy benefits, as described in the section above on non-energy benefits of aerators.

Measure Life

Measure life for LEDs is 12 years, consistent with other Energy Trust measures for LED screw-in lamps intended for residential applications.

Measure life for water-saving products is 15 years, consistent with other Energy Trust showerhead, wand and aerator measures.

Costs

Costs reflect the per-item cost of the product and shipping to consumers.

Follow-Up

Energy Trust will continue to monitor lighting changes in the region. Lighting products will need to be reevaluated at least yearly to determine cost effectiveness for the following program year.

1.5 gpm showerheads and wands have previously had low customer satisfaction and high un-install rate. Newer models may limit these issues; though careful monitoring of installations will be necessary. Kit recipients will be surveyed by a third party firm for customer satisfaction and product installation rates during Q3-4 of 2017.

Assumptions and analysis for water savings devices should be examined in greater detail, including adopting methodology more in alignment with other regional entities, updating water heating efficiency assumptions and showers per person per showerhead per day.

Supporting Documents

The cost effective screening for these measures is attached and can be found at:

CEC 27 ESK 2018.xlsx

ETO Lighting calculation tool for 2018:
https://staffnet.energytrust.org/Operations/PandE/MeasureDev/CrossProgram%20Measure%20Work/ResLighting_v5.1%20ETO%20Version.xlsm?Web=1

References

- RTF Meeting on LEDs http://rtf.nwcouncil.org/meetings/2015/08/
- Retail lighting calculation tool for 2017: https://staffnet.energytrust.org/Operations/PandE/MeasureDev/CrossProgram%20Measure%20Work/ResLighting_v5.1%20ETO%20Version.xlsm?Web=1
- BPA's 2017 Northwest Residential Lighting Market Data Summary: https://www.bpa.gov/EE/Utility/research-archive/Documents/Momentum-Savings-Resources/2017_Residential_Lighting_Final_Report.pdf
- 2016 Existing Homes Process Evaluation: https://www.energytrust.org/wp-content/uploads/2017/02/Existing_Homes_Process_Evaluation_FINAL_wSR.pdf
- 2013 Existing Homes Process Evaluation: https://energytrust.org/wp-content/uploads/2016/12/EH_Process_Eval_0414.pdf
- RTF lighting workbook v5.2: https://nwcouncil.box.com/v/ResLightingv5-2https://nwcouncil.box.com/s/vu2d2uw5si5uyop848gyk2er0sg0xlv6
- RTF standard information workbook v2.6: https://nwcouncil.box.com/s/lm02cbwg419pxueedtvhw76newdhoxr3
- RTF residential showerhead workbook v3.1: https://nwcouncil.box.com/s/n7yzfpk5q5sfge39n7rfv68orbyxn45n

- Oregon Public Utility Commission 2015 Factbook: http://www.puc.state.or.us/docs/statbook2015WEB.pdf
- Clark Public Utilities current electric and water rates: https://www.clarkpublicutilities.com/about-cpu/public-documents/current-electric-water-rates/
- Multifamily Showerhead Study Report: https://www.energytrust.org/wp-content/uploads/2017/02/Energy_Trust_MF_Showerhead_Study_Report_FINAL_wStaffResponse.pdf

Version History and Related Measures

Table 4 Version History

Date	Version	Reason for revision
2/28/2013	27.X	New kitchen aerator flow rate
11/1/2013	27.X	Updated costs
8/26/2014	27.X	Updated baseline, sink water temperature
11/7/2014	27.X	RBSA and RTF alignment, LEDs replace CFLs
9/22/2015	27.X	RBSA and RTF alignment on showerhead and LED costs and savings
10/11/2016	27.X	Updating savings, installation rates for 2017 program year, added 1.5 gpm showerhead
6/13/2017	27.2	Updating savings, household occupants, showerhead/wand baseline flow rates, aerator usage duration, aerator annual occupancy days, installation rates for 2017 program year based on new form design, added 1.5 gpm shower wand, new incremental costs
6/21/2017	27.3	Fixed error in incremental costs for shower wands
10/5/2017	27.4	Updated avoided costs, lighting savings for 2018

Table 5 Related Measures

Measures	MAD ID
Single family direct install lighting	16
Multifamily direct install lighting	139
Direct Install Showerheads and Shower wands	157
Retail lighting	140
Retail shower wands	156
Retail showerheads	26
Living wise kit	30
Carry home savings kit	154
Community event and utility giveaway	155
Direct install showerheads	157
Residential aerator	51

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Measure Approval Document for Efficient Gas Fireplaces and Electronic Fireplace Ignitions

Valid Dates

January, 1 2018 to December 31, 2020

End Use or Description

Installation of thermally efficient gas fireplaces in existing single and multifamily construction and sales of electronic ignition equipped units in new and existing construction.

Program Applicability

Based on the referenced analysis and associated cost-effectiveness screening, the measures described below are approved on a prospective basis for use in the following programs:

- Electronic Ignitions
  - New Homes
  - Existing Homes
- Fireplace Efficiency Upgrades
  - Existing Homes
  - Existing Multifamily (2-4 living units and side-by-side units)

Purpose of Re-Evaluating Measure

Inputs updated in this MAD:

- Incorporation of midstream program data on unit fireplace efficiency and costs for common market baseline
- Updated fireplace efficiency distributions based on 2015's market transformation manufacturer and distributor forecasts for 2018
- Frequency of electronic ignitions being disabled
- Frequency of standing pilot lights reported to be turned off during the year
- Hours of use in existing homes
- Net to Gross calculations

Cost Effectiveness

Table 1 Cost Effectiveness Calculator Oregon

Measure	Measure Life (years)	Savings (therms)	Incremental Costs ($)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR
Gas fireplace Electronic Ignition	20	42.2	$108	$108	3.10	3.10
Existing Homes Fireplace Thermal Efficiency from 70 to 74.9 FE	20	51.4	$0	$150	2.72	40,808
Existing Homes Fireplace Thermal Efficiency at 75+ FE	20	63.2	$47	$250	2.01	10.8

Table 2 Cost Effectiveness Calculator Washington

Measure	Measure Life (years)	Savings (therms)	Incremental Costs ($)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR
Gas fireplace Electronic Ignition	20	42.2	$108	$108	3.23	3.23
Existing Homes Fireplace Thermal Efficiency from 70 to 74.9 FE	20	51.4	$0	$150	2.84	42,605
Existing Homes Fireplace Thermal Efficiency at 75+ FE	20	63.2	$47	$250	2.10	11.24

Requirements

Downstream Fireplace Efficiency Upgrade Measures

- Model listed on the Canadian EnerGuide list with natural gas specific FE rating[1]
- 70 or greater fireplace efficiency rating with ignition system identified as 'Intermittent' or 'Pilot On demand'

Midstream Electronic Ignitions

- Model listed on the Canadian EnerGuide list with natural gas specific FE rating [1]
- Model ignition system identified as 'Intermittent' or 'Pilot On demand'

Savings and Baseline

Energy Savings from Thermal Efficiency Improvements

The efficiency rating is the Fireplace Efficiency score from the Canadian P4 test.[2] Savings are calculated according to the following formula:

$$\Delta therm = hr\ x\ \frac{kBtu}{hr}\ x\ (\frac{1}{baseline} - \frac{1}{FE})$$

Fireplace Efficiency Market Baseline

The common market fireplace efficiency baseline for existing homes is determined by removing the portion of the total fireplaces installed in new residential construction and the associated efficiency distribution of these fireplaces.

Table 3 below describes the estimate of total fireplace units sold in Oregon and the splits between new and existing homes.

In 2016, an estimated 7,515 gas heated homes were completed in Oregon. Energy Trust surveys of builders and new home owners, with findings in both studies being given equal, indicate an average of 0.92 fireplaces are installed in new gas heated construction, resulting in an estimated market size of 6,913.

[1] Natural Resources Canada gas fireplace energy efficiency ratings search
[2] CAN/CSA-P.4.1-15 - Testing method for measuring annual fireplace efficiency

Results from the Energy Trust 2015 gas fireplace market transformation study indicated the total market at that time was 10,500 units.[3] Analysis for MAD 29.1 estimated the existing homes market to be 4,047 units. The volumes of downstream incentives since 2015 have been consistent and assuming a constant market share, the existing homes market is estimated to still be 4,047 units.

Taken together, the current estimated Oregon gas fireplace market is 10,960 units with 63% installed in new homes.

Table 3 New and Existing Home Market Share Estimates

Annual market Share Estimate Inputs		Estimated Market Shares
2016 Energy Trust Single and 2-4 dwelling homes completed	9,243	
Gas share of new homes	7,515	
Average of builder/new home owner survey reported fireplaces per new home	0.92	
Estimated unit installations in new homes	6,913	63%
Estimated unit installations in existing homes	4,047	27%
Total estimated Oregon gas fireplace market	10,960	100%

Midstream fireplace data collected from April 2017 – August 2017 indicate the majority of zero clearance fireplace units are installed in new construction, and these units are used as a proxy for the fireplace efficiency distribution for the new homes market.

Table 4 below presents the midstream distribution of fireplace efficiency applied to the estimated total units installed in new homes.

Table 4 New Home Fireplace Efficiency Distribution

FE Bin	Count of Midstream Zero Clearance Units	FE Distribution	Estimated new home unit distribution
75+ FE	15	0.3%	18
70-74.9 FE	129	2.2%	154
65-69.9 FE	491	8.5%	587
50-64.9 FE	5,107	88.4%	6,111
0-49.9 FE	36	0.6%	43
Total	5,778	100%	6,913

In 2015 gas fireplace manufacturers and regional distributors were asked to forecast the distribution of fireplace efficiency both in Energy Trust territory and in a comparison territory in eastern Washington and northern Idaho where incentives were not offered. This comparison territory forecast is the basis for the baseline fireplace calculation.

Table 5 and Table 6 below detail the manufacturer and distributor forecasts of fireplace efficiency applied to the total estimated fireplace market less the new home market share (based on new home unit distribution in Table 4) to estimate a weighted baseline efficiency for the existing homes market.

[3] Energy Trust Gas Hearth Market Transformation Study

Weighting the forecasts equally results in a baseline fireplace efficiency of **59.6**.

Average fireplace efficiency within each bin are based on midstream data collected from April 2017 – August 2017.

Table 5 Manufacturer Forecasted Existing Homes Baseline Fireplace Efficiency

FE Bin	FE bin mid-point	Manufacturer reported 2018 comparison FE distribution	Estimated units in market	Market Less new homes FE distribution	Weighted FE
75+ FE	76.4	1.8%	197	179	3.4
70-74.9 FE	72.3	10.0%	1,098	944	16.8
65-69.9 FE	67.9	23.9%	2,614	2,027	34.0
50-64.9 FE	55.7	60.4%	6,623	513	7.1
0-49.9 FE	45.4	3.9%	428	385	4.3
Totals	**-**	**100%**	**10,960**	**4,047**	**65.6**

Table 6 Distributor Forecasted Existing Homes Baseline Fireplace Efficiency

FE Bin	FE bin mid-point	Distributor reported 2018 comparison FE distribution	Estimated units in market	Market Less new homes FE distribution	Weighted FE
75+ FE	76.4	2.1%	232	214	3.8
70-74.9 FE	72.3	0.0%	-	-	-
65-69.9 FE	67.9	4.4%	484	-	-
50-64.9 FE	55.7	81.1%	8,891	2,780	35.9
0-49.9 FE	45.4	12.4%	1,354	1,311	13.8
Totals	**-**	**100%**	**10,960**	**4,305**	**53.6**

Hours of use

A total of 525 annual hours of use were extrapolated from the Energy Trust gas fireplace metering study for Existing Homes based on 15 hours of use per week for 35 weeks.[4] These figures match well with an estimated based on the study's finding of 0.18 hours of use per base 60 heating degree day multiplied by 2,955 (TMY3 base 60) long run heating degree days for Portland, OR, where the overwhelming majority of fireplaces are installed in Energy Trust service territory.

Table 7 shows the final therm savings for gas fireplace efficiency upgrades in existing homes. Average existing homes fireplace capacity and efficiency within incented tiers is derived from insert and freestanding gas fireplace midstream data.

Table 7 Existing Homes Fireplace Efficiency Therm Savings

FE Tier	Total Existing Homes HOU	Average Unit Capacity (kbtu/hr)	Baseline FE	Efficient FE	**Therm Savings**
70 - 74.9 FE	525	33.1	59.6	72.3	**51.4**

[4] Gas Fireplace Market Research & Metering Study

75+ FE	525	32.6	59.6	76.4	**63.2**

Energy Savings from Electronic Ignitions
The savings equation for electronic pilot light ignitions is:

$$\Delta therm = (8760 - Annual\ fireplace\ HOU)\ x\ (1 - disabled\ ignitions\ fraction)\ x$$
$$(1 - standing\ units\ disabled\ fraction)\ x\ \frac{1\ kbtu}{hr}$$

Table 8 below details the inputs used to calculate both gross and net savings for electronic ignitions on gas fireplaces.

Energy Trust's metering study in existing homes determined incented, efficient fireplaces are used for an average of 15 hours per week during the heating season, while new home occupants reported weekly hours of use at 6.1. A heating season duration of 35 weeks is used in line with the thermal efficiency savings estimates. Based on the new and existing home market share reported in Table 3 average heating season hours of use per week is 7.9, or 276 hours of use per year.

US DOE technical support documentation identified the average pilot light in standing mode is one kbtu/hr resulting in 84.8 therms saved over the 8,484 annual hours of off time for electronic ignitions compared to standing pilot lights.

Research by the Northwest Energy Efficiency Alliance (NEEA) in 2017 found that 12% of owners with electronic ignition equipped fireplaces disable the units resulting in standing pilot light operation. Additional NEEA research found just under 50% of owners with standing pilot light units left the pilots running during the non-heating season in Energy Trust service territory. Regionally this figure was 63%, due to uncertainty in the Energy Trust territory estimate the average of these figures and the wide interval the average, 56.4%, of the estimates is used in this analysis.

These factors combine to yield a gross savings estimate of 42.2 therms per electronic ignition.

Distributors interviewed for the market transformation study forecasted a difference in prevalence of electronic ignitions between Energy Trust and its comparison territory of 22% for the 2018 program year. These market actors also estimated that the existence of Energy Trust's program and incentives are responsible for 60% of the difference.

Multiplying these two factors results in a net to gross ratio of 13% for electronic ignitions and an estimated net savings of 5.6 therms per ignition.

Table 8 Full Electronic Ignition Savings Inputs

Electronic Ignition Savings (IPI and On-demand)	**Input**
Weeks in heating season	35
Weighted Hours of use (15 HOU/27% Existing Homes, 6.1 HOU/63% New Homes)	7.9
Total annual fireplace hours of Use	276
Annual fireplace off hours	8,484

Electronic Ignition Savings (IPI and On-demand)	**Input**
Ignition therm savings (pilot light usage 1 kbtu/h)	84.8
NEEA Study reported fraction of customers disabling EI	11.8%
Electronic Ignition Savings (IPI and On-demand)	74.8
Fraction of Standing Pilot Units left on in the off-season	56.4%
Electronic Ignition Gross Savings	**42.2**
Net to Gross Ratio	13.2%
Electronic Ignition Net Savings	**5.6**

Measure Life

US DOE technical support documentation estimates an effective useful life of 20 years for gas fireplaces.

Cost

Thermal Efficiency Improvement Costs

Common market baseline cost for fireplace efficiency upgrades is based on data used to determine the market baseline for savings. Table 9 and Table 10 detail the market actor forecasts of fireplace efficiency distribution less new homes.

Midstream median costs for insert and freestanding units, the bulk of which are installed in existing homes, are weighted to estimate a common market baseline cost.

Table 9 Manufacturer Forecasted Existing Homes Baseline Fireplace Efficiency

FE bin	Manufacturer reported 2018 distribution	Estimated units in market	Less new homes	Existing Homes FE Distribution	Insert/Freestanding Median Costs	Weighted Cost Baseline
75+ FE	1.8%	197	179	4%	$2,289	$101
70-74.9 FE	10.0%	1,098	944	23%	$2,031	$473
65-69.9 FE	23.9%	2,614	2,027	50%	$2,677	$1,341
50-64.9 FE	60.4%	6,623	513	13%	$2,110	$267
0-49.9 FE	3.9%	428	385	10%	$1,800	$171
Totals	**100%**	**10,960**	4,047	100%	-	**$2,354**

Table 10 Distributor Forecasted Existing Homes Baseline Fireplace Efficiency

FE bin	Distributor reported 2018 distribution	Estimated units in market	Less new homes	Existing Homes FE Distribution	Insert/Freestanding Median Costs	Weighted Cost Baseline
75+ FE	2.1%	232	214	5%	$2,289	$114
70-74.9 FE	0.0%	-	-	0%	$2,031	$0
65-69.9 FE	4.4%	484	-	0%	$2,677	$0
50-64.9 FE	81.1%	8,891	2,780	65%	$2,110	$1,363
0-49.9 FE	12.4%	1,354	1,311	30%	$1,800	$548
Totals	**100%**	10,960	4,305	100%	-	**$2,025**

Weighting the manufacturer and distributor derived cost baseline equally yields a common market baseline cost of **$2,189**. Table 11 below shows the median incremental cost for both fireplace efficiency upgrade tiers.

Table 11 Fireplace Efficiency Upgrade Incremental Costs by Tier

FE Tier	Median Tier Cost	Common market baseline cost	Median Incremental Cost
70 to 74.9 FE	$2,031	$2,189	-$159
75+ FE	$2,236	$2,189	$47

Negative incremental costs associated with fireplace efficiency improvements.

Market studies spanning 2009 to 2017 have consistency found fireplace unit aesthetics, including the flame, are the most important factor when purchasing a gas fireplace, with efficiency and price being the other most importance factors. These studies have also found a persistent and negative or negligible incremental cost for qualifying fireplaces.

Despite this, the existing homes market is still dominated by lower efficiency units, suggesting that incentives can play a role in further increasing the prominence of price and efficiency in the purchasing decision for a long lived piece of heating equipment.

As there are no indications that this negative/zero incremental cost scenario will change, the program is proposing hard caps on incentives in order to maintain a substantive presence and endorsement in the retail fireplace marketplace to continue influencing efficiency decisions but constraining incentive outlays.

In the long run, as the common market baseline efficiency increases, as indicated from market studies conducted from 2009 onward, savings per unit for fireplace efficiency upgrades will dwindle to the point where substantive incentives can't be offered, necessitating an exit from the existing homes market.

Electronic Ignition Costs

US DOE Technical Support Documentation for the rulemaking process gives the incremental manufacturing cost of electronic ignitions at $28 for vented fireplaces and $70 for vented log sets. This analysis takes the higher number and applies a 50% contractor mark-up for a 2015 incremental cost of $105, and $108 when adjusted to 2017 dollars using the GDP deflator.[5]

Incentive Structure

Fireplace Efficiency Upgrades

The maximum incentives for upgrades are capped at $150 for the 70-74.9 FE tier and $250 for the 75+ FE units. Fireplace efficiency upgrade incentives are currently paid to consumers through downstream application submission. Future program design may shift fireplace efficiency upgrade incentives to midstream and utilize a payment method similar to electronic ignitions.

[5] Regional Technical Forum SIW with GDP Deflator

Electronic Ignitions
The maximum incentives listed in Table 1 and Table 2 are for reference only and are not suggested incentives. Incentives for electronic ignitions will be paid on a per fireplace unit basis via midstream channels to distributors and retailers.

Follow-Up

Input variables most likely to change:

- Common market fireplace efficiency baseline
- Total fireplace units sold in Oregon
- Estimated market share of electronic ignitions in new and existing homes
- Estimated market share of new and existing homes
- Common market baseline costs as non-electronic ignition equipped unit data becomes available

Supporting Documents

The cost effective screening for these measures is attached and can be found at:

CEC 29 Residential Fireplace and Ignitic

Version History and Related Measures

Table 12 Version History

Date	Version	Reason for revision
2/28/2013	29.x	Approve fireplace efficiency tiers of 65-<70 and 70+ FE
8/11/2014	29.x	Approve electronic ignition savings and updated baseline for fireplace efficiency tiers of 70-<75 and 75+ FE
5/4/2015	29.x	Approve small multifamily applications
8/17/2015	29.1	Approve new fireplace efficiency and electronic ignition savings based on 2015 market transformation study baseline findings
10/27/2017	29.2	Approve new fireplace efficiency baseline, savings and cost calculations. Update savings for electronic ignitions based on Energy Trust and regional research findings

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September 4, 2014

Blessing Memo for condensing gas furnaces in two tiers for Northwest Natural Washington Service Territory

End Use

Gas furnace

Scope

Condensing furnaces in two tiers:

- AFUE 90%-94.9%
- AFUE 95%+

Program

Based on the referenced analysis, the measure described below is "blessed" on a prospective basis for inclusion in the Home Energy Savings and Multifamily Existing Buildings programs for properties with four or fewer living units in Northwest Natural's Washington service territory. The building stock for multifamily properties with four or fewer living units tends to be row houses or garden style apartments of two stories or less, having separate attic spaces, and individual entrances. For those reasons, we believe that the thermal properties for this subsector of the multifamily market is largely similar to detached single family homes in Washington. Furnaces in renter occupied properties in Oregon and Savings Within Reach are expected to have higher savings and are blessed separately, as the housing stock for Clark County, Washington is newer.

Description of the Measure

AFUE 90%+ gas furnaces operate in the condensing range, transferring more of the heat available in the moisture vapor in the exhaust gases to the circulating warm air.

Purpose of Evaluating Measure

This memo defines gas savings and maximum incentive for two furnace efficiency tiers in Northwest Natural Washington service territory.

Program Requirements

Condensing gas furnace installations must have a minimum AFUE of 90% and be located within Northwest Natural Washington service territory.

BCR Calculator attached and linked: E:\Planning\EE Programs\Home Energy Savings\HOUSE TYPES AND measures\single family\furnaces\Washington\bencost\SW WA Furnaces ETO C-E Calculator Residential 2015- 4.5.xlsx

Project	Measure Lifetime (Maximum 70 yrs)	Annual Gas Savings, therm	Total Cost	Max ETO Incentives	Utility System PV of Benefits	Societal PV of Benefits	Combined Utility System BCR	Combined Societal BCR
90-94.9% AFUE gas furnace	25	60.7	$500	$424	**$424**	**$424**	**1.00**	**0.8**
95%+ AFUE gas furnace	25	80.7	$950	$563	**$563**	**$563**	**1.00**	**0.6**

Note: this table uses 2015 avoided costs

Measure Analysis

Annual savings for 90%+ AFUE condensing gas furnaces range from 65 to 78 therms, with an average of 71 therms, based on the 2006-2009 impact evaluation estimates for the Oregon program.

This memo uses the multiple variable model estimates assuming that it more closely resembles potential load reductions from a newer housing stock in NW Natural Washington service territory. The model includes interactive effects from multiple measure installation, which diminish the per measure savings due to reduction in overall gas usage from such measures as weatherization.

Savings

Based on these findings, furnace savings in existing single family dwellings can be estimated using the following equation:

*Estimated multiple variable therm savings = (Efficient AFUE – 80% Baseline) * 5.14*

Northwest Natural Washington 2012-April 2014 incented gas furnace installation AFUE and estimated savings

Furnace efficiency tier	Weighted average AFUE	Therm savings relative to baseline
AFUE 90% to 94.9%	91.8%	60.7
AFUE 95%+	95.7%	80.7

Savings, Economics and Incentives

Incremental costs for furnaces can vary widely depending on manufacturer, product features and efficiency levels. Market research conducted in April 2014 collected a number of contractor bids for gas furnaces with a variety of options and efficiency levels. The study found that very high AFUE rated furnaces frequently featured ECM blowers and multi-stage burner controls associated with higher prices, but were not pre-requisites of furnaces achieving the higher range of AFUE ratings.

Cost effectiveness screening uses the economy bids. These bids are more competitive bids, as they are for models with fewer of those features that increase cost, but do not improve energy savings. The difference in contractor bids has a wide range, with one price quote showing no cost difference between a AFUE 80 and a AFUE 90 furnace, while another set of bids showed a nearly $1000 difference between a AFUE 80 and a AFUE 92 furnace. Incremental costs between economy bids by each contractor for 80 AFUE, 90 AFUE, and 95 AFUE furnaces were compared with the bids from the same contractor, in order to minimize the non-energy related differences between models. The median cost increment was $500, which is used in the cost effectiveness analysis. The median difference between a AFUE 80 and AFUE 95 was $950.

The maximum cost effective incentive for furnace from 90 to 94 AFUE is $424 and the maximum incentive for furnaces 95 AFUE and better is $563. Neither tier passes the Total Resource Cost test. However, the Washington Utilities and Transportation Commission has allowed such measures in the efficiency portfolio, provided that the incentive passes the Utility Cost Test and the portfolio passes the TRC. The Commission will monitor the effect of such measures on the Total Resource Cost of the efficiency program as a whole.

Measure life of 25 years, consistent with Energy Trust gas furnace measures since 2005 based on research on furnace age at retirement conducted in British Columbia (Natural Gas Furnace Market Assessment, August, 2005, Haybart and Hewitt).

Measure Approval Document for Residential Gas Storage Water Heaters

Valid Dates
January 1, 2018 – December 1, 2020

End Use
ENERGY STAR gas storage water heaters sold to retailers, water heater contractors, builders and homeowners.

Program Applicability
Based on the referenced analysis and associated cost-effectiveness screening, the measures described below are approved for use in the following programs:

- Residential
- Existing Multifamily, buildings with 2-4 units and side by side structures

Within these programs, the following situations are expected:

- New
- Replacement

Purpose of Re-Evaluating Measure
This update merges tiers and simplifies requirements to support the UEF ratings/test procedure change and removes non-energy benefits associated the Residential Energy Tax Credits (RETC) and better reflects the program design shift to a retail and midstream offerings.

Cost Effectiveness
Cost effectiveness for gas tank water heaters is shown in Tables 1 and 2.

Table 1 Cost Effectiveness Calculator Oregon

Measure	Measure Life (years)	Savings (therms)	Incremental Costs ($)	NEBs (Annual $)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR
ENERGY STAR Storage Water Heater	13	25.7	$215	$5.34	$103	1.00	0.72

Table 2 Cost Effectiveness Calculator Washington

Measure	Measure Life (years)	Savings (therms)	Incremental Costs ($)	NEBs (Annual $)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR
ENERGY STAR Storage Water Heater	13	25.7	$215	$4.71	$104	1.00	0.68

Exceptions
On 11/8/2017 Energy Trust received an exception through the minor exception process to offer ENERGY STAR gas storage water heaters in Oregon based on the following UM 551 criteria.

B. inclusion of the measure is expected to lead to reduced cost of the measure. Early indications suggest the retail strategy is driving lower incremental cost units. Similar results are expected for the distributor channel.

The PUC requires that the exception expire on 13/31/2020 or when the measure becomes more than 5% of the program's savings or when a new MAD is produced with a lower cost effectiveness.

Measure level cost effectiveness is not required in Washington.

Program Requirements

- Gas storage water heaters must be approved by ENERGY STAR
- Power vent models qualify for this measure, but power vent is not a requirement.
- Condensing storage and tankless units are *excluded* from these measures.
- Manufacturers have created a category of "hybrid" gas water heaters between tankless and storage, that have a greater than 2 gallon tank and a greater than 75 kBtu/hr burner. Further testing of the hybrids is needed to determine their energy savings potential. These are *excluded* from this measure.

Details

In 2015, new federal energy efficiency standards for water heaters went into effect. These standards increased the minimum EF rating to 0.60 for a 50 gallon water heater. ENERGY STAR efficiency specifications for gas storage water heaters remained unchanged with a minimum qualifying EF of 0.67. In 2017, ENERGY STAR updated their specifications for gas water heaters to establish UEF qualification criteria. ENERGY STAR is not requiring recertification of existing units, only newly produced models will need to meet new UEF specifications. Existing models will continue to be ENERGY STAR approved. Throughout 2018 and perhaps beyond, there will be water heaters on the market with a mix of EF and UEF ratings, which would create a complex set of participation requirements if one or the other were used to specify requirements. ENERGY STAR will be the qualifying criteria for this measure to avoid that confusion.

Savings and Baseline

Beginning in mid-2017, all new water heaters are required to be tested under the UEF test protocol. DOE also allows current models with EF ratings to be mathematically converted to UEF in the short term. UEF ratings differ from EF ratings, but the difference is not consistent across models due to underlying differences between the test procedures. More study is required to understand the impacts of the UEF test protocols including how this change impacts savings calculations. For 2018 Energy Trust will maintain the existing savings methodology, however tiering will be removed as it is not possible to determine the tier of a water heater from its UEF rating.

Savings for gas storage water heaters are based on an estimated water heating energy consumption of 218 therms for a baseline, 0.60 EF gas water heater. This figure is a result of the 2009 draft study by Stellar Processes, on contract for Energy Trust of Oregon. The savings for equipment with higher Energy Factors are calculated using the following equation:

$$Savings\ (therms) = 218\ therms * \left(1 - \frac{baseline\ EF}{efficient\ EF}\right)$$

The average energy factor of water heaters participating in the program in recent years is 0.68 EF. This results in an average energy savings of 25.7 therms.

Costs

Existing Homes Program median incremental cost data from 2011-2015 was blended with 2016-2017 retail program median incremental costs to determine incremental cost for high efficiency gas water heaters. These values were normalized to 2017 dollars using the RTF GDP deflator to ensure comparability. Sales tax was removed from Washington project costs. Installed cost information was not available for 0.60 EF units from program historical data. To estimate incremental costs for the 2011-2015 Existing Homes data, program data from a retired 0.62-0.66 EF unit measure was used as a proxy for a 0.60 EF baseline installation. Baseline costs for the retail data set were sourced from the models available in two primary home improvement stores via their websites. Incremental costs listed in Table 3 are blended together in the cost effectiveness tables.

Table 3 Incremental Costs for 2011-2015 Existing Homes program data

Efficiency Tier	Count	Median Cost	Average Energy Factor	Incremental Cost From Baseline
0.63 EF Baseline Proxy	277	$1,189	0.63	-
ENERGY STAR qualified	2,009	$1,407	0.68	$219

Table 4 Incremental Costs for 2016-2017 Retail program data

Efficiency Tier	Count	Median Cost	Average Energy Factor	Incremental Cost From Baseline
Baseline	60	$548	0.62	-
ENERGY STAR qualified	148	$715	0.68	$167

Non-Energy Benefits

Warranty Benefit

Retail research revealed that qualifying atmospherically drafted ENERGY STAR units, which make up the majority of the products, have significantly longer warranty lives than baseline units (typically 12 years instead of 6 or 9 years). Extended coverage offers a financial benefit to consumers who purchase qualifying equipment. Given that warranties are typically provided by manufacturers, retail water heater data was used to estimate the typical warranties for program qualifying equipment that is installed by contractors as well.

To estimate the benefit associated with the longer warranty lengths research conducted by Lawrence Berkeley National Laboratory on water heater stock over time was used.[i] The analysis used a Weibull distribution to model the turnover for water heaters over time. Modeled parameters determine the shape of the distribution as well as the speed at which equipment is estimated to fail. In addition, the LBNL analysis used a three year delay in their function to model units being replaced under warranty. This analysis removes this delay and instead uses the average length of warranties for qualifying and non-qualifying equipment.

The warranty benefit is estimated as the percent of units surviving relative to the baseline equipment's warranty. In the case of power vented units the warranty is actually a penalty, due to its shorter duration. Each qualifying equipment type's retail cost unit is multiplied by the relative fraction surviving relative to the baseline to calculate the lifetime warranty benefit. At the end of the average qualifying atmospheric unit's warranty 59% are estimated to be surviving relative to 44% at the end of the baseline warranty length. Multiplying the difference in survival rate by the qualifying units' retail cost yields a $107 benefit. This approach also yields a $62.77 penalty when comparing qualifying power vented units to baseline equipment due to shorter warranty on power vented equipment.

Table 5 Warranty Lengths and Unit Cost by Venting Configuration and Efficiency Tier at Retail for Gas Storage Water Heaters

Venting Configuration	Average Warranty Length (Years)	Failure Percent Relative to Baseline	Average Retail Unit Cost	Warranty Benefit
Non-ENERGY STAR	7.7	-	-	-
Atmospheric 0.67+ EF	10.7	15%	$709	$107
Power vented 0.67+ EF	6.5	-7%	$916	-$62

To calculate an annual non-energy benefit, the value of the warranty benefit or penalty is annualized over its warranty life. To create an annualized benefit or penalty, the present value of the units is taken based on a discount rate of 4.3% in Oregon and 5.53% in Washington and the average warranty length for that piece of equipment. These values are then weighted by the share of program-incented water heaters that are power or atmospherically vented, not on efficiency tiers. The final weighted annual warranty non-energy benefit is $5.34 in Oregon and $4.71 in Washington as shown in Table 6.

Table 6 Weighted Warranty Non-Energy Benefit by Venting Configuration

Venting Configuration	Weight In Program	Warranty Benefit At Year Of Failure	Present Value Of Warranty Benefit (Oregon)	Annualized (Oregon)	Present Value Of Warranty Benefit (Washington)	Annualized (Washington)
Atmospheric 0.67+ EF	85%	$107.47	$68.49	$6.99	$60.42	$6.16
Power vented 0.67+ EF	15%	-$61.89	($39.44)	($4.02)	($34.79)	($3.55)
Weighted annual warranty NEB				**$5.34**		**$4.71**

Residential Energy Tax Credit

All Oregon state tax credits for residential efficiency expired at the end of 2017. No tax credits are included in this analysis.

Midstream Adjustment Factors

For midstream water heater sales, Energy Trust will use the Distributor Sales Allocation Tool (DSAT) and Retail Sales Allocation Tool (RSAT) to allocate the savings and incentives from each unit sold by participating distributors and retailers to the appropriate utilities. DSAT and RSAT outputs were used to calculate an adjustment factors for midstream savings to account for expected leakage – units recognized in the midstream water heater program but installed in non-Energy Trust territory. Because all gas utilities in Oregon and SW Washington participate with Energy Trust, leakage for gas midstream water heaters to non-Energy Trust territory is expected to be near zero. For more information on the DSAT and RSAT methodology, refer to the DSAT documentation in supporting documents.

Measure Life

The lifetime of this measure is 13 years, from the DOE Technical Support Document for the 2015 federal standards change.

Incentive Structure

The maximum incentives listed in Table 1 and Table 2 are for reference only and are not suggested incentives.

Incentives are likely to vary by program and sales channel and may be paid to retailers, distributors, contractors, end customers or home builders. Midstream incentives may be passed through or kept by retail channels or distributers.

Follow-Up

As more water heater data from the midstream and retail program becomes available such as costs and model EF and UEF specifications, this measure should be reevaluated as necessary.

The current savings methodology and the impacts of the UEF test procedures should be revisited when information is available. Energy Trust currently lacks a method to determine savings as a function of UEF, which will be necessary if higher efficiency tiers will be targeted in the future.

Supporting Documents

The cost effective screening for these measures is attached and can be found along with supporting documentation at:
I:\Groups\Planning\Measure Development\Residential\Res Water Heating\gas storage water heat

Gas Storage DHW 2018 CE_9_20_2017.x

DSAT and RSAT methods:
I:\Groups\Planning\Measure Development\Residential\Res Water Heating\heat pump water heater\DSAT

ENERGY STAR Water Heater Specifications:
https://www.energystar.gov/products/spec/residential_water_heaters_specification_version_3_0_pd

Version History and Related Measures

Energy Trust has been incentivizing gas water heaters for many years and the offering has evolved over time and predates our record retention and measure approval practices. Table 7 shows the measure history since 2010 when 0.67 EF was introduced as an efficiency tier in our residential program and may be incomplete for activities prior to 2013.

Table 7 Version History

Date	Version	Reason For Revision
5/26/10	102.x	Introduce 0.67 EF water heaters for existing and manufactured homes
5/27/10	102.x	Include small multifamily homes in prior approval.
6/2/10	102.x	Include condensing tank units.
8/10/10	102.x	Included distributor incentive.
1/6/12	102.x	Update cost and incentives.
6/19/12	102.x	Update approval to include maximum incentive.
9/2/15	102.x	Update savings due to federal standard influence of baseline. Removes condensing units.
9/15/15	102.x	Includes small multifamily.
2/16/16	102.x	Includes the products program.
12/30/16	102.1	Update costs and non-energy benefits.
11/8/17	102.2	Updated costs, NEBs. Change qualifying criteria to ENERGY STAR. Clarifies mid-stream program design.

Table 8 Related Measures

Water Heating Measures	MAD ID
Residential and existing small multifamily heat pump water heaters	52
New small multifamily heat pump water heaters	176
New homes and small multifamily tankless water heaters	178
Commercial condensing tank water heaters	21
Commercial tankless water heaters	72

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Disclaimer

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[i] James D. Lutz, Asa Hopkins, Virginie Letschert, Victor H. Franco, and Andy Sturges . Using National Survey Data to Estimate Lifetimes of Residential Appliances.

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjtmfa5-63PAhUK02MKHZI2B6UQFgghMAA&url=https%3A%2F%2Fpublications.lbl.gov%2Fislandora%2Fobject%2Fir%253A157288%2Fdatastream%2FPDF%2Fdownload%2Fcitation.pdf&usg=AFQjCNFmN6Mdlvs9kS10fGHANQnhY5baTw

Measure Approval Document for 2018 EPS™ New Homes in Washington

Valid Dates
1/1/18 – 12/31/20 or until a substantial Washington residential code update

End Use
Residential New Construction

Program
New Homes Washington

Scope
New Homes EPS™ pathways and program structure are approved for new gas-heated single family construction in Washington. Energy Trust's programs serve only gas customers in Washington and while these homes save both gas and electricity, only gas savings are eligible for incentives.

Background
The New Homes EPS program in SW Washington utilizes the Oregon EPS framework to establish performance criteria for its incentive structure. The EPS is a compliance method that allows builders to select a custom combination of measures that exceed Washington residential energy code and provides incentives beyond code compliance. The EPS provides flexibility when designing new homes allowing builders and raters to compare multiple packages to find feasible and cost-effective options.

Reason for updating measure
All savings and costs are updated using the modeling software, protocols and updated costs and are in alignment with the 2018 Oregon EPS analysis in MAD 181.2. Additionally, program requirement language in this document has been updated for clarification purposes and to remove modeling software type and version specifications.

The modeling protocol, "Northwest Modeling Requirements", and REM/Rate™ version used for this analysis were reviewed and discussed as part of a collaborative, Standard Modeling Protocol working group including Northwest Energy Efficiency Alliance, the Bonneville Power Administration, and Energy Trust. Updates include using REM/Rate™ v15.3, model setup and defaults following the Northwest Modeling Requirements, weighting used within the analysis use distribution based on 2017 participating home counts in Washington from January 1 through September 21, 2017.

Program Requirements
- Homes must be built in Washington and have primary heat provided by Northwest Natural Gas service.
- All projects entering the new homes program will be simulated using program approved modeling software, following program modeling protocol.
- Energy models and supporting documentation will be submitted to the program via the Axis database, with modeling results used for determination of incentives, savings, and overall EPS score. Homes must be field verified by a program verifier.
- Homes must achieve a minimum of ten percent gas improvement over code
- Builders must meet current code requirement and follow the programs requirements as described in the most current EPS Field Guide for quality installation, performance testing, health/safety and qualifying products.
- Verifiers performing field testing and home modeling must be current Trade Ally New Homes Verifiers and meet current program requirements.

Cost-Effectiveness
Table 1 presents the benefit cost ratios for the pathways modeled for SW WA EPS homes, as well as a weighted average of all pathways based on the 2017 distribution of EPS pathways in Washington.

Table 1 EPS Pathways in Washington Cost Effectiveness

Measure	Measure Life (years)	Savings (kWh)	Savings (therms)	Incremental Costs ($)	Non-Energy Benefits (Annual $)	ELE Bill Savings (Annual $)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR
SWWA Path 1	34	21	80	$949	$11	$2	$949	1.0	1.2
SWWA Path 2	39	42	142	$2,463	$11	$3	$1,806	1.0	0.8
SWWA Path 3	42	501	258	$6,437	$11	$41	$3,378	1.0	0.7
SWWA Path 4	43	520	293	$8,519	$11	$42	$3,866	1.0	0.6
Weighted Paths 1-4	36	51	110	$1,751	$11	$4	$1,356	1.0	0.9

All paths pass the Washington UCT screening, only Path 1 passes the TRC. These measures are only approved for use in Washington. In Washington, the Washington Utilities and Transportation Commission (WUTC) has directed Energy Trust to use the Utility Cost Test as the primary determinant of cost effectiveness, and to monitor the Total Resource Cost. There is a long history of new home programs leading to market transformation, by increasing building acceptance of advanced practices, leading to lower costs and enhanced building codes. As a result, the long term cost-effectiveness is likely to be better than that shown here.

In Washington, Energy Trust does not claim electric savings. The benefits of the electric savings are used in the TRC test, but not in the utility test. Energy Trust will track the electric savings as unclaimed savings and coordinate with electric utilities in the area as needed. All electric savings use the Clark Public Utility residential retail rate from June 29, 2017, $0.082/kWh, to calculate the non-energy benefit associated with reductions in electric usage.

Savings
Savings for actual projects are calculated on a case by case basis. To obtain an estimate of the energy savings and the resulting EPS score, the program has elected to use REM/Rate to model both the expected baseline as well as each home entering the program. As an energy modeling tool, REM/Rate is a widely-accepted energy modeling engine used for estimating the performance

of new homes. Internal Energy Trust review has found the EPS program and modeling protocol to have relatively good accuracy modeling home consumption in the 2009-2011 New Homes Billing Analysis from 06/15/2015.[i]

To calculate savings over a defined baseline, each home is modeled in REM/Rate using installed components and performance testing results. REM/Rate calculates the energy consumptions of the modeled home and simultaneously calculates the consumption of a User Defined Reference Home (UDRH) which uses the specifications of the baseline code home as a comparison baseline to the modeled home. Consumption outputs from the code and improved homes are uploaded from REM/Rate into the EPS calculator tool, Axis. The difference between code and improved consumption determines the savings to be claimed by the program, these savings are compared to the code home consumption to determine the modeled homes percent improvement over code. The EPS score is calculated by converting the annual consumption of the home in kWh and therms to MBtu.

Savings for low flow fixtures are prescriptive rather than modeled, they are determined by the water heating fuel and match the savings for one 1.75 gpm showerhead as approved in the MAD for Low Flow Showerheads in New Homes, MAD ID 131 published April 15, 2016. Non-energy benefits associated with reduced water and sewer charges are also included in the cost effectiveness screening and align with MAD ID 131.

Baseline

The 2016 Washington Energy Code requires builders to select from a menu of shell and mechanical upgrades to achieve a total of 3.5 points. Based on past NW ENERGY STAR participation, builders were tending to comply following ducts inside and high efficiency equipment options on top of basic ENERGY STAR shell improvements. These two ENERGY STAR and shell improvements are roughly equivalent to 3.5 points on the Washington code table. These familiar combinations were selected to use for the WA Code reference home; additionally, these options leave room for additional improvements to the program. The code baseline used for REM/Rate models and savings include the following options from the 2015 Washington State Energy Code Section R406.2 Table 406.2 Energy Credits:[ii]

- 1a-Efficient Building Envelope-5% Ua reductions-0.5 points
- 3a-High Efficiency HVAC Equipment-1 point
- 4-High Efficiency HVAC Distribution (Ducts Inside)-1 point
- 5b-Efficient Water Heating-1 point

Example Paths

Modeled pathways use 2015 Washington State Energy Code as the baseline and likely component combinations that have been seen in Energy Trust's New Homes Program in both Oregon and Washington**.** Pathways were built based on incremental improvements over the code baseline, using combinations of measures that have been seen in the Oregon and Washington programs. These combinations are meant to be incremental in cost, difficulty and create incremental improvements of 10% from one pathway to the next. These pasts are used to illustrate methods of achieving savings, budgeting and planning purposes and testing cost effectiveness. Builders are not required to follow pathways.

Table 2 Pathways compared to 2015 Washington State Energy Code

	Base Code Insulation	**Code w/ Option 1a-3a-4-5b**	**Path 1 - 10%**	**Path 2 - 20%**	**Path 3 - 30%**	**Path 4 - 40%**
Slab	R-10 2' Perimeter	R-10 full (1a)	R-10 full (1a)	R-10 full (1a)	R-10 full (1a)	R-10 full (1a)
Framed Floor	R-30 (U-0.034)	R-38 (1a)	R-38 (1a)	R-38 (1a)	R-38 (1a)	R-38 (1a)
Basement Wall	R-21 Int. (U-0.054) 10 ext/15 int. continuous/21 int framed	R-21 Int. (U-0.054) 10 ext/15 int. continuous/21 int framed	R-21 Int. (U-0.054) 10 ext/15 int. continuous/21 int framed	R-20 Cont	R-20 Cont	R-20 Cont
Wall	R-21 int. (U-0.054) 16" OC & headers R-10	R-21 int. (U-0.054) 16" OC & headers R-10	(U-0.051) R-23 BIB or R-21 Adv	(U-0.051) R-23 BIB or R-21 Adv	(U-0.035) 2x 8 Adv. BIB or R-23+7 cont	(U-0.025) R-23+20 cont
Window	U-0.30 (SHGC 0.30 no req.) Skylight U-0.50	**U-0.28 (1a) Skylight U-0.50**	U-0.28 (1a) Skylight U-0.50	U-0.25 SHGC-no requirement- 0.30	U-0.22 SHGC-no requirement-0.25	U-0.20 SHGC-no requirment-0.25
Ceiling	R-49	R-49	R-49 + R-21 Heel	R-60 Adv.	R-60 Adv.	R-60 Adv.
Water Heater	0.82 EF Tankless	**0.74 EF Storage (5b)**	**0.82 EF Tankless**	0.90 EF Tankless	0.95 EF Tankless	0.95 EF Tankless
Furnace	78 AFUE	**94 AFUE (3a)**	94 AFUE	96 AFUE	96 AFUE	96 AFUE
Duct Location	Attic	**Ducts and HVAC Inside (4)**	Ducts and HVAC Inside (4)	Ducts and HVAC Inside (4)	Ducts and HVAC Inside (4)	Ducts and HVAC Inside (4)
Duct Insulation	R8	n/a (R-8 10' return 5' supply unconditioned)	n/a (R-8 10' return 5' supply unconditioned)	n/a (R-8 10' return 5' supply unconditioned)	n/a (R-8 10' return 5' supply unconditioned)	n/a (R-8 10' return 5' supply unconditioned)
Duct Leakage	4% CFM_{25}/CFA	40 CFM_{50}	40 CFM50	40 CFM_{50}	40 CFM_{50}	40 CFM_{50}
Infiltration	5 ACH50	5 ACH50	4.5 ACH50	3.0 ACH 50	2.5 ACH50	2.0 ACH 50
Mechanical Ventilation	Exhaust, standard efficiency 24 hours 40 watts	Exhaust, standard efficiency 24 hours 40 watts	High Efficiency Exhaust (2.857 CFM/watt)	High Efficiency Exhaust (2.857 CFM/watt)	HRV (75% SRE 1.25 CFM/w)	HRV (75% SRE 1.25 CFM/w)
Lights and Appliances	75%	75%	75%	75%	100% and ESTAR Appliances	100% and ESTAR Appliances
Other	x	x	Low flow fixtures	Low flow fixtures	Low flow fixtures	Low flow fixtures
		Therm Savings	80	142	258	293
		kWh Savings	21	42	501	520
		% Better-Gas Only	**15%**	**26.7%**	**44.9%**	**51.0%**

Measure life

Weighted average measure lives are presented in **Table 1**. Each improvement pathway has its own estimated measure life. REM/Rate does not provide outputs by all specific end-use heating related components. To estimate a weighted average measure life for pathways, incremental modeling of gas efficiency improvements was used to assign savings to specific end uses. Once all gas end uses savings were assigned to an end use load profile, a weighted average measure life was generated for each improvement pathway based on gas avoided costs allowing for cost effectiveness testing and potential incentive levels.

Incentive Structure

Table 1 lists the maximum cost effective incentive level for each pathway and associated percent savings above code. *The maximum is not a suggested incentive and is to be used by the program as a reference only*. Incentives will be developed based on percent savings above code. For REM/Rate modeled homes that have savings which fall between the defined pathways a "sliding scale" approach will be used to estimate the savings to be claimed by the program and the incentive level to be paid.

Costs

Costs in **Table 1** are based on a variety of sources for individual improvements in the modeled pathways for a typical 2,200 square foot home. Specific end-use cost sources came from the following sources with a brief discussion of assumptions employed in the analysis.

All Northwest Power and Conservation Council 6th Power plan costs referenced below can be found on the Northwest Power and Conservation Council's website. **All costs have been updated to 2017 $ and are in alignment with costs used in the OR EPS MAD 181.2.**

Weatherization and Windows

- **Ceiling Insulation R49 + R21 heel -** $0.17/ sqft RTF New Construction Built Green Washington workbook, cost adjusted to $0.17 over R-49 baseline[iii]
- **Ceiling Insulation R-60 Adv. -** $0.17/sqft Sixth power plan Appendix G: table G-2[iv]. Incremental cost of $0.17/sqft.
- **Wall R-23 BIB (U-0.057) -** $0.18/sqft Incremental cost between R-19 Standard to R-21 Advanced is used as a proxy for the incremental cost between R-21 Intermediate and R-23 Intermediate BIB insulation. Sixth power plan Appendix G: table G-2
- **Wall R-30 2x8 BIB (U-0.033) -** $1.02/sqft from baseline. NEEA next step home Phase I data collected from NEEA.
- **Wall R-23+20 cont (U-0.025) -** $1.52/sqft from US DOE, NREL, Measure Guideline: Incorporating Thick Layers of Exterior Rigid Insulation on Walls, Building Science Corp[v].
- **Window U-0.25 -** Energy Trust PT data shows a negative incremental cost based on $52.58/sqft. $0 is used in the analysis for incremental cost.
- **Window U-0.22 -** Energy Trust PT data shows a negative incremental cost based on $60.74/sqft. $0 is used in the analysis for incremental cost. Same cost use for U-0.22 and U-0.20.
- **Window U-0.20 -** Energy Trust PT data shows a negative incremental cost based on $60.74/sqft. $0 is used in the analysis for incremental cost.
- **Infiltration 1 ACH50 reduction -** $0.11/sqft based on RTF analysis of New Construction Built Green Washington[vi]

Space and Water Heating Systems

- **Gas Furnace 96 AFUE -** $457.81 incremental cost from 94 AFUE. $500 cost for 90-94 AFUE and $950 for 95+ AFUE in Gas Furnace in Washington MAD 23 9/4/2014. $457.81 is based on removal of Washington sales tax followed by adjustment to 2017 $s
- **0.82 EF Tankless Water Heater -** $0 incremental cost, California, High-efficiency Water Heater Ready[vii] new construction analysis, cost assumes partial avoidance of a future storage replacement, 13-year measure life, compared to a tankless expected life of 20 years. Cost over 0.74 EF storage unit.
- **0.90 EF Tankless Water Heater -** $704.50 incremental cost, California, High-efficiency Water Heater Ready new construction analysis, cost assumes partial avoidance of a future storage replacement, 13-year measure life, compared to a tankless expected life of 20 years. Cost over 0.74 EF storage unit.
- **0.95 EF Tankless Water Heater -** $939.36 incremental cost, California, High-efficiency Water Heater Ready new construction analysis, cost assumes partial avoidance of a future storage replacement, 13-year measure life, compared to a tankless expected life of 20 years. Cost over 0.74 EF storage unit.

Mechanical Ventilation

- **ASHRAE up to 10.0 cfm/watt -** $59.18 RTF, Oregon Energy Star New SF Homes 2012 RTF workbook v3.3[viii]
- **Heat Recovery Ventilator -** $1,302 from RTF meeting on Energy Star New Homes 8/25/10[ix]

Low Flow Fixtures

- **Low-flow Showerheads - $8.42 showerhead cost based on** the MAD for Low Flow Showerheads in New Homes, MAD ID 131 published April 15, 2016**.**

Lighting upgrades

- **100% High Efficacy Lighting –** $0 no incremental cost to upgrade from 75% to 100% high efficacy Oregon Energy Star New SF Homes 2012 RTF workbook v3.3

Thermostats

- **Web enabled Smart Thermostat -** $100 incremental cost in MAD 153.2; incremental cost for smart thermostats is supported by information from several high-volume program builders purchasing smart thermostat over a standard 7-day programmable thermostat.

Non Energy Benefits

Non energy benefits are from reduced water use. These are based on customer's reduced water and sewer bills as well as reduce water pumping. Avoided water system pumping from these low flow devices creates additional energy savings in accordance with the 7th Power Plan. For installations outside Energy Trust electric service territory the savings are considered non-energy benefits and are multiplied by the average industrial retail rate of electricity for non-investor owned utilities in Washington. The combined NEB for residential water savings in Washington is $10.90/1,000 gallons.

Supporting Documents

The cost-effective screening for these measures is attached and can be found along with supporting documents at:

I:\Groups\Planning\Measure Development\Residential\New Homes\EPS\WA EPS

2018 WA EPS CEC.xlsx

Follow up

This offering is approved for homes built to the 2015 Washington State Energy Code. Washington code cycles are on a three-year review/change cycle. The program will review code during the next code cycle and will make any necessary updates to the program pathways, savings and incentives if/when substantial energy code changes are implemented.

Measure History and Related Measures

Table 3 New homes in Washington measure approval history

Date	Version	Reason for Revision
6/30/2012	124.x	Introduce NW Energy Star BOPs in Washington
3/4/2014	124.x	Allowed Earth Advantage as “equivalent path”
9/22/2014	124.x	Transition from BOPs to Performance Paths, update for 2012 building code
10/1/2015	145.x	Introduce EPS in Washington, replace MAD ID 124
9/7/2016	145.1	Updates for 2015 building codes, redesigned pathways
10/7/2017	145.2	Update savings and requirements for newer REM/Rate version and modeling protocol

Table 4 Related Measures

Measure	MAD ID
EPS in Oregon	181

Approved by

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Sr. Planning Engineer

Mike Bailey PE

Engineering Manager Planning

Disclaimer:

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[i] 2009-2011 New Homes Billing Analysis: Comparison of Modeled vs. Actual Energy Usage:
http://assets.energytrust.org/api/assets/reports/2009-2011_New_Homes_Billing_Analysis.pdf
[ii] 2015 Washington State Energy Code:
https://fortress.wa.gov/ga/apps/sbcc/Page.aspx?nid=14
[iii] RTF, Residential Single Family Energy Star Built Green Homes, WA 2014:
https://nwcouncil.app.box.com/s/xixol3altfb4tvdsttcukkzz3qnj2wnm
[iv] Sixth Northwest Conservation and Electric Power Plan Appendix G:
https://www.nwcouncil.org/media/6311/SixthPowerPlan_Appendix_G.pdf
[v] Measure Guideline: Incorporating Thick Layers of Exterior Rigid Insulation on Walls, Building Science Corp, April 2015:
https://www.nrel.gov/docs/fy15osti/63337.pdf
[vi] RTF, New Construction Built Green Washington v2.4:
http://rtf.nwcouncil.org/measures/measure.asp?id=143

[vii] California, High-efficiency Water Heater Ready, Codes and Standards Enhancements Initiative, October 2011:
http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/current/Reports/Residential/Water_Heating/2013_CASE_WH2.WH5_WaterHeaterReady-10.28.2011.pdf

[viii] RTF, Oregon Energy Star New Single Family Homes 2012 v3.3:
http://rtf.nwcouncil.org/measures/measure.asp?id=182

[ix] RTF, Energy Star New Homes, Cost Meeting 8/25/2010:
http://rtf.nwcouncil.org/meetings/2010/0825/EStar_WA-ID-MT_BG_WA-NewConstruction_ProCostRunsv2.xls

Measure Approval Document for Residential Gas Tankless Water Heaters in SW Washington

Valid Dates

June 1, 2017 – December 31, 2019

End Use

0.82+ EF gas tankless water heaters sold to homeowners.

Program Applicability

Based on the referenced analysis the measure described below is approved for use in the following programs offered in SW Washington:

- Existing Homes
- Existing Manufactured Homes
- Existing Multifamily: 2-4 units and side by side structures, administered by the residential programs

Purpose of Re-Evaluating Measure

In 2012, Energy Trust removed tankless water heater offerings for the Existing Homes program in both Oregon and Washington due to TRC ratio below 1. Beginning in 2015, the Washington Utilities and Transportation Commission (WUTC) no longer requires the TRC to be the primary metric for measure screening, relying instead on the Utility Cost Test. This update reintroduces tankless in Washington.

Cost Effectiveness

Cost effectiveness for gas tankless water heaters in Washington is shown in Table 1.

Table 1 Cost Effectiveness 2017 v1.3 Calculator - Washington

Measure	Measure Life (years)	Savings therms	Incremental Costs ($)	Maximum Incentive ($)	Utility BCR at Max Incentive	TRC BCR
0.82+ EF Tankless	20	74.2	$1,834	$444	1.00	0.24

Exceptions

Measure level total resource cost effectiveness is not required in NW Natural Washington's portfolio. The WUCT is anticipated to revisit this requirement in 2018 to determine if relying on the UCT as the primary cost effectiveness screening method for NW Natural Washington programs should continue.

Program Requirements

- Installed in SW Washington.
- Gas tankless water heaters with an energy factor (EF) greater than or equal to 0.82.
- Manufacturers have created a category of "hybrid" gas water heaters between tankless and storage that have a tank with a capacity over two gallons burner with a rating greater than 75 kBtu/hr. These are *excluded* from eligibility under this MAD.

Details

In 2015, new federal energy efficiency standards for water heaters went into effect. These standards, based on capacity of storage tank, effectively increase the minimum EF rating to 0.60 for a 50 gallon water heater. Tankless water heater designs can improve the efficiency factors to over 0.90 by eliminating standby losses incurred from storage tanks and electronic ignitions.

Savings and Baseline

Baseline equipment is a new gas storage water heater with and EF of 0.60. While the required minimum efficiency for tankless in the program is 0.82 EF, the expected average EF is 0.91 based on past installations.

Savings for gas storage water heaters are based on an estimated water heating energy consumption of 218 therms for a baseline, 0.60 EF gas water heater. This figure is a result of the 2009 draft study by Stellar Processes, on contract for Energy Trust of Oregon. Average tankless EF of 0.91 for savings calculations is sourced from past SW Washington program data on incented tankless units.

The savings for equipment with higher energy factors are calculated using the following equation:

$$\text{Savings} = 218 \text{ therms} * (1-(\text{baseline EF}/\text{efficient EF}))$$

Comparison to other offerings

Savings for this measure are higher than for the new homes tankless measure because we assume homeowners select tankless units with EF higher than builders.

Measure Life

Measure life of 20 years, based on federal water heater standard Technical Support Document.

Costs

Past project cost information from the Existing Homes program in Washington from 2009-2012 for tankless water heaters and 2011-2015 for gas storage units. These values were normalized to 2016 dollars using the RTF's GDP deflator to ensure comparability. Sales tax was removed from Washington project costs. Installed cost information was not available for 0.60 EF units from program historical data. The cost of installing tankless units in existing homes is higher than in new homes or the costs seen in retail or at distributers due to the frequent necessity of upgrading gas lines to accommodate the tankless units.

To estimate incremental costs, program data from a retired 0.62-0.66 EF measure was used as a proxy for a 0.60 EF baseline including installation given that these units all use a standing pilot light and are expected to have similar costs.

Table 2 Installed costs

Efficiency Tier	Cost
0.62-0.66 EF Storage Baseline Proxy	$1,167
0.82+ EF Tankless	$3,313
Increment	$2,146

The expected useful life of tankless water heaters is 20 years compared to 13 years for a gas storage unit. This longer measure life will result in a partially avoided replacement cost for a storage water heater after year 13, or 54% of a future storage water heater. The future value of the avoided replacement is $628, with a present value of $312, which is deducted from the initial incremental cost of $2,146 for a final value of $1,834. This process is described in Table 3.

Table 3 Avoided future cost calculations

	Calculation	Result
Useful life of tankless beyond baseline	20-13 = 7 7/13	54%
Estimated storage installation cost	From Table 2	$1,167
Avoided future replacement cost	$1,167 * 54%	$628
Present values of avoided future replacement at 5.53% discount rate	PV ($628, 5.53%,7)	$312
Incremental cost	From Table 2	$2,146
Final incremental cost	**$2,146 - $312**	**$1,834**

Incentive Structure

The maximum incentive listed in Table 1 is for reference only and is not a suggested incentive. Incentives are likely to vary by program and sales channel and may be paid to end customers, home builders, or passed through or kept by retail channels or distributers.

Follow-Up

If the WUTC reinstates TRC screening requirements this MAD will need to be revisited due to the TRC benefit cost ratios being less than 1.0.

Supporting Documents

The cost effective screening for these measures is attached and can be found at:
I:\Groups\Planning\Measure Development\Residential\Res Water Heating\tankless\Existing homes\Wa only\bencost

CEC 2017 Tankless WA.xlsm

Supporting documents can be found at:
I:\Groups\Planning\Measure Development\Residential\Res Water Heating\tankless\Existing homes

References

US DOE Technical Support Document for residential water heaters:
https://www.regulations.gov/contentStreamer?documentId=EERE-2006-STD-0129-0170&attachmentNumber=26&disposition=attachment&contentType=pdf.

Version History and Related Measures

Tankless measures predate our current approval and record keeping processes, Table 4 may be incomplete.

Table 4 Measure History

Date	Version	Reason for Revision
2007	x	Tankless in existing homes approved
12/31/2011	x	Measure canceled for existing homes
4/24/2017	197.1	Re-introduce tankless water heaters to existing homes in SW Washington

Table 5 Related Measures

Water Heating Measures	MAD ID
Residential gas storage water heaters	102
New homes and new small multifamily tankless water heaters	178
Multifamily central system tankless water heaters ≤199 kBtu/h	196
Commercial tankless water heaters	72

Approved & Reviewed by

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Disclaimer

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Measure Approval Document for Residential Windows

Valid Dates
January 1, 2018 – December 31, 2020

Measure Description
Two tiers of windows measures installed in the applicable programs.

Program Applicability
Based on the referenced analysis and associated cost-effectiveness screening, the measures described below are approved on a prospective basis for use in the following programs:

- Existing Multifamily (2-4 living units and side-by-side units)
- Residential

Within these programs, applicability to the following project types are allowed:

- Replacement

Purpose of Re-Evaluating Measure
This measure is undergoing a simple update only to update to avoided costs. No changes to costs or savings.

Cost Effectiveness
Table 1: Cost Effectiveness Calculator in Oregon

Measure	Measure Life (years)	Savings (kWh)	Savings (therms)	Incremental Costs ($)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR
U-factor 0.30-0.28, Ele heat, per sqft	45	2.86		$1.11	$5.04	1.00	4.54
U-factor 0.30-0.28, Gas heat, per sqft	45		0.20	$1.11	$2.85	1.00	2.57
U-factor ≤ 0.27, Ele heat, per sqft	45	6.92		$4.36	$4.36	2.79	2.79
U-factor ≤ 0.27, Gas heat, per sqft	45		0.48	$4.36	$4.36	1.57	1.57

Table 2: Cost Effectiveness Calculator in Washington

Measure	Measure Life (years)	Savings (kWh)	Savings (therms)	Incremental Costs ($)	Maximum Incentive ($)	UCT BCR at Max Incentive	TRC BCR
U-factor 0.30-0.28, Gas heat, per sqft	45	0	0.20	$1.11	$2.68	1.00	2.41
U-factor ≤ 0.27, Gas heat, per sqft	45	0	0.48	$4.36	$4.36	1.47	1.47

Requirements
- Windows, glass doors or skylights with:
  - Tier 1: NFRC U-factor rating of 0.28-0.30
  - Tier 2: NFRC U-factor of 0.27 or less
- Window/door/skylight is installed between a conditioned space and an unconditioned space

Savings and Baseline

Calculation of market baseline

For both tiers, energy savings from reduced space heat use are measured against a market baseline of what homeowners would likely have purchased in the absence of the Energy Trust program.

The results of the survey for the market share of windows at various efficiency levels are shown in Table 3.

Table 3: Percent of Sales by Efficiency Bin

U-Factor Bin	Relative Market Share
> 0.35	2.78%
.33 to .35	26.25%
.31 to .32	15.05%
.29 to .30	45.87%
.26 to .28	7.91%
.25 or lower	2.15%
Total	**100.00%**

These data include new homes and replacement windows as well as the portion of sales from participants in the program. To construct a natural market baseline to define the existing home, replacement market without our program influence two adjustments were made. 1) The new homes market was estimated to be approximately half of the overall market, based on NEEA's Long Term Monitoring and Tracking report and to be composed almost entirely of windows with a U-factor of 0.30 or less. Therefore, we removed fifty percent of the market share of new homes at 0.3 or less from the data. 2) Approximately 6% of the overall market, after removing free-riders, participated in the Energy Trust Existing Homes program. This proportion was also removed from the data.

The adjusted weighted average market baseline of replacement windows for Existing Homes was calculated, with a resulting U-factor of 0.334.

Descriptions of tiers

Energy Trust uses two tiers for residential windows. The lower tier includes windows with a U-factor of 0.30 to 0.28 while the more efficient tier includes windows with a U-factor of 0.27 or lower.

Calculation of savings

An electric impact analysis was conducted by EcoNorthwest using data from 2005 and 2006. That analysis found 564 kWh per year savings. The gas impact analysis was completed in 2007 and 2008 by Opinion Dynamics Corporation using data from 20015 to 2008, and found 39 annual therms, which was corroborated by billing analysis done by Energy Trust evaluation staff for gas heated homes that installed windows in 2009. The average area of windows replaced was 151 square feet, so that the savings per square foot are 3.76 kWh per year and 0.26 annual therms for windows with a U-factor equal to or less than 0.30.

To translate those energy savings into values that would apply to the tiering structure, a linear fit was assumed in relation to the change in U-factor and 2013 program average U-factors were

binned into the tiered structure. The resulting savings are 2.86 kWh per year per square foot or 0.198 annual therms per square foot for windows with a U-factor between 0.30 and 0.28. For windows with a U-factor of 0.27 or lower or equivalent energy performance, savings are 6.92 kWh per year per square foot or 0.478 annual therms per square foot.

Measure Life

Measure life is 45 years, consistent with previous Energy Trust windows measures.

Cost

The market research used to set the market baseline efficiency also indicated wholesale incremental cost for each efficiency bin, as shown in Table 4.

Table 4: Wholesale Incremental Cost by Efficiency Bin

U-Factor Bin	Incremental Wholesale Cost to the Next Efficiency Bin per square foot
.33 to .35	baseline
.31 to .32	$ 0.47
.29 to .30	$ 0.32
.26 to .28	$ 0.59
.25 or lower	$ 1.72

Wholesale cost does not accurately reflect measure incremental cost for two reasons. First, these do not directly translate into retail incremental costs, and second, many features of windows such as style and frame material affect the cost but are unrelated to efficiency. To determine incremental cost, both the RTF and Energy Trust have previously used the 25th percentile cost, in order to separate out the cost of other features.

Using the 25th percentile of program cost data for windows installed in 2013, the incremental cost of efficiency from a maximum U-factor of 0.30 to an average U-factor of 0.24 is $3.25. The market research data indicated a wholesale incremental cost of $2.31. Therefore, the 25th percentile retail cost appears to be approximately 41% higher than average wholesale cost.

No program data exist for the baseline window, as they are less efficient than any windows that receive an Energy Trust incentive. To calculate the baseline cost, the mark-up was applied to the wholesale incremental cost between the baseline and the first efficiency tier, and the result subtracted from the average cost of an efficient window at that level to arrive at a baseline cost of $25.45. The incremental retail costs are then calculated from the baseline to the 25th percentile cost, as shown in Table 5.

Table 5: Incremental Retail Cost

Maximum U-factor	Minimum U-factor	Average U-factor	25th percentile cost ($/SF)	Calculated Incremental Retail Cost ($/SF)
Baseline		0.334	25.40	
0.30	0.28	0.296	26.56	$1.16
0.27	0.15	0.242	29.81	$4.41

Incentive Structure

The maximum incentives listed in Table 1 and Table 2 are for reference and are not suggested incentives. Incentives will be per square foot of window area.

Given the rigorous application requirements for windows and to prevent backsliding of the local market baseline, the program uses an incentive exceeding incremental cost for the first tier of windows to provide a more substantive motivation to both choose qualified windows and submit applications. Given the 25th percentile method, most projects are not expected to exceed actual incremental costs.

Follow-Up

Future rescreening of the windows measure should be informed by market data to identify baselines and potential for tiering adjustments.

Supporting Documents

The cost effective screening for these measures is attached and can be found along with any supporting documents at:
\\Etoo.org\home\Groups\Planning\Measure Development\Residential\Res Weatherization\windows

ETO CEC windows 2018.xlsx

Version History and Related Measures

Energy Trust has been offering incentives for residential windows for many years. These offerings predate our record retention and approval processes. Table 6 may be incomplete, particularly for approvals prior to 2013.

Table 6 Version History

Date	Version	Reason for revision
7/29/10	x	Residential windows approval tiers at 0.22 and 0.30
10/31/11	28.x	Update tiers to 0.25 and 0.30
6/20/14	28.x	Updated baseline. New tiers at 0.27 and 0.30
8/15/14	28.x	Adds small multifamily windows.
5/9/16	28.1	Update definition of small multifamily.
10/18/17	28.2	Update to 2018 avoided costs resulting in updated max incentives. Minor clarifications throughout

Table 7 Related Measures

Measures	MAD ID
Multifamily windows	171

Approved & Reviewed by

Jackie Goss, PE
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Disclaimer

Measure Approval Document for Web-Enabled Thermostats

VALID DATES

June 1, 2017 – December 31, 2019

DESCRIPTION

Web-enabled thermostats with occupancy sensors provide energy savings through reduced run hours of heating systems. Some models achieve additional savings when paired with heat pumps when they change strip heat settings.

PROGRAM APPLICABILITY

Based on the referenced analysis and associated cost-effectiveness screening, the measures described below are approved on a prospective basis for use in the following programs in Oregon and Washington:

- Home Energy Solutions
- Efficient Home Products
- Existing Multifamily

Within the multifamily program, small buildings are most likely to have heating equipment compatible with web-enabled thermostats and are most likely to participate.

PURPOSE OF RE-EVALUATING MEASURE

Addition of Existing Multifamily savings and update to include fan savings in gas applications.

COST EFFECTIVENESS

Cost effectiveness is demonstrated in Table 1 and Table 2 below. In Energy Trust's gas-only territory in Oregon, the unclaimed electric savings are listed as non-energy benefits reflecting customer bill savings in Table 1. The electric savings shown for Washington measures are also unclaimed by Energy Trust and are treated as non-energy benefits in the cost effectiveness calculations, though shown as electric savings in Table 2.

Table 1 Cost Effectiveness - Oregon

Measure	Measure Life (years)	Savings		Incremental Costs ($)	Non-Energy Benefits (Annual $)	Maximum Incentive ($)	Utility BCR at Max Incentive	TRC BCR	Benefit Ratio	
		kWh	therms						Electric	Gas
SF web-enabled thermostat electric	11	331		$100	$0	$100	2.50	2.50	100%	0%
SF web-enabled thermostat gas	11	15	32	$100	$0	$100	1.47	1.47	8%	92%
SF web-enabled thermostat gas gas only territory	11		32	$100	$1.83	$100	1.35	1.51	0%	100%
MF web-enabled thermostat electric	11	260		$100	$0	$100	1.97	1.97	100%	0%
MF web-enabled thermostat gas	11	9	25	$100	$0	$100	1.13	1.13	6%	94%
MF web-enabled thermostat gas gas only territory	11		25	$100	$1.02	$100	1.06	1.15	0%	100%

Table 2 Cost Effectiveness - Washington

Measure	Measure Life (years)	Savings		Incremental Costs ($)	Non-Energy Benefits (Annual $)	Maximum Incentive ($)	Utility BCR at Max Incentive	TRC BCR	Benefit Ratio	
		kWh	therms						Electric	Gas
SF web-enabled thermostat gas	11	15	32	$100	$0	$100	1.40	1.50	0%	100%
MF web-enabled thermostat gas	11	9	25	$100	$0	$100	1.10	1.16	0%	100%

PROGRAM REQUIREMENTS

- Thermostat must be on Smart Thermostat Qualified Products List.
- Home must be heated with fuel provided by a participating Energy Trust utility.

The qualified product list is maintained by the residential sector with input by the Planning and Evaluation teams. It is based on proven savings in conjunction with required features.

- Thermostat utilizes a motion sensor to detect occupancy and can automatically change the temperature during unoccupied periods.
- Demonstrate savings and customer satisfaction from at least one published study or pilot program with 3rd party evaluation.
- Include simple, step-by-step instructions for customer installation of the thermostat. If instructions are not included in the box, they must be easily accessible online.

SAVINGS AND BASELINE

Energy Reduction

Energy Trust of Oregon has performed two pilots to determine the savings generated from web-enabled thermostats. The first pilot's evaluation[i] analyzed homes heated by heat pumps and treated with thermostats with electric-resistance lockout optimization and found heating savings of

12%. The second pilot's evaluation[ii] analyzed homes heated by a gas furnace which yielded heating savings of 6%. The difference in savings is attributed to the electric resistance lockout for heat pumps. For ease of program design we do not plan to ask participants to report heating technology beyond fuel type and not all the qualified products have electric resistance lockout features. This analysis utilized the 6% savings assumption for all homes since all qualifying systems should be able to achieve this level of savings.

For gas heated homes, the runtime of the furnace fan will be reduced and will generate electrical savings. The average annual fan energy usage is derived from the Regional Technical Forum's (RTF) Residential Single Family Existing HVAC and Weatherization[iii] analysis. Since gas furnace fan savings are achieved through runtime reduction, savings are assumed to be 6%, which is in agreement with the heating load savings. Fan savings are only calculated for heating zone 1 in order to take a conservative approach.

Baseline heating loads

For single family homes, the average annual heating loads are derived from the RBSA[iv]. The average heating loads for Oregon homes are 5,992 kWh and 583 therms for electric and gas heated homes respectively. These values include both heating zone 1 and heating zone 2.

For multifamily dwelling units, the average annual heating load for electrically heated units is derived from the RTF's Connected Thermostat[v] measure analysis. To determine the annual heating load for multifamily gas heated units, the ratio of the multifamily electric heating load to the single family electric heating load was calculated and applied to the single family average gas heating load of 583 therms. The electric heating ratio was found to be 0.79 which resulted in a multifamily average gas heating load of 458 therms. Additionally, the furnace fan savings were determined from the RTF Connected Thermostat measure analysis.

Homes with cooling controlled by the web-enabled thermostat may experience additional savings. Due to the low fraction of homes with cooling systems that are compatible with these thermostats, cooling was not included in this analysis.

Install rate

The 2014 gas thermostat pilot, which depended on self-install, yielded 415 total purchased thermostats, of which 32 were returned. This is a 92% install rate. This factor was used to reduce the energy savings of web-enabled thermostats to account for products that are purchased but not installed or later uninstalled.

Comparison to RTF

Energy Trust's savings are lower than RTF's for electric measures. This is due to our choice of blending base loads for forced air furnaces and heat pumps based on RBSA averages across our heating zones while the RTF has distinct measures for each heating systems and heating zone. Additionally, the RTF assumes 14% savings for homes heated with heat pumps, which is higher than Energy Trust's heat pump pilot achieved and requires qualified thermostats to have electric resistance lockout, which limits the offer to a smaller qualified products list.

MEASURE LIFE

The California Database for Energy Efficiency Resources (DEER) lists the expected lifespan of a programmable thermostat as 11 years.

NON-ENERGY BENEFITS

In Energy Trust's gas-only territory in Oregon, the unclaimed electric savings are listed as Non-energy benefits as customer bill savings in Table 1. The electric savings shown for Washington measures are also unclaimed by Energy Trust and are treated in as non-energy benefits in the cost effectiveness calculations.

COST

Retail prices for web-enabled thermostats from most major manufacturers have converged at $250. Programmable thermostats in contrast, vary widely in price from less than $25 to more than $200 based on features. Because this offering is designed for tech-savvy consumers who want a feature-rich thermostat, the baseline product is a feature-rich programmable thermostat. The Honeywell VisionPro 8000 provides a representative product of a feature rich thermostat as it is 7-day programmable and comes either with built-in WiFi or Redlink technology. The VisionPro 8000 retails for approximately $150.

INCENTIVE STRUCTURE

Incentive is per thermostat and is expected to be the same across fuels and building types to ensure accurate reporting by customers. Table 1 and Table 2 list the maximum cost effective incentives. *These are provided for reference only and is not a suggested incentive*.

FOLLOW-UP

Energy Trust may add qualified products at any time without updating this document. The price of web-enabled thermostats should be reviewed every few years to determine if they have changed substantially. As further research, evaluations, and studies become available regarding web-enabled and other "smart" thermostats, their results may be used in future versions of these measures.

SUPPORTING DOCUMENTS

The cost effective screening for these measures is attached and can be found along with other supporting documents at:
I:\Groups\Planning\Measure Development\Residential\Res HVAC\thermostat\web-enabled thermostat

web thermostats 1532 CEC.xlsm

VERSION HISTORY AND RELATED MEASURES

Table 3 Version History

Date	Version	Reason for revision
9/12/13	x	Nest heat pump pilot
10/9/14	132	Web-enabled thermostat gas heated homes pilot
8/17/15	138	Retail and contractor installed web-enabled thermostats, electric and gas
10/22/15	148	Contractor installed web-enabled thermostats for heat pumps only
4/1/16	153.1	Retail-only web-enabled thermostat measure, electric and gas. Update avoided costs. Supersedes MAD 138.
5/15/17	153.2	Specifies savings for multifamily. Fan savings added. Contractor install included, may be offered concurrently with MAD 148.

Table 4 Related Measures

Measures	MAD ID
Automated Thermostat Optimization	173
Strip heat lock out for heat pumps	19
Contractor installed thermostats on heat pumps	148

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[i] Energy Trust of Oregon Nest Thermostat Heat Pump Control Pilot Evaluation. Apex Analytics. Prepared for Energy Trust of Oregon.
[ii] Energy Trust of Oregon Smart Thermostat Pilot Evaluation. Apex Analytics. Prepared for the Energy Trust of Oregon.
[iii] Residential Single Family Existing HVAC and Weatherization – February 2016. Regional Technical Forum. https://rtf.nwcouncil.org/work-products/supporting-documents
[iv] Baylon, D., Storm, P., Garaghty, K., Davis, B. 2012. "2011 Residential Building Stock Assessment: Single-Family Characteristics and Energy Use." Prepared for the Northwest Energy Efficiency Alliance. http://neea.org/docs/reports/residential-building-stock-assessment-single-family-characteristics-and-energy-use.pdf?sfvrsn=8
[v] Connected Thermostats. Regional Technical Forum. https://rtf.nwcouncil.org/measure/connected-thermostats

4.3 Appendix 3: Residential Program Action Plan

Note: This Appendix contains Energy Trust's Action Plan for NW Natural's Residential program. The action plan is included for reader reference and additional background or context unless specifically referenced in the body of the Company's Plan.

Residential Program Description

Residential programs in southwest Washington acquire cost-effective gas savings by engaging with builders and homeowners. Energy Trust engages with builders to increase energy efficiency of newly constructed homes through incentives, education, trade and program ally support and quality assurance. For single-family and small multifamily homeowners, Energy Trust provides energy savings through incentives for efficient space heating and controls, water heating, insulation, windows, water conservation and behavioral actions, education, trade ally support, financing with repayment through utility bills, and market interventions.

2018 Strategic Focus

- Transition to consolidated delivery of Washington residential PMC services with New Homes Program Delivery Contractor TRC.
- Bolster participation among diverse customer and trade ally groups through further enhancements of targeted offerings and outreach based on continuous data input.
- Continue outreach that builds on existing relationships with trade allies while continuing to enhance participation through engagement across the supply chain to increase cost-effective savings acquisition.
- Grow the residential incentive portfolio by introducing multifamily measure options.
- Coordinate with NW Natural stakeholder and trade ally relationships to drive participation in Existing Homes core measures and EPS homes.
- Monitor and incorporate new gas saving technologies and products into the program.
- Continue to grow and develop builder and verifier networks through outreach activities to support increased market share of EPS homes.
- Prepare for 2019 Washington Residential Energy code changes, including monitoring and tracking updates and participation in stakeholder groups.
- Identify opportunities for operational efficiencies in incentive processing, trade ally management, quality assurance, and consolidated measure analysis and submission processes across sectors.
- Ensure program is forecasted, budgeted and managed to meet performance criteria as defined by the Washington Utility and Transportation Commission (WUTC) and as specified in the 2018 NW Natural WA Energy Efficiency Plan, including incentive to delivery ratio, Utility Cost Test and Total Resource Cost Test results. Provide rationale as to why the portfolio should still only be evaluated on Utility Cost Test.

2018 Activities—Ongoing

- Work with NW Natural to ensure program delivery is in alignment with goals.
- Work with NW Natural to ensure compliance to Washington Utilities and Transportation Commission regulatory requirements and to provide robust and accurate reporting.
- Explore and execute on strategies to increase incentive spending compared to total program delivery costs. Strategies and activities include supply chain and midstream efforts for gas

fireplace electronic ignition and gas tank water heaters, Nest Seasonal Savings, Energy Saver Kit distribution and introduction of a consumer facing tankless water heater measure.
- Collaborate with NW Natural on marketing campaigns and strategies.

Existing Homes

Expand participation
- Support trade ally experience through customized in-person engagements that facilitates incentive application submission.

Grow program offerings and explore new savings opportunities
- Increase engagement across the supply chain to increase cost-effective savings acquisition of thermostat optimization, fireplace electronic ignition and midstream water heaters.

Streamline program operations
- Collaborate with Craft3, a nonprofit Community Development Financial Institution, to improve processes for financing with repayment through utility bills.
- Reduce administrative impacts through improved program quality assurance processes, leveraging technology innovations, program partners and available data resources.
- Launch updated Energy Saver Kit measures; showerheads, shower wands, as well as kitchen and bathroom aerators.

New Homes and Products

Maintain and grow program offerings and increase market penetration
- Promote EPS™, a home energy performance score, through engagement, training and support of verifier and builder networks.
- Collaborate with Bonneville Power Administration Simple Steps, Smart Savings™ to offer discounted showerheads at retail stores.

Technical and design assistance
- Support administration of third-party field quality assurance, including coordination with verifiers to maintain quality assurance and quality control procedures.
- Provide outreach and technical services to help participating builders maximize energy savings.

Streamline program operations and refine delivery strategy
- Collaborate with Axis software provider company, Pivotal, to identify database improvements.
- Leverage permit data to target builder recruitment and engagement with existing trade allies.

2018 Activities—New

Existing Homes

Expand participation and increase market share of efficient equipment
- Engage trade allies and other interested stakeholders to increase market share of smart thermostats.
- Engage with community stakeholders and allies to drive participation and offerings aligned with community needs.
- Reach new and diverse customer through targeted marketing.

Grow program offerings
- Add offerings for small multifamily customers in Washington with support from Lockheed Martin.

Explore new savings opportunities
- Assess introduction of additional small multifamily incentives in the residential portfolio as part of a midyear WUTC tariff filing.

Streamline program operations

- Develop efficiencies and enhanced customer service through incentive processing changes, including direct deposit payments and automated communications
- Evolve quality assurance protocols to reduce administrative impacts, including exploration of new technologies, program partners and available data resources.

Deepen relationships with customers

- Leverage data analytics to target email marketing.
- Ensure culturally appropriate messaging for multiple Hispanic target markets through consulting with IZO Marketing.

Refine delivery strategies

- Diversify distribution of incentives across the supply chain to increase savings and participation across the service territory.

New Homes

Expand participation and increase market share of efficient equipment

- Customize EPS market actor and stakeholder support.

Comprehensive market delivery

- Identify market engagement strategies to support builder retention and recruitment.

Increase market penetration

- Support real estate market engagement across residential programs.

Deliver technical assistance and design support

- Provide early design assistance to builders and verifiers to identify more savings opportunities at the design phase.

2018 Key Assumptions, Risks and/or Challenges

Existing Homes

- A strong home improvement market will continue to bolster energy upgrade purchases with Energy Trust's strong trade ally participation and awareness and endorsement being a key component of participants' to choose the more efficient option.
- Additional financing options in the market will continue to compete with On-Bill Repayment
- Midstream engagement relies on market actors' acceptance of data reporting requirements.

New Homes and Products

- New construction will continue to be robust in Clark County. High market adoption and participation in EPS New Homes is expected. The program will work to ensure accurate forecasting and budgeting for an evolving and expanding market.

2019 Expected Changes

- Expand specialized ally participation opportunities to increase low participation areas.
- Diversify distribution of incentives across the supply chain to increase savings acquisition and participation across the service territory.
- 2018 Washington Residential Energy code changes will impact 2019 planning and evaluation and 2020 New Homes administration and savings trends.

4.4 Appendix 4: Commercial Program Action Plan

Note: This Appendix contains Energy Trust's Action Plan for NW Natural's Residential program. The action plan is included for reader reference and additional background or context unless specifically referenced in the body of the Company's Plan.

2018 Commercial Program Strategic Focus

- Identify and work with customers, architects and trade allies on new construction projects.
- Continue to work with school districts based on recent bond approvals.
- Strengthen the trade ally network to work with small and medium businesses.
- Introduce new gas measures including HVAC, restaurant equipment and measures for multifamily structures.
- Continue emphasis on diversity based on customer size, location, customer types and business ownership.

2018 Commercial Program Activities—Ongoing

Expand participation

- Work with organizations that focus on minority-owned businesses.

Grow program offerings

- Promote non-funded studies to accommodate medium usage customers through the custom track. Trade allies are encouraged to submit single measure custom projects to the program for review without a proposal for funding or request for study incentive. This cuts out several steps and time delays in the process (proposal for study, negotiation on study cost, issuing a work order for a study, etc.) This also helps medium customers with smaller projects because the program cannot pay for studies where potential savings do not justify the study costs. Non-funded studies are for custom projects where only a limited number of variables determine the savings. Projects may include custom boilers or roof insulation over 50,000 square feet.

Streamline program operations and deepen relationships with customers

- Refine customer acquisition and account management to identify market opportunities and serve NW Natural commercial ratepayers efficiently.

Refine delivery strategies

- Increase focus on trade ally delivery through trade ally coordinator outreach and training.

Deliver technical assistance and design support

- Focus on working with active allied technical assistance contractors.

Increase market penetration

- Continue outreach to minority-owned businesses.
- Explore opportunities for Spanish or other language collateral.

Refine measures and offerings

- Continue to review measures nearing expiration while developing new gas measures.

2018 Commercial Program Activities—New

Expand participation

- Use building permit information to expand new construction participation.

Grow program offerings

- Investigate a midstream offering for HVAC for a 2019 launch.

Streamline program operations

- Refine and implement improvements to multisite applications.

Deepen relationships with customers

- Create a standardized spreadsheet for long-term planning for larger customers.

Deliver technical assistance and design support

- Introduce every-other month trainings for allied technical assistance contractors.

Refine measures and offerings

- Explore offering instant incentives paid directly to trade allies.

2018 Commercial Program Key Assumptions, Risks and/or Challenges

- Gas savings continue to be a challenge based on low gas costs and current avoided costs. It will be harder for gas measures to pass cost-effectiveness tests and offerings may be eliminated.
- Forecasting custom pipeline development and realization of custom project savings in a relatively small commercial program can challenging. One large project can make up a large percentage of program budget. Ensuring an accurate forecast for 2018 is a high priority for the commercial program.

2019 Commercial Program Expected Changes

- Boilers bring in the largest savings per standard applications. Over the past few years, as participation in boiler projects decreased, incentives were raised. This measure has one of the highest run rates. If participation in 2018 continues at the same level, in 2019 it may be necessary to reduce the boiler incentives to level the overall run rate.

4.5 Appendix 5: On-the-bill Repayment

Residential Loans and On-The-Bill Repayment Services: Description of On-the-Bill Repayment Services

The Company assists in marketing a low-interest financing offer to residential homeowners who heat their homes with gas heat. The program lender will originate loans granted for the purposes of installing conservation and energy efficiency measures incented by the existing homes program, and the Company will provide billing and remittance services to the program lender by placing the loan repayment fee on the customers' monthly gas bill. Customers who obtain a loan with On-the-Bill Repayment Services will receive a loan repayment charge separately itemized as "Energy Upgrade Loan" on their monthly bill for natural gas service. This will be reflected for the term of the loan or until the loan has been paid off, transferred, or otherwise discharged or removed from the bill in accordance with the terms and conditions of the Company's service agreement.

Program Lender

Craft3, a non-profit community development financial institution (CDFI) lender, will act as the program lender, under the terms and conditions of a service agreement with Energy Trust. Craft3 received a grant from the State Of Washington's Clean Energy Revolving Loan Fund[3] for the purpose of providing financing to Washington residents for the purpose of installing energy efficiency measures. The intent of this offering is to facilitate the acquisition of cost-effective natural gas savings while extending the benefit of the State Of Washington's Clean Energy Revolving Loan Fund to natural gas ratepayers in Southwest Washington.

Loan

The loan offerings through Craft3 that will qualify for On-the-Bill Repayment Services must fit the following parameters:

- Loans must be granted to residential homeowners who use natural gas as their primary heating fuel.
- Loan amounts must be used to install conservation and energy efficient measures incented under NW Natural's existing homes program.
- Loan Amount:
  - Loan amounts must be no less than $2,500 and no more than $15,000.
- Term of loan:
  - Loans up to $7,500 to have a max term of 7 years,
  - Loans between $7,500-$15,000 up to 15 years.
- The program has a fixed interest rate at 4.49%. Contingent on market conditions, Craft3 may at a later date revise the interest rate offer for future customers, not to

[3] *See* http://www.commerce.wa.gov/Programs/Energy/Office/Pages/Clean-Energy-Funds.aspx

exceed 5.49%. Under all circumstances rates will be fixed and consistent for any qualifying customer.

- Loans will be unsecured.
- No penalty for early repayment.
- Craft3 may assess a financing fee of $100 for loans between $2,500-$7,500, $200 for loans between $7,500-$15,000
    - Fees may be financed as an addition to the loan balance
- At least 51% of the loan must be for costs that are directly attributable to the commissioning and installation of the qualifying measure(s), costs incurred to comply with applicable building code, mechanical code, or other pertinent regulations, or costs incurred to meet any technical specifications established by the Energy Trust. Whereas 49% of the loan may be allocated toward non-qualifying energy measures such as cooling.

Terms and Conditions

1. The Company will directly bill Energy Trust or Craft3 for ongoing administrative costs, including costs associated with loan setup, loan termination and other incremental activities related to accounting and processing of bill payments.
2. The business relationship and the services exchanged between Energy Trust and the Company shall be in accordance with an executed Service Agreement. The Energy Trust will act as the program manager of this offering.
3. The provision of On-the-Bill Repayment Services will in no way conflict with the Company's compliance to WAC 480-90, Washington Administrative Code (WAC).
4. A Customer's decision to enter into a loan agreement with Craft3 will not affect his/her ability to establish credit with the Company; it will have no impact on the amount that a Customer may be required to pay on deposit for Natural Gas utility service; and it will have no effect on a Customer's ability to receive reliable natural gas service. The Company will communicate this in writing to customers who participate in this loan program.
5. By entering into a loan agreement with Craft3, the customer will be responsible to remit the monthly loan repayment amount to NW Natural with his/her monthly bill payment for natural gas services.
6. NW Natural is not a party to the loan agreements and has no financial interest in these loans.
7. Monthly payments received from customers participating in this program will be allocated to the customers' account in accordance with Rule 4 of this the Company's Tariff.
8. The Company will not disconnect gas service to a customer for non-payment of loan repayment charges.
9. NW Natural is solely a billing agent for Craft3. Participating Customers must acknowledge that the Company shall be held harmless for any liability resulting from

contractors' actions with regard to installation of energy efficiency measures resulting from this program.

10. NW Natural has no responsibility to collect charges, penalties, or fees beyond the remitting to Craft3 the loan repayment collections the Company receives from Customers in accordance with the services described herein.
11. Craft3 is responsible to tell the Company how much to bill per month for each loan and how many months each customer should be billed. The Company is not responsible for any information provided by Craft3.
12. The Company will not a) accept loan pay-offs, b) issue refunds on loan payments, c) offer payment arrangements on loan amounts due, or d) allow energy assistance to be applied to loan balances.
13. Craft3 must obtain a signed consent form from participating Customers that states that the Customer agrees to allow the Company to provide Craft3 with Customer-specific bill payment information.
14. Craft3 must obtain signed documentation from the Customer that certifies that the Customer has been made aware of the Company's limited role in the loan repayment process.
15. Craft3 must provide the Company with a toll-free customer service phone number to which the Company will refer Customers who have questions or concerns about their loan. The Company is not responsible for Customer questions and disputes related to the loan or the Customer's perceived or real experience related to any portion of the loan or energy efficiency measures.
16. The Company will provide Customers with an overview of the loan product. Specific terms and conditions of the loan will be provided by Craft3.
17. A Customer with a loan open at the time he/she sells his/her home may either pay the loan off at the time of the sale; or if the new homeowner is willing to assume the loan and is able to pass the Craft3's credit requirements, the new homeowner may assume the remaining balance of the loan.
18. If a Customer with a loan refinances his/her mortgage, Craft3 will work with the Customer. A fee may be assessed if Craft3 subordinates its lien to the new mortgage lender.