NW Natural's 2015 Energy Efficiency Plan

I. Background

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 NW Natural to create and begin offering a program.

II. Oversight

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

III. Program Administration

NW Natural's general energy efficiency programs are administered by the Energy Trust, which 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[2] for multiple reasons including allowing non-residential 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.

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

As agreed to in UG-080546, Energy Trust administered the Company's program for one pilot year. During this time, the EEAG monitored the program's performance and assessed whether Energy Trust should be the ongoing program administrator. On May 25, 2011, NW Natural made a compliance filing in UG-080546 wherein it stated the

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

EEAG's opinion to allow Energy Trust to continue administering NW Natural's energy efficiency programs in Washington. On June 8, 2011, Public Counsel separately filed a letter supporting this decision.

NW Natural's Washington Low Income Energy Efficiency Program ("WA-LIEE") is administered by Clark County Community Action Agency, Klickitat County Community Action Agency and Skamania County Community Action Agency.

IV. Programs Offered

NW Natural offers the following general energy efficiency programs:

Residential – Residential customers with gas heated homes are offered home energy reviews wherein an energy consultant identifies measures that could be installed to improve the efficiency of the customer's home. Specific incentive offerings are also available for the installation of certain efficient gas appliances. The Company also offers on-the-bill repayment services for loans offered by Craft3 for the purpose of installing energy efficiency measures

New Homes – The New Homes program encourages builders to construct homes to an energy efficiency standard that is better than Washington building code. Qualifying homes must meet the criteria established in ENERGY STAR's Builder Option Package ("BOP") for natural gas heated new construction.

Commercial – Commercial customers are offered incentives for prescriptive efficient gas appliance installations, as well as efficient installations unique to the customer's facilities that are identified in a custom study.

Specific measure offerings are as listed in Appendix A to this Plan.

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. Agencies are paid $3,500 per home for cost effective energy efficiency installations as well as an average of $440 per home for health and safety repairs. Program details are available in the Company's Schedule I, "Washington Low Income Energy Efficiency Program (WA-LIEE)."

V. Cost Effectiveness Standard

The goal of NW Natural's portfolio of residential, new homes, and commercial energy efficiency programs is to acquire cost-effective gas therm savings. The portfolio of programs offered through the Energy Trust will be deemed cost-effective if at the end of the program year the program portfolio passes the Utility Cost (UCT) test by having a benefit to cost ratio of one or more. The UCT is defined as follows:

The UCT measures the present value of the energy savings in relation to the net costs incurred by the program, including incentive costs and excluding any net costs incurred by the participant. The UCT is Benefits divided by Costs where each is defined as follows:

UCT **Benefits** are:

1. The value of gas energy saved based on the Company's avoided costs. The Company's avoided costs include the following values:
   - The long term gas price forecast compiled from a consultant's gas price forecast;
   - A price for carbon included in the gas price forecast.
   - Gas storage carrying costs for inventory;
   - Upstream variable transmission costs; and
   - Peak related on-system transmission costs; and
2. The 10% credit for the benefits of conservation in addressing risk and uncertainty as well as unquantified environmental benefits.

UCT **Costs** are:

1. Incentives paid to the participant;
2. Administrative costs; and
3. Evaluation, verification, and monitoring.

The Company will continue to monitor and report the how the portfolio fairs using the Total Resource Cost (TRC), which is benefits divided by costs when each is defined as follows:

TRC **Benefits** includes

1. The value of gas energy saved based on the Company's avoided costs. The Company's avoided costs include the following values:
   - The long term gas price forecast compiled from a consultant's gas price forecast;
   - A price for carbon included in the gas price forecast.
   - Gas storage carrying costs for inventory;
   - Upstream variable transmission costs; and
   - Peak related on-system transmission costs; and
2. Non-energy benefits as quantified by a reasonable and practical method; and
3. The 10% credit for the benefits of conservation in addressing risk and uncertainty as well as unquantified environmental benefits.

TRC **Costs** are:

1. Incentives paid to the participant;
2. Administrative costs;
3. Evaluation, verification, and monitoring; and

4. The participant's remaining out-of-pocket costs for the installed cost of the measures after incentives and Federal tax credits.

Levelized Cost Metric

The portfolio of measures promoted through the program will also meet and report on a Levelized Cost metric, which is determined as follows:

The levelized cost is the present value of the total 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.

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

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 Integrated Resource Plan (IRP) and further refined through the BCR test.

VI. Program Evaluation, Monitoring and Verification ("EM&V")

Impact Evaluations

Deemed gross savings by measure are used to determine total therms reported as saved per program year. The deemed savings used will be consistent with the most current impact studies performed on the programs that the Energy Trust delivers in Oregon until after mid-2012 when such impact evaluations will include results from the Washington-delivered programs. The Energy Trust performs the impact study wherein they analyze customers' energy usage data before and after a measure is installed. The savings from all measures' are analyzed annually unless sample sizes based on participation rates are not statistically significant. From the impact evaluation, the Energy Trust is able to determine if average savings are consistent with deemed savings. If they are not, the deemed savings are "trued-up" once annually to reflect the findings. A link to the annual true up report as well as a short summary of the results will be provided in the quarterly report following the report's release.

Process Evaluations

Besides impact evaluations, the Energy Trust contracts with a third party to perform a process evaluation on all general energy efficiency programs offered, typically on an annual basis. The third party studies and reports on the processes employed for each program. Study results are available on the Energy Trust's website: www.energytrust.org. A link to the annual process evaluation as well as a short summary of the results will be provided in the quarterly report following the report's release.

VII. Process for Program Changes

NW Natural will file to revise Appendix A of its Energy Efficiency Plan when it plans to add, change, or remove a long- term incentive offering. Every year the Company will consider if program year changes are needed. If they are, the Company will revise its EE 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 the Plan. This does not preclude the Company from filing to revise Schedule G or its EE Plan at any time during the year. Advice filings revising or adding measures will include:

1) A benefit cost ratio ("BCR") calculator demonstrating the measure's life, measure cost, the quantifiable non-energy benefits, the utility system benefits and the societal BCR; and

2) For new measures, a blessing memo which refers to an in-house Energy Trust document that summarizes 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.

Please note that 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 completely 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.

VIII. 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 that will contain all the required reporting for the calendar year, including a link to the Purchased Gas Adjustment (PGA) filing wherein program costs are recovered:

Budget

The Company will provide a total estimated program budget for the next calendar year. The budget will present expected expenditures by program and customer class.

Please note that this budget forecast will be based on the best information available at the time. As the year progresses, budgeted dollars may be reallocated among various programs or new offerings that are approved by the WUTC.

Funding Schedule

A funding schedule is a contractually-agreed-to timeline between NW Natural and Energy Trust wherewith NW Natural will provide Energy Trust the necessary money for program administration and delivery. The amounts dispersed to the Energy Trust in one year are the sum of all funds needed for that program year determined by subtracting any unspent or uncommitted funds previously dispersed to the Energy Trust for the Washington program from the total forecasted budget.

Metrics

The Company will propose performance metrics that will address the following:

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

The Company expects that Utility Cost (UC) at the portfolio level shouldbe greater than 1.0 and will report compliance to this on an annual basis. The Company will also report on the portfolio TRC.

The Company will come to agreement with the EEAG on 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.

Generally, milestones for the program year will be as follows:

Program Year Schedule	
January 1	Start of program year
April 25	Annual report for previous program year is filed.
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
December 1	Latest date to file EE Plan for next program year
January 1	Start of next program year; new EE Plan effective

IX. Reporting

The Company will file all required reporting with the WUTC in the docket established for the current program year.

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 on the following schedule:

1Q – May 25
2Q – August 25
3Q – November 25

Annual

An annual report will be due annually for the previous year by April 25th.

EEAG Review

The EEAG will meet either in person or by teleconference to review the annual report and on an as requested basis.

Content of Reports

The quarterly reports will include

- Quarterly progress toward annual program metrics
- A breakdown of costs by program and customer sector
- A reporting on percentage of program costs spent on customer incentives

- The funding received to date
- Energy payback estimator site traffic statistics both in aggregate and by geography, detailing the volume of visits to the URL
- A status report on NEEA, market transformation efforts, spending, and activity
- The 2Q report will include a report on the Company's mid-year transactional review of the Energy Trust's expenses
- 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, 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

The annual report will include the following:

- Budget compared to actual results by program
- Cost-effectiveness calculations on a program by program and total portfolio basis. Total Portfolio means all residential and commercial programs.
- Cost-effectiveness calculations of the total portfolio plus NEEA expenses
- Measure level participation (units installed and savings) under each program
- Reporting on achievement of metrics
- Energy payback estimator site traffic statistics both in aggregate and by geography, detailing the volume of visits to the URL
- A status report on NEEA, market transformation efforts, spending, and activity
- An overview of the Company's year-end review of Energy Trust transactions.
- Evaluation results (if performed)
- WA-LIEE program results including:
  - total program year costs
  - homes served
  - estimated total therm savings, and
  - average therms saved per home.

X. Annual Program Budget

<u>Budgets</u>

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 general energy efficiency and WA-LIEE program costs.

XI. Cost Recovery

Energy Efficiency and WA-LIEE program costs 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. Beginning in 2012, the Company will annually submit a stand-alone filing concurrently 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 which will include detail on the achievement of performance metrics; the forecasted budget for that year and actual expenditures
- 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.

XII. 2015 Performance Metrics

Below are the 2015 program metrics. Each metric is followed by a statement explaining how it was determined.

- Total residential and commercial program costs, including NEEA gas efficiency market transformation, will be between $1,342,559 and $1,570,292

  The total costs for this metric correlate to the range of costs estimated to achieve all cost effective therms for the programs being offered as determined in the Company's 2014 Integrated Resource Plan ("IRP").

- Therms saved for the residential and commercial program will be between 220,991 and 259,895. Including WALIEE, therm savings targets for the total portfolio will be between 223,021 and 262,427.

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 2014 Modified IRP.

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

This metric is unchanged from last year. The profile of NW Natural 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.

- First-year therms will cost less than $6.50 per therm

This metric remains unchanged from 2013and 2014.

- The UCT at the portfolio level is greater than 1.0

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

<u>Schedule I, Washington Low Income Energy Efficiency (WA-LIEE) 2015 Performance Targets</u>

In 2015, the WA-LIEE program will strive to weatherize 10-12 homes for a cost of $89,300 to $111,625. Assumptions are as provided below in Table II.

Table II – WA-LIEE 2015 Performance Targets

Estimated homes served	10-12
Estimated Average Cost of Incentives per home	$3,500
Maximum Cost per home ($3,500 incentives + $440 health, safety and repairs and $525 administration costs)	$4,465
Maximum cost based on estimated homes served	$44,650 to $53,580
Estimated therms saved per home	211
Total estimated therms saved	2110 to 2532

XIII. 2015 Budget and Funding Schedule

Below is the 2015 budget for the residential and commercial energy efficiency programs, NEEA gas market transformation, and the WA-LIEE program.

Range	**Low**	**High**
Commercial		
Retrofit	$587,753	$691,474
Residential		
Retrofit	$402,697	$473,761
New Homes	$300,035	$352,982
NEEA		
NEEA*	$52,075	$52,075
Total For Schedule G Programs		
WALIEE	$44,650	$53,580
Total	$1,387,209	$1,623,872

Funding Schedule: As of the November 2015, the Company and Energy Trust have not executed a contract to define the 2015 funding schedule but parties expect the funding schedule will mirror what was done in prior years, which was that 50% of budgeted need was provided to Energy Trust on March 1 and the remaining 50% was provided on October 1.

XIV. Gas Market Transformation, First Year Pilot

NW Natural will participate in a regional gas market transformation initiative lead by the Northwest Energy Efficiency Alliance (NEEA). The Company views such activities as a necessary investment in the future of gas demand side management (DSM) 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 gas emerging technologies. NEEA uses a stage-gate approach to managing 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 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 not near-term savings, but to develop additional efficiency measures and strategies available to programs—cost-effective, reliable, and having a viable delivery strategy and channel to acquire savings at 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 are where most of the activity will be in the early years of the NEEA gas collaborative. Significant savings begin at the market development stage, stage five.
The Company is not including the costs invested in gas market transformation in the analysis it performs when reporting on its 2015 and 2016 cost effective performance metrics. For 2017, the Company will discuss with the EEAG whether or not keeping these costs out of its cost effectiveness analysis continues to be appropriate. The Company acknowledges that this practice of excluding market transformation costs from its cost effectiveness analysis for at least a two-year period of time is in no way precedent setting, and should the Company make any future requests for the unique treatment of costs, such requests will be evaluated by the EEAG on a case-by-case basis.

X. RESIDENTIAL LOAN ON THE BILL REPAYMENT SERVICES

Description of On the Bill Repayment Services

NW Natural will assist in marketing a low-interest, unsecured financing offer to residential homeowners who heat their homes with gas heat. The program lender will originate loans granted for the purposes of installing 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 as a separately itemized as "Energy Upgrade Loan" on their monthly bill for natural gas service 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 terms and conditions of the Company's service agreement with Energy Trust, who will manage the coordination of activities between the program lender, the program management contractor, and the company.

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. Craft

3 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 energy efficient measures incented under NW Natural's existing homes program.
- Term of loan:
    - Loans up to $7500 to have a max term of 7 years,
    - Loans between $7500-$15,000 up to 15 years.
- The program will launch with a fixed interest rate at 4.49%. Contingent on market conditions, Craft 3 may at a later date revise the offer for future customers, not to 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.
- Craft 3 may assess a financing fee of $100 for loans between $2500-$7500, $200 for loans between $7500-$15,000
    - Fees may be financed as an additional to the loan balance
- No more than 25% of loaned dollars may be used for non-energy related measures. Expenditure that are non-energy related will be restricted to costs incurred by the commissioning of EE measures (for example, removal of knob and tube wiring).

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.

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

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.

Blessing Memos

RESIDENTIAL PROGRAMS

Program	Measure	Description
Existing Homes	1.0gpm Bath Aerator	"Build Your Own" Kit, 65% installation rate
Existing Homes	1.5gpm Kitchen Aerator	"Build Your Own" Kit, 65% installation rate
Existing Homes	1.75gpm Showerhead Gas 2014	"Build Your Own" Kit, 75% installation rate

March 20, 2014

Blessing Memo for Leave Behind Showerheads, Showerwands, and Aerators in Washington

T Blessing Memo for Leave Behind Showerheads, Showerwands, and Aerators in Washington

End Use
Showerheads, showerwands, and aerators in NW Natural Washington service territory

Scope
1.75 or 1.5 gpm showerhead, 1.5 gpm showerwand, 2.0 or 1.5 gpm kitchen faucet aerator, and 1.5 or 1.0 gpm bathroom faucet aerator

Program
Based on the referenced analysis and associated cost-effectiveness screening, the measure described below is "blessed" on a prospective basis for inclusion in the Home Energy Savings in NW Natural Washington service territory.

Description of the Measure
Showerheads, showerwands, and aerators reduce the amount of water heating energy by restricting the flow rate of water.

Purpose of Evaluating Measure
This memo updates savings and incentives for showerheads, showerwands, and aerators installed by the homeowner. Homeowner installs are also called leave behinds.

Program Requirements
A maximum of 2 showerheads per household. 1 showerwand may be substituted for a showerhead. 1 kitchen aerator per household and up to two bathroom faucet aerators

Project	Measure	Measure Lifetime (Maximum 70 yrs)	Annual Electricity Savings, kWh	Annual Gas Savings, therm	Total Cost	ETO Incentives	Non Energy Benefits (if any)	Combined Utility System BCR	Combined Societal BCR
Homeowner installed showerhead	1.75 GPM	15	0	14.4	$3.60	$3.60	$212	35.83	94.72
Homeowner installed showerhead	1.5 GPM	15	0	17.9	$3.60	$3.60	$263	44.44	117.50
Homeowner installed showerwand	1.5 GPM	15	0	13.3	$7.21	$7.21	$197	16.5	43.83
Homeowner installed kitchen aerator	2.0 GPM	15	0	3.8	$2.07	$2.07	$56	16.43	43.48
Homeowner installed kitchen aerator	1.5 GPM	15	0	6.4	$2.07	$2.07	$94	27.54	72.95
Homeowner installed bath aerator	1.5 GPM	15	0	5.0	$1.57	$1.57	$74	28.66	75.80
Homeonwer installed bath aerator	1.0 GPM	15	0	7.6	$1.57	$1.57	$112	43.31	114.65

Measure Analysis:

Assumptions which have been copied exactly from the HER direct install measure are listed below:

- Baseline 2.51 gpm
- 75 degree Fahrenheit temperature rise
- 68% of water is hot, which results in a delivery of approximately 106 degrees Fahrenheit
- 0.46 showers per person per day
- 7.84 minutes per shower
- Measured flow rate is 90% of rated flow rate, as rated flow is tested at 80 psi, which is higher than the water pressure in most locations.

Homeowner installed measures incorporate a combined discount for equipment which is never installed and equipment which is removed. The rates for homeowner installs are taken from the Energy Saver Kit analysis. Showerheads and showerwands are installed and remain in place 75% of the time and aerators are installed and remain in place 65% of the time.

Household occupancy in Clark County, Washington is 2.76 people, according to the 2010 U.S. Census.

For a homeowner installed 1.75 gpm showerhead, energy savings are 14.4 annual therms. For a showerhead with a flow rate of 1.5 gpm, energy savings are 17.9 annual therms. For a homeowner installed 1.5 gpm showerwand, energy savings are 13.3 annual therms.

Assumptions necessary to calculate the aerator savings are taken from analysis completed by David Robison of Stellar Processes in 2005, and are as follows:

- Baseline 2.74 gpm for kitchen faucets and 2.48 gpm for bathroom faucets.
- 50% percentage of max flow,
- 2.5 minutes of faucet use per person per day
- 365 days per year
- 52˚F at the cold water inlet
- 104˚F delivery temperature.

For a homeowner installed 2.0 gpm kitchen aerator, energy savings are 3.8 annual therms. For a kitchen aerator with a flow rate of 1.5 gpm, the energy savings are 6.4 annual therms. For a homeowner installed 1.5 gpm bathroom faucet aerator, energy savings are 5.0 annual therms. For a bathroom faucet aerator with a flow rate of 1.0 gpm, the energy savings are 7.6 annual therms.

Savings, Economics and Incentives

When left for the homeowner to install, the showerhead incentive is $3.60. The showerwand incentive is $7.21. Bath aerators are $1.57, and kitchen aerators are $2.07.

ETO uses the water and sewer rates of the City of Vancouver to calculate the non-energy benefit of reducing water consumption in Washington. The combined rate is $8.14 per 1000 gallons. The change in water volume annually includes both cold and hot water.

Net to Gross ratio of 1 is applied to all measures in Washington.

Program	Measure	Description
Existing Homes	Ceiling/Attic Insulation per SQFT	Updated maximum pre-treatment R value of R19, treat to R38

September 9, 2014

Subject: REVISED Blessing memo for single family insulation retrofit

Allows for different starting condition requirements for attic insulation in Washington, shown in blue.

REVISED Blessing memo for single family insulation retrofit

End Use

Reduced space heat use

Scope

Attic, wall, and floor, insulation

Program

Based on the following analysis, the measures described below are blessed for inclusion in the Existing Homes and Home Performance w/ ENERGY STAR programs

Description of the Measure
Insulation provides a thermal barrier and reduces heat loss.

Purpose of Evaluating Measure

For attic insulation in Oregon, the maximum R value allowed in the existing condition was decreased to focus the program on homes that have the greatest energy saving opportunity. Attic insulation in Washington may still continue to replace existing insulation up to R19. Wall and floor insulation are also documented here, in order to update savings based in impact evaluations and to discuss challenges to the societal BCR. This analysis provides expected cost-effectiveness based on the most recent gas avoided cost forecasts and measure specifications, consistent with evaluation findings.

Table 1: Cost effectiveness calculator Active WA Measures Highlighted

Project	Measure	Measure Lifetime (Maximum 70 yrs)	Annual Electricity Savings, kWh	Annual Gas Savings, therm	Total Cost	MAX ETO Incentives	Combined Utility System BCR	Combined Societal BCR
attic insulation ELE SPHT	HES	45	1.39		$0.83	$2.89	1.0	3.5
attic insulation GAS SPHT	HES	45		0.060	$0.83	$0.55	1.0	0.7
attic insulation GAS SPHT zone 2	HES	45		0.066	$0.83	$0.61	1.0	0.7

attic insulation in WA (R0-R19 starting condition)	HES	45		0.052	$0.83	$0.48	1.0	0.6
wall insulation ELE SPHT	HES	45	1.21		$1.39	$2.52	1.0	1.8
wall insulation GAS SPHT	HES	45		0.052	$1.39	$0.48	1.0	0.3
wall insulation GAS SPHT zone 2	HES	45		0.057	$1.39	$0.53	1.0	0.4
floor insulation ELE SPHT	HES	45	0.98		$1.60	$2.04	1.0	1.3
floor insulation GAS SPHT	HES	45		0.042	$1.60	$0.39	1.0	0.4
floor insulation GAS SPHT zone 2	HES	45		0.046	$1.60	$0.43	1.0	0.3
attic insulation ELE SPHT	HPF	45	1.39		$1.70	$2.89	1.0	1.7
attic insulation GAS SPHT	HPF	45		0.060	$1.70	$0.55	1.0	0.3
attic insulation GAS SPHT zone 2	HPF	45		0.066	$1.70	$0.61	1.0	0.4
wall insulation ELE SPHT	HPF	45	1.21		$2.76	$2.52	1.0	0.9
wall insulation GAS SPHT	HPF	45		0.052	$2.76	$0.48	1.0	0.2
wall insulation Gas SPHT zone 2	HPF	45		0.057	$2.76	$0.53	1.0	0.2
floor insulation ELE SPHT	HPF	45	0.98		$1.90	$2.04	1.0	1.1
floor insulation GAS SPHT	HPF	45		0.042	$1.90	$0.39	1.0	0.2
floor insulation GAS SPHT zone 2	HPF	45		0.046	$1.90	$0.43	1.0	0.2

Note: this table uses 2015 avoided cost

Attic Insulation Measure Analysis

Billing analysis from CSG indicates energy savings for attic insulation in gas heated homes ranges from 96 therms to 66 therms, depending on the starting condition, as shown in the table 2 below.

Table 2: CSG energy savings analysis by starting insulation level

Pre R-Value	N	Net Therm Savings	95% C.I.	Pre-treatment Therms	% Savings	Home sqft	Insulation sqft	Therms per sqft
0	119	96	± 55	803	12.0%	1,962	1,126	0.085
2 thru 8	204	74	± 16	700	10.6%	1,860	1,333	0.056
9 thru 11	215	66	± 19	735	9.0%	1,929	1,340	0.049

Table 2a: Weighted average of CSG energy savings analysis by starting insulation level

Starting condition R0 to R11	75.7		737		1,910	1,290	0.060
Starting condition R0 to R19	66.8		717		1,954	1,313	0.052

The weighted average energy savings per square foot of insulation is 0.052 annual therms, when the starting condition is R19 or less as shown in Table 2a. By comparison, Energy Trust billing analysis on projects in 2007 and 2008 resulted in the same energy savings to within two significant digits. Energy Trust billing analysis from 2009 (the most recent available) shows energy savings slightly less than previous years, though the reason for the difference is not known.

When only those homes that had a starting condition below R12 are included in the weighted average energy savings per square foot of insulation is 0.060 annual therms, as shown in Table 2a. Energy Trust billing analysis did not attempt to describe savings variation as a result of starting insulation levels, so this memo relies on CSG's analysis to do so.

Billing analysis is difficult to obtain for electrically heated homes, as fewer have received weatherization treatments in recent years. To calculate the energy savings for electrically heated homes in the absence of billing analysis, the geometry and heat transfer characteristics were considered to be the same as the average gas heated home. The average gas furnace was assumed to be 85% efficient, whereas the average electric heating plant was assumed to be 107%, including zonal heat, forced air furnaces, and heat pumps, proportional to their market share. These efficiencies are aligned with other Energy Trust measures and (on the electrical side) with RTF analysis. Therefore, the end use for heating a home with electricity was calculated to be 22% less than for gas heated homes in terms of BTUs, or 1.39 kWh per square foot per year.

Energy Trust has only one year's analysis to compare the energy savings between projects in the Existing Homes and Home Performance w/ ENERGY STAR. That indicated that the savings are roughly equivalent per measure for all measures combined. Therefore, the energy savings is assumed to be the same.

Oregon code has required attic insulation to be R19 or greater since 1973 and Washington code has required it since 1986. Although there will be exceptions, the program is most likely to find eligible homes were built before then.

Median cost of attic insulation was $0.83 per square foot in the HES program in 2011, and $1.70 in HPF over the same time period. The maximum cost effective incentive is $0.55 per square foot in Oregon and $0.48 in Washington.

Wall Insulation Measure Analysis
Energy Trust billing analysis of wall insulation projects from 2007 to 2009 show varying amounts of energy savings, from 0.038 to 0.062 annual therms per square foot. As there is a fairly wide range between the results, this analysis uses 0.052 annual therms from the 2007 impact evaluation, which is the median amount. Not enough electrically heated homes received treatment to produce a statistically significant result, so the gas energy savings were converted to kilowatt hours and multiplied by the efficiency of the typical gas furnace, with the result of 1.21 kWh per year per square foot of insulation.

Oregon code has required wall insulation to be R11 or greater since 1973 and Washington code has required it since 1986, so newer homes are likely to be ineligible.

Median cost of wall insulation was $1.39 per square foot in the HES program in 2011. The maximum cost effective incentive is $0.48 per square foot.

Floor Insulation Measure Analysis
Energy Trust billing analysis of floor insulation projects from 2007 to 2009 show varying amounts from 0.035 to 0.051 annual therms per square foot. As there is a fairly wide range between the results, this analysis uses 0.036 annual therms from the 2009 impact evaluation, which is the median amount. Not enough electrically heated homes received treatment to produce a statistically significant result, so the gas energy savings were converted to kilowatt hours and multiplied by the efficiency of the typical gas furnace, with the result of 0.98 kWh per year per square foot of insulation.

Beginning in 2013, residential programs will only install insulation in floors that have no insulation in them, as the starting condition. No additional savings are expected, as the large majority of homes in which insulation has been installed in the past met this condition, even though it was not previously required. Oregon code has required floor insulation to be R19 or greater since 1979 and Washington code has required it since 1986, so newer homes are likely to be ineligible.

Median cost of floor insulation was $1.60 per square foot in the HES program in 2011, and $1.90 in HPF over the same time period. The maximum cost effective incentive is $0.39 per square foot.

Savings, Economics and Incentives
Measure lifetime is 45 years, consistent with other Energy Trust shell measures.

Attic insulation in homes heated with electricity is cost effective. Energy Trust has sought and received approval from the OPUC to continue attic insulation in gas heated homes until October, 2014, on the basis of our investigating means of reducing the cost of the measure and limiting the number of participants, and, in the Home Performance w/ ENERGY STAR, on the basis of seeking new cost strategies, including giving payback information to customers. In Washington, the 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.

Wall and floor insulation in homes heated with electricity are cost effective in the HES program, but not HPF. They are not cost effective in either program for gas heated homes. Energy Trust has sought and received approval from the OPUC to continue wall and floor insulation on the basis of our investigating means of reducing the cost of the measure.

Program Requirements

Attic insulation when the starting condition is less than or equal to R12 in Oregon and R19 in Washington and the post-treatment condition is R38 or greater.

Wall insulation when little to no insulation is present at the start and the post-treatment condition is R11or the wall cavity is filled. All heated exterior walls must be insulated.

Floor insulation when no insulation is present at the start and the post-treatment condition is R30 or the floor cavity is filled.

Program	Measure	Description
Existing Homes	Gas Hearth - Intermittent Pilot Light	new incentive designed to phase out standing pilot light gas hearths
Existing Homes	Gas Hearth 75+ FE and intermittent ignition	new FE tier
Existing Homes	Gas Hearth 65 to 69 FE Intermittent ignition	updated FE tier

UPDATED Blessing Memo for Gas Fireplaces

Measure Description

Direct vent gas fireplaces, including zero clearance and freestanding units and inserts. The measure is currently offered in the Existing Homes and Home Performance with ENERGY STAR programs. Additional research is needed to expand the measure to the Existing Buildings Multifamily and Efficient New Homes programs.

Reason for Review

For the past 5 years, program activity has increased significantly. To better inform our market understanding, three studies were commissioned over the course of 9 months;

- Updated market data vendor survey to determine current market efficiency baseline and use of standing pilot lights
- A metering study to determine the hours of use compared to our 20 hours/week assumption
- Survey of distributors to determine if the Oregon market was more efficient than other states/regions and if Energy Trust's program influenced upstream decisions regarding efficiency

Proposed changes

The updated vendor survey showed a shift in the market baseline to 66.8 FE. As a result, two new efficiency tiers are proposed: a lower efficient tier from 70 to 74 FE and a more efficient tier at 75 FE and above. With the minimum requirement of 70 FE very close to the 66.8 FE baseline, there appears to be no incremental cost. We are offering an incentive at this efficiency level based upon a market design need to retain widely available equipment while the market can adapt to the higher efficiency tier. When calculating savings, the average efficiency in the range will be used, not the minimum, so there is still calculated energy savings in the lower tier. The higher efficiency tier is cost effective but equipment availability may be limited. This shift will support the market advancing toward the new level while retaining the current, most popular efficiency level.

Energy savings based on thermal efficiency

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

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

The efficiency is based on the average in each bin, as shown in the table below. The heat capacity for each efficiency tier was averaged from program data from 2013. Fireplaces with an efficiency rating between 70 and 74 FE averaged 33 kBtu/h, and fireplaces with ratings of 75 FE or higher had an average heat capacity of 26 kBtu/h. Hours of use averaged 15 per week in the metering study.

Table 3: baseline efficiency

	overall market	total program (includes free-riders)	free-riders (subset of total program)	non program	non program or free rider	average FE in each bin
below 65	1971	0	0	1971	1971	61.0
65 to 69	2806	260	117	2546	2663	67.0
70 to 74	2806	1074	483	1732	2215	71.6
75 +		20	9		9	77.2
total	**7583**	**1354**	**609**	**6249**	**6858**	**66.8**

The overall market size was an outcome of the market survey. 23 out of the 48 members of the Oregon Hearth, Patio, and Barbecue Association were interviewed and their responses assumed to be representative of the members the survey contractor was unable to interview. The extrapolated responses were compared to program activity. The market baseline of top selling brands was calculated by averaging the efficiency of non-program equipment, including free-riders. Free-ridership is 45%, according to rolling average quarterly Fast Feedback results. However, this reflects the impressions of participants, and may be somewhat distorted in two ways. First, the program appears to have influenced the efficiency of available equipment, based on at least one distributor's perspective. Second, as is the case for all replacement equipment measures, customers may have difficulty distinguishing between the efficiency of the model chosen and the efficiency they would have otherwise chosen. They may or may not have been presented with a choice by the dealer, who may or may not have proposed the same equipment without incentives. Free-riders surveys are particularly difficult to interpret during periods of significant market transition. The baseline survey indicates that we have been experiencing such a period. Thus, we may incorporate the free-riders calculations into our savings forecasts, but will also- but not in this memo- examine whether we should claim some market transformation savings for this baseline improvement.

For the new lower efficient tier (Tier 1, 70-74 FE), the savings are 19.9 annual therms (15 hours per week x 40 weeks x 33 kBtu/h x (1 / 66.8 FE – 1 / 71.6 FE). For the higher efficient tier (Tier 2, 75+FE), the savings are 31.5 annual therms (15 hours per week x 40 weeks x 26 kBtu/h x (1 / 66.8 FE – 1 / 77.2 FE).

A sensitivity analysis was done to determine the effect of free-ridership on the energy savings. Although we know that some degree of free-ridership is present, the sensitivity of the savings to changes in free-ridership can be determined by removing the free-riders from the baseline. The resulting average baseline efficiency is 66.4 FE. If an alternative approach to free-ridership were selected, the maximum energy savings from thermal efficiency would be 21.7 annual therms for equipment from 70 to 74 FE and 32.9 annual therms for equipment at or above 75 FE, a change of 9.0% and 4.5% respectively. Given the absence of an alternative empirical method for estimating free riders, we stuck with our initial analysis, and incorporated the self-reported free riders in the baseline.

Energy savings based on intermittent pilot ignition

Intermittent ignition savings are calculated by multiplying the heat input by the number of hours the pilot would otherwise be on and the Net to Gross ratio (NTG). The heat input is 900 Btu/h, up from the previous version of the measure, based on information that thermostatically controlled and remote controlled fireplaces require pilot lights with higher heat inputs. The hours are 8760 minus the hours the fireplace is in operation, and NTG is 0.81 based on the percentage of standing pilot lights in the baseline when the measure was implemented in 2009. Savings from the intermittent ignition system are 59.5 therms ((8760 hours – 40 weeks x 15 hours per week) x 0.009 therms / h x 0.81).

A third party contractor interviewed representatives of three manufactures whom they assert cover the majority of the Portland market and approximately 30% of the state market. We learned that standing pilot lights have nearly vanished and at least one distributor credits our program with that change. One expert noted that they sell standing pilot lights in other states but only about 1% of Oregon sales have standing pilot lights. To recognize this influence, although standing pilots are no longer in the market baseline, savings for intermittent ignition systems will be claimed for each unit in the program in 2015, including units between 65 and 69 FE, for which no thermal efficiency savings are claimed. These savings recognize that we helped move the market away from standing pilot lights earlier than they otherwise would have. Continuation of this practice beyond 2015 will depend upon additional market data we are able to collect and if we can determine from that data a reason to continue to claim ignition system transformation savings.

In addition, one interviewee from the distributor survey claimed that due to Energy Trust influence, they changed their product line and only sell high efficiency units now. To account for this influence, we propose <u>estimating the balance of this distributor's sales in Oregon that did not receive an Energy Trust incentive and booking those savings for 2014</u>. That analysis is not complete, nor documented in this memo, but will be pursued over the next several months.

Measure Cost

Table: 2013 program data

Tier	Average cost
67 to 69	$4,553
70 to 74	$4,067
75 and up	$4,241

	Measure	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
1	70 to 74 FE and intermittent ignition	20	79.4	$1	$476	$476	$476	1.0	476
2	75+ FE and intermittent ignition	20	90.9	$173	$550	$545	$545	1.0	3.1
3	Intermittent ignition (65 to 69 FE)	20	59.5	$110	$357	$357	$357	1.0	3.2

Program	Measure	Description
Existing Homes	Gas Furnace $100 Incentive (90% to 94%)	updated tier
Existing Homes	Gas Furnace $350 Incentive (95%+)	new high efficiency tier

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.

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, and 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).

Program	Measure	Description
Existing Homes	Smart Thermostat	Pilot Smart Thermostat

Blessing Memo for Self-Installed Advanced Thermostats on Gas Furnaces Pilot

End Use

Residential Space Conditioning

Scope

This measure is applicable in existing single family homes that have a gas furnace which is used as the primary heating source.

Program

Existing Homes

Description of Measure

The purpose of the advanced thermostats on gas furnace pilot is to determine if cost effective energy savings can be consistently achieved by consumers self-installing devices capable of reducing furnace run times when occupants deviate from a fixed schedule. Through improved user interfaces, remote programming and adaptive setbacks utilizing advanced features to determine whether or not a home is occupied, smart thermostats should be able to add additional setbacks into their schedule, thus savings energy even under less than ideal programming. Products in this Pilot Project will be limited to the NEST and Honeywell's Lyric.

Savings, Economics and Incentives

Savings stemming from advanced thermostats on gas furnaces are not well understood. Savings are estimated by the manufacturers at 2-7%. Savings estimates from Puget Sound Energy's current Pilot study are 8%. The NEST pilot for heat pumps showed a heating load reduction of 10%. Savings estimate range is 2-10% of heating load. Assuming a conservative 4% of gas space heating savings estimated therm reduction is 23 annual therms based on Residential Buildings Stock Assessment average single family Oregon gas heating load of 583 therms.

A 13 year measure life was assumed as this is the midpoint of a gas furnace's expected useful life.

Average retail prices for the NEST and Lyric are $249, and this retrofit cost is used for the benefit cost analysis below. However this measure is not cost effective as a retrofit measure. Web enabled thermostats without adaptive setback capabilities range in price from $100-$300+, making this a viable incremental measure. If the midpoint of the baseline cost is used as a reference point, the incremental cost would be around $50. Once the energy savings have been proven, it would be possible to make the incentive less of the overall cost, and target the amount needed to persuade the customer to make the incremental improvement from a programmable thermostat to an adaptively learning one. In addition, if the pilot is successful, packaging these devices with new furnaces at the distributor level would offer another cost effective delivery method. So, the first line in the chart below shows the cost-benefit of the measure in the pilot. The second line shows the potential for future cost-effectiveness and explains why the pilot is important research.

The pilot will install about 200 NEST and 200 Lyric thermostats by the end of December, 2014.

Evaluation

As with other residential weatherization measures, savings will be estimated using standard Energy Trust billing analysis methodology when one year of billing analysis are available. In addition, feedback will be gathered around customer satisfaction on an ongoing basis in an effort to correct any issues with the measure design as soon as possible. We will also look at the patterns of gas furnace age and home characteristics to determine whether to use one average savings estimate or vintage and climate-specific estimates. NEST labs and Honeywell may or may not provide us with additional data on the performance of the thermostats.

BCR (link:\\eto-share\etoo_share\Planning\EE Programs\Home Energy Savings\HOUSE TYPES AND measures\single family\tstats- web addressable\bencost\ETO CEC web enabled gas Tstat.xlsx)

Project	Measure Lifetime (Maximum 70 yrs)	Annual Gas Savings, therm	Total or incremental Cost	ETO Incentives	Utility System PV of Benefits	Societal PV of Benefits	Combined Utility System BCR	Combined Societal BCR
Web enabled gas Tstat	13	23	$249	$200	$101	$101	0.5	0.4
Potential incremental measure	13	23	$50	$100	$101	$101	1.0	2.1

Program	Measure	Description
Existing Homes	Windows U .28-.30	High Efficiency Windows New Tiers
Existing Homes	Windows, U <= .27	High Efficiency Windows New Tiers

UPDATED Blessing Memo for Windows in Single Family, Manufacture Homes, and Small Multifamily

Applicable Programs:

Home Energy Savings, Home Performance with ENERGY STAR, and Existing Manufactured Homes programs and the Multifamily Existing Buildings program for properties with four or fewer living units in both Oregon and Washington

Measure Description

Energy Trust offers incentives for two tiers of windows measures installed in the applicable programs. 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. At the present time, Tier 1 is for new windows with a U-factor between 0.26 and 0.30; Tier 2 is for the even more efficient windows with a U-factor 0.25 or less. Since last updated in 2009, our assumption for the market baseline U-factor has aligned with the RTF at 0.35.

Multifamily Existing Buildings has separate windows retrofit measures for large properties with five or more living units, which calculate savings and costs from the existing condition. The difference between larger multifamily buildings and the single family and small multifamily measures is a result of market research that indicates that large multifamily projects are less likely to have occurred without Energy Trust incentives, whereas single family homeowners are more likely to replace their windows without our incentive, but may be influenced to purchase more efficient windows than they would otherwise have done.

Multifamily properties with four or fewer properties were moved from the single family to the multifamily program in 2012 because the delivery channel had more similarities with other multifamily properties. However, the characteristics of the buildings have more in common with detached single family homes. More detailed data on windows in small multifamily buildings are not available and would be costly to develop. Further, the number of projects in small multifamily buildings is far less than single family, so that any small differences in building construction would be further diminished in their impact by their relative infrequency. This iteration of the windows blessing memo asserts that the savings used for single family windows measures may be used for multifamily properties with four or fewer living units.

Need for Review

Since 2009, Energy Trust has received indications that the market baseline has become more efficient than the 0.35 U-factor baseline we currently assume. ENERGY STAR released a draft windows specification change announcement in the summer of 2013 for a 2016 proposed change, which showed that 81% of the national windows market meets their current criteria of a 0.30 U-factor or better. Also, anecdotal evidence suggests that most new homes in the region are using 0.30 U-factor windows or better. Due to a lack of local market data to support these indications Energy Trust decided to commission a market survey to inform any change to baseline U-factor assumptions.

The market survey consisted of interviews with regional window manufacturers, which were conducted by an independent contractor who has existing relationships with manufacturers in the area and who is considered an expert on this technology in the region. Participating window manufacturers represented 74.5% of sales in the region.

Interviews took place in October and November of 2013. Manufacturers were asked about their regional and Oregon market share, the percent of sales in each efficiency category, and the average incremental cost for each efficiency category for the time period Q3-2012 to Q3-2013. The data allow us to calculate sales weighted average baseline window efficiency and sales weighted average incremental cost of efficiency for the entire NW windows market.

Energy Savings

<u>Calculation of market baseline</u>

The results of the survey for the market share of windows at various efficiency levels are shown in Table 1.

Table 1: Percent of Sales by Efficiency Tier

U-Factor Tier	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 our 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.

Proposed changes to tiers

Before working through adjustments to measure savings and cost assumptions due to this adjusted market baseline, it was important to look to market influences to help define what new measure tiers could be implemented going forward that would continue to drive the market towards higher efficiency levels. Energy Trust proposes to change the windows tiers at the beginning of 2015 in anticipation of expected changes to ENERGY STAR windows specifications in 2016 for the Northern climate zone. For Energy Trust, the first tier will include windows with a U-factor of 0.28 to 0.30. The second tier will include windows with a U-factor equal to or less than 0.27 or with an equivalent energy performance, as defined by ENERGY STAR.

The basic requirement will be a U-factor of 0.27 or better, though equivalent performance may be achieved with a higher SHGC, as shown in table 2. By shifting one year ahead of Energy Star, we have time to better help prepare the market for 2016 changes.

Table 2: ENERGY STAR Qualification Criteria for Windows, version 6.0

Climate Zone	U-factor	SHGC
Northern*	≤0.27	Any
	=0.28	≥0.32
	=0.29	≥0.37
	=0.30	≥0.42

***** The effective date for the Northern Zone prescriptive and equivalent energy performance criteria for windows is January 1, 2016.

Calculation of savings

Gas savings estimates are based on billing analysis from installations completed in the program from 2005 to 2008. Electric savings are taken from earlier years, as in later years not enough homes with electric space heat installed windows to produce a statistically valid sample. The impact analysis from 2005 and 2006 done by EcoNorthwest found 564 kWh per year savings. The impact analysis from 2007 and 2008 done by Opinion Dynamics Corporation 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 for our new tier structure, a linear fit was assumed in relation to the change in U-factor and 2013 program average U-factors were binned in the new tier 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 Cost

The market research used to set the new efficiency market baseline also indicated wholesale incremental cost for each efficiency bin.

Table 3: Incremental Cost by Efficiency Bin

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

However, the cost for measure analysis is properly defined as the cost of efficiency, which is not reflected in the wholesale cost for two reasons. First, the costs should be retail, and second, many features of windows such as style and frame material affect the cost and are not related to efficiency. To determine the cost of efficiency, both the Regional Technical Forum and the Energy Trust have previously used the 25th percentile cost of windows, in order to separate out the cost of other features. The 25th percentile cost is the cost at which one quarter of the windows are cheaper than the given amount, and three quarters are more expensive.

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 4: 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	$0.00
0.30	0.28	0.296	26.56	$1.16
0.27	0.15	0.242	29.81	$4.41

The absence of market data on the baseline retail cost introduces some uncertainty into the calculation of measure cost. Unfortunately, this lack of data is unavoidable for the windows measure. Program data will not include products with the baseline efficiency and considerable effort to collect market cost data through a survey gathered only the wholesale cost. Planning staff consider the given baseline cost estimate to be the best achievable with the available data.

Measure life

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

Incentives

The current incentive for windows with a U-factor of 0.25 is $3.50 per sq ft. It compares to an incentive of $2.25 per sq ft for windows with a U-factor of 0.30. For 2015, the maximum cost effective incentive is $4.31 per sq ft. for products with a U-factor of 0.27 and less, and $1.78 for products with a U-factor between 0.28 and 0.30.

Cost Effectiveness

The proposed measures are cost-effective. Table 1, below provides maximum incentives that pass the Utility Cost Test and are no more than incremental cost.

Table 1. Cost-Effectiveness Summary for Efficient Single Family Windows

Project	Measure Lifetime (Maximum 70 yrs)	Annual Electricity Savings, kWh	Annual Gas Savings, therm	Incre-mental Cost	Max ETO Incentives	Combined Utility System BCR	Combined Societal BCR
U-value 0.30 to 0.28	45	2.86		$1.11	$1.78	3.0	4.6
U-value 0.30 to 0.28	45		0.196	$1.11	$1.78	1.0	1.5
U-value equal to or less than 0.27	45	6.92		$4.36	$4.31	3.0	2.9
U-value equal to or less than 0.27	45		0.475	$4.36	$4.31	1.0	1.0

Program	Measure	Description
New Homes	Gas Hearth .70+ FE with Intermittent Pilot Light	Proposed Measure for New Construction
New Homes	Gas Hearth .75+ FE with Intermittent Pilot Light	Proposed Measure for New Construction

September, 2014

PROVISIONAL Blessing Memo for Gas Fireplaces in New Single Family Homes Pilot

Measure Description

Direct vent gas fireplaces, including zero clearance and freestanding units and inserts. The measure is currently offered in the Existing Homes and Home Performance with ENERGY STAR programs. Field data collection of 106 EPS, EnergyStar and code homes in Oregon and Washington from August – September 2014 indicate that fireplace efficiency in New Homes lags behind that of the Existing Homes market. Additional research is needed to determine hours of use of these units in Efficient New Homes programs.

Estimated fireplace savings are driven by three key variables: market prevalence of standing pilot lights, baseline fireplace efficiency and hours the unit is used. For New Homes the hours of use is unknown, and anticipated to be less than that of Existing Homes measured at 15 hours/week. This pilot measure will be coupled with a study in a sample of new homes to determine if unit operating characteristics differ from current existing homes observations. To recognize the uncertainty in usage, this pilot measure uses an estimate of 7.5 hours/week until metering results become available.

Proposed Pilot Measure

Field data collection from August – September 2014 showed a New Homes market baseline of 55.8 FE. To align with Existing Homes offerings, the New Homes pilot tiers will be from 70 to 74 FE and a higher efficiency tier of 75+ FE. Savings are also estimated for Intermittent Pilot Ignitions for additional fireplace units beyond the primary installation.

When calculating New Home savings, the average efficiency within each tier identified in the Existing Homes program data is used not the minimum. The higher efficiency tier is cost effective but equipment availability may be limited.

Energy savings based on thermal efficiency

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

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

The efficiency is based on the average in each bin, as shown in the table below. The heating capacity of each efficiency tier was averaged using Existing Homes program data from 2013. Fireplaces with an efficiency rating between 70 and 74 FE averaged 33 kBtu/h, and fireplaces with ratings of 75 FE or higher had an average heat capacity of 26 kBtu/h. While hours of use averaged 15 per week in the Existing Homes metering study, this variable is unknown in new homes. A metering study will accompany this pilot measure to determine if hours of use differ between new and existing homes. For this pilot measure runtimes are assumed to be 7.5 hours/week.

Table 1: Field Data Collection Results - Fireplace Efficiency and Prevalence of Standing Pilot Lights

Mean FE	**55.8**
Median FE	53
Max FE	71.5
Min FE	45
% with IPI	**54.7%**
N below 65%	98
Total N	106

Field data collection of 106 EPS, EnergyStar and code homes in Oregon and Washington from August – September 2014 indicate that fireplace efficiency in New Homes lags behind that of the Existing Homes market.

Table 2: Average Fireplace Efficiency - 2013 Existing Home Data

	Average FE in each bin	Average heating capacity kBtu/hr.
70 to 74	71.6	71.6
75 +	77.2	77.2
total	**66.8**	**66.8**

For the new lower efficient tier (Tier 1, 70-74 FE), the savings are 39.1 annual therms (7.5 hours per week x 40 weeks x 33 kBtu/h x (1 / 55.8 FE – 1 / 71.6 FE). For the higher efficient tier (Tier 2, 75+FE), the savings are 38.7 annual therms (7.5 hours per week x 40 weeks x 26 kBtu/h x (1 / 55.8 FE – 1 / 77.2 FE).

Energy savings based on intermittent pilot ignition

Intermittent ignition savings are calculated by multiplying the heat input by the number of hours the pilot would otherwise be on and the Net to Gross ratio (NTG). The heat input is 900 Btu/h, up from the previous version of the measure, based on information that thermostatically controlled and remote controlled fireplaces require pilot lights with higher heat inputs. The hours are 8760 minus the hours the fireplace is in operation, and NTG is 0.453 based on the percentage of standing pilot lights found in 106 EPS, EnergyStar and code built homes during field data collection from September-August 2014. Savings from the intermittent ignition system are 34.5 therms ((8760 hours – 40 weeks x 7.5 hours per week) x 0.009 therms / h x 0.453).

Measure Cost

Table 3: Fireplace Unit Cost by Efficiency Tier - 2013 Program Data

Tier	Average cost
67 to 69	$4,553
70 to 74	$4,067
75 and up	$4,241

Cost information for new home fireplace installation is not currently well understood. Existing homes data indicate that incremental costs for more efficient units are typically negligible or negative and are driven by factors other than energy efficiency such as aesthetics.

Cost Effectiveness Calculator:

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
70 to 74 FE and intermittent ignition	20	73.64	$1	$452	$452	$452	1	452
75+ FE and intermittent ignition	20	73.24	$173	$449	$449	$449	1	2.6
Intermittent ignition (65 to 69 FE)	20	34.5	$110	$212	$212	$212	1	1.93

Program	Measure	Description
Products	Clothes Washer MEF 2.4 or higher	Updated MEF, incentive is for customers with gas fired dryers. Administered in conjunction with Clark PUD

Measure Update:

The Energy Trust Of Oregon partners with Clark PUD to offer an incentive on high efficiency clothes washers in SW Washington. The updated minimum MEF for the 2015 program year is 2.4. Energy Trust offers a two-tiered incentive in Oregon, as described below. The savings analysis for Washington assumes the average of both tiers, as the offer in Washington is uniform for any unit with an MEF equal to or greater than 2.4. Energy Trust incentives are applied solely to those units sold with a gas fired dryer. Although the measure is not cost effective as a gas-only measure, it is being offered in 2015 for the purpose of continuing a partnership with Clark PUD, and supporting a regional effort to transition the market to higher efficiency units. It is anticipated that 2015 will be the final year Energy Trust offers a clothes washer incentive, on account of updated federal appliance standards taking effect during March of 2015.

Project	Measure Lifetime (Maximum 70 yrs)	Annual Gas Savings, therm	Total Cost	ETO Incentives	Non Energy Benefits (if any)	Combined Utility System BCR	Combined Societal TRC
MEF 2.4 GAS DHW / GAS DRY / GAS ONLY	14	3.32	$132	$25	$116	0.6	1.0
MEF 2.6 GAS DHW / GAS DRY / GAS ONLY	14	4.13	$165	$25	$128	0.7	0.9
Average	14	3.73	$149	$25	$122	0.7	0.9

Measure Analysis

This memo moves the retail clothes washer baseline efficiency upward from MEF 1.9. The new baseline is the median of characteristics of models in the California Energy Commission database, with those washers that do not meet the minimum federal standard removed. The median MEF is 2.1 cycles/kWh/cubic ft, the median WF is 4.5 gallons/cubic ft, and the median volume is 3.3 cubic ft.

Incremental costs are based on research conducted by Navigant for the RTF. The cost data come from three Portland chain retail stores, with the store managers verifying that prices did not vary at locations outside of Portland.

The other principle factors deemed by the RTF and adopted in this analysis are a 0.157% hot water to total water ratio and 65°F temperature rise at the water heater. Gas water heat is assumed to have a thermal efficiency of 75%. These last three factors have not changed since the previous RTF analysis completed in 2010.

The number of wash cycles per year is provided by the 2012 Residential Building Stock Assessment (while still in draft form). The regional average annual cycles is 256. For each model, the amount of laundry was standardized by volume, so that a unit with a small wash compartment would complete more cycles, but the same volume as the average washer in the RBSA.

Program	Measure	Description
New Homes	Washington Energy STAR Performance Path	Updated to 2012 WA Energy Update

BLESSING MEMO FOR 2014 HOMES WITH NW ENERGY STAR PERFORMANCE PATH IN WASHINGTON

End Use

- New Homes Washington

Scope

Measures are "Blessed" for New Single family construction gas heated homes in Washington.

History

The New Homes program in SW Washington leverages the Northwest Energy Star Homes (NWESH) certification to establish performance criteria for its incentive structure. The NWESH certification is designed to achieve energy savings to energy performance standards above and beyond that which is mandated by code. Washington State's updated 2012 residential building energy code was made effective for all new construction permitted after July 1, 2013. New construction permits are valid for up to one year. Homes permitted after July 1, 2013 must be built to the 2012 code standards, whereas homes permitted prior to July 1, 2013 are not subject to the updated code. The 2012 code allows builders to choose between several compliance paths.

The transition of the NWESH program from Builder Option Packages (BOPs) to a Performance Path coincides with a Washington State building energy code update. In April 2014, the Regional Technical Forum, RTF, deactivated the measures associated with the 2011 BOPs and convened a subcommittee to explore feasible measure packages that garner significant savings over and above anticipated pathways to reaching code. On August 12, 2014 the RTF approved Performance Path savings based on recommendations made by the New Construction Measure Specification Subcommittee using Simplified Energy Enthalpy Modeling, SEEM.

The Performance Path is a compliance method that allows builders to select a custom combination of measures that are equivalent in performance to the corresponding state-level Northwest Energy Star Homes Builder Option Package, also called the Performance Path Reference Home. The Performance Path provides flexibility when designing buildings to qualify for Northwest Energy Star certification, enabling buildings and raters to compare multiple package to find the most cost-effective options for builders.[1]

Cost-Effectiveness

Table 1 presents the BCR for the NWESH Performance Pathway Specification. 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**.

This measures does not pass the TRC. This measure is only blessed for use in Washington. In Washington, the 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. Furthermore, 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 ultimately to enhanced building codes. So the long run cost-effectiveness is likely to be far better than that shown here.

Table 1

Measure	Measure Lifetime	Annual Electricity Savings, kWh	Annual Gas Savings, therm	Total Cost	MAX ETO Incentives	Non Energy Benefits	Combined Utility System BCR	TRC BCR
WA Performance Path	28	537	114	$3,107	$856	$183	1.00	0.58

Program Requirements

- Homes must be heated with gas
- Builders are required to work with a NW Energy Star Homes qualified HERS Rater who has been certified under RESNET, or
- Earth Advantage Certification is designed to meet or exceed Energy Star Performance Path savings compared to the 2012 code and will be considered an equivalent path.

Savings

The following analysis uses the RTF approved Performance Path and code pathway modeled prototypes and aligns the weightings with housing attributes found in Northwest Natural's Southwest Washington service territory.

The RTF has developed three code pathways for gas heated homes. The three paths share the majority of shell characteristics but differ on either equipment or duct configurations to achieve the 2012 Washington code. Table 2 presents housing shell and equipment groupings anticipated to be the most common pathways to build to code and the Performance Path.

Table 2: RTF Code Pathways and Performance Path Housing Attributes

Housing Attribute	RTF Code Pathway Homes (Baselines)			NWESH v3.1 Performance Path 1
	Gas Furn 3a 2a 5a	Gas Furn 4 5a	Gas Furn 5b	
Ceiling	R-49 std	R-49 std	R-49 std	R-49 + 21 heel
Wall	R-21 Int (U-.054)	R-21 Int (U-.054)	R-21 Int (U-.054)	R-21 Adv or R-23 Int (U-.051)
Floor	R-30	R-30	R-30	R-30
Window U-factor	0.30	0.30	0.30	0.28
Heating Equip	95 AFUE	80 AFUE	80 AFUE	94 AFUE
DHW	Low Flow + .62 Tank	Low Flow + .62 Tank	.81 Tankless	Low Flow + .62 Tank
Lighting	75% (.78 w/ft^2)	75% (.78 w/ft^2)	75% (.78 w/ft^2)	90% (.59 w/ft^2)
Infiltration	4.0	5.0	5.0	3.0
Ventilation	Exhaust, High efficacy (2.857 CFM/W)	Exhaust, High efficacy (2.857 CFM/W)	Exhaust, "Standard" efficacy	Exhaust, High efficacy (2.857 CFM/W)
Ducts	6% of CFA @50pa	Ducts Inside	6% of CFA @50pa	Ducts Inside
RTF Proposed Weighting	40%	40%	20%	100%
Program Proposed Weighting	35%	30%	35%	100%

The RTF has assigned weights based on expected uptake and prototype housing size. The code baselines are similar to BOP pathways that were first incented by the program in August 2012 – when the pathways replaced a generic BOP measure. RTF proposed code path weighting differ from the distribution of housing characteristics chosen by builders receiving incentives for BOPs through July 2014. Assuming that the builders in SW Washington will continue to follow similar code compliance pathways to meet Washington's code, the baseline weighting in SW Washington is:

- 30% ducts inside code path (RTF baseline Gas Furn 4 5a)
- 70% equipment path giving equal weight to the furnace and tankless pathways:
  - 35% tankless code path (RTF baseline Gas Furn 5b)
  - 35% furnace code path (RTF baseline Gas Furn 3a 2a 5a)

For the RTF, CLEAResult modeled these three code paths, at three sizes and at six climate zones and developed a comparison to the NWESH Performance Pathway home. SEEM was used to model the three RTF code pathways and the Performance Path home's total energy usage and spreadsheet calculations were uses to adjust the DHW savings. While savings were modeled for both heating zone one and two, this analysis focuses on the heating zone one because Energy Trust will only offer this measure in SW Washington. This analysis assumes an average home size of 2200 sf. Table 3 presents modeled therm savings of the Performance Path relative to the RTF code pathways using the program's weights. Based on these weights therm savings for the Performance Path above the weighted baseline is 114 therms.

Table 3: Performance Path Therm Savings Relative to RTF Baseline Pathways

	Code SEEM Model	Baseline Path Weight	Heating Therm Savings	DHW Therm Savings	*Total Therm Savings*
Northwest Energy Star Home Therm Savings Relative to RTF Baselines	3a2a5a (Furnace)	35%	106	-	106
	4 5a (Ducts Inside)	30%	92	-	92
	5b (Tankless)	35%	183	(43)	140
	Weighted	**100%**	**129**	**(15)**	**114**

In Washington, Energy Trust does not claim electric savings. In the cost effectiveness calculator in Table 1, 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. SEEM modeling showed weighted electric savings of 537 kwh/year from the following sources.

- Efficient blower – 272 kwh
- AC upgrade - 21 kwh
- Ventilation – 3 kwh
- Lighting - 233 kwh
- DHW savings- 8 kwh

Non Energy Benefits are included in the cost effectiveness calculator in Table 1, based on water savings from low flow aerators and showerheads. The baseline homes with 0.62 storage water heaters are assumed to have low flow fixtures. However, low flow fixtures aren't ideal for use with tankless, and the modeling/weighting in the analysis assumed 35% of baseline homes would use a tankless - so the water savings for 35% of cases could be included in the NEBs for the Performance Path cost effectiveness screening.

Measure life

The measure life is a weighted average of 28 years.

Cost

Costs in Table 1 are based on the RTF's measure workbook cost breakdown for individual measures. Costs of baseline homes were weighted using the same weighting as savings. Costs are based on a 2200 sf home.

Incentive Structure

Table 1 lists the maximum cost effective incentive level. *This is not a suggested incentive and is to be used by the program as a reference only*. A fixed incentive will be offered for homes that meet or exceed the NWESH certification or Earth Advantage certification. At this time the incentive is not performance based or on a "sliding scale".

[1] http://www.northwestenergystar.com/sites/default/files/resources/Performance-Path-Fact-Sheet_072913.pdf

COMMERCIAL PROGRAMS

Program	Measure	Description
Existing Buildings	Attic Insulation	no existing insulation, must insulate to R19
Existing Buildings	Attic Insulation R-19 to R-38 gas heat	pre-existing insulation up to R19, must insulate to R38
Existing Buildings	Roof Insulation - Gas heating	no existing insulation, must insulate to R19
Existing Buildings	Roof Insulation R-5 to R-20 gas heat	pre-existing insulation up to R5, must insulate to R20

September 11, 2014

Addition of Tiered Insulation Levels Blessing Memo for Prescriptive Commercial Insulation

Update 9/9/14 – updates in blue

- Add new measures for existing Roof insulation with pre-existing insulation up to R-5.
- Add new measure for existing attic insulation with pre-existing insulation up to R-19 for gas heating buildings in Washington.
- Updated to 2015 CEC avoided costs and discount rate.

End Use

Wall, roof and attic insulation for existing commercial buildings

Scope

Proposal to review deemed savings for standard prescriptive incentives currently being offered with the following minimum R-values:

- Wall R-value: 11
- Roof R-value: 11 or 20 with existing condition of R-5 or less
- Attic R-value: 19 or 38 with existing condition of R-19 or less

Measures are "Blessed" as cost-effective for use in the following market segments:

- Retrofit

Program Applicability

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

- Existing Buildings including WA.
- Production Efficiency

The measure is applicable to any type of commercial or small industrial building, but will be marketed toward small to medium sized businesses no larger than 50,000ft^2. These measures do not apply to large multi-family buildings, dormitories, assisted living facilities, etc. which typically behave more like a residential structure and have different internal loads.

TABLE 1 showing cost-effectiveness of various types of insulation for commercial/small industrial buildings depending on heating fuel type

Measure #	Energy Efficiency Measure Name	Measure Lifetime (Maximum 70 yrs)	Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	Total Incremental Cost of Measure	Annual Non-Energy Benefits $ (if any)	MAX Allowable Incentive	Combined Utility System BCR	Combined Societal BCR
1	Wall R-11 Gas Heat	40		0.16	$1.41		$1.41	**1.0**	**1.0**
2	Wall R-11 Electric Resistance	40	3.72		$1.41		$1.41	**4.7**	**4.7**
3	Wall R-11 Heat Pump	40	1.49		$1.41		$1.41	**1.9**	**1.9**
4	Roof R-11 Gas Heat	30		0.25	$0.64		$0.64	**3.1**	**3.1**
5	Roof R-11 Electric Resistance	30	5.96		$0.64		$0.64	**14.3**	**14.3**
6	Roof R-11 Heat Pump	30	2.38		$0.64		$0.64	**5.7**	**5.7**
7	Roof R-20 Gas Heat	30		0.09	$0.64		$0.64	**1.1**	**1.1**
8	Roof R-20 Electric Resistance	30	2.10		$0.64		$0.64	**5.1**	**5.1**
9	Roof R-20 Heat Pump	30	0.84		$0.64		$0.64	**2.0**	**2.0**

10	Attic R-19 Gas Heat	30		0.25	$0.90		$0.90	**2.2**	**2.1**
11	Attic R-19 Electric Resistance	30	5.79		$0.90		$0.90	**9.9**	**9.9**
12	Attic R-19 Heat Pump	30	2.32		$0.90		$0.90	**4.0**	**4.0**
13	Attic R-38 Gas Heat WA ONLY	30		0.05	$0.90		$0.90	**1.0**	**0.5**

Program requirements

- Existing partially insulated walls are not eligible for incentives under this prescriptive offering.
- Insulation projects with no existing insulation must meet the minimum R-Values of:
    1. Wall R-value: 11
    2. Roof R-value: 11
    3. Attic R-value: 19
- Insulation project with some existing insulation must meet the minimum R-Values of:
    1. Roof: R-Value 5 or less upgraded to at least 20
    2. Attic: R-Value of 19 or less upgraded to at least 38 (Washington Only)
- Projects upgrading from no insulation to the higher tiers of insulation are not eligible for both incentives (for example, a project can't apply for an incentive to go from R-0 to R-19 and then again from R-19 to R-38.
- The following is required to be submitted for incentives:
    1. Invoices
    2. Insulation specifications
- Building size shall be less than 50,000ft^2

Details

Commercial insulation has been a prescriptive measure for existing buildings and production efficiency for some time, and realizes modest uptake in the small building market where energy modeling is rarely done. An update was needed for this measure because the original analysis was done in 2001, and had little documentation and justification for savings estimates. The proposed deemed savings are based on the same minimum requirements as the previous ones: R-11 for wall and roof, and R-19 for attic, but the analysis was updated using a more integrated method of energy simulation modeling rather than the previous steady-state heat transfer analysis. In 2013 the energy models were re-run with existing insulation baselines and more insulation in the efficient case.

Savings

Savings were calculated using eQuest to simulate three (3) typical building sizes: 10,000 ft^2, 30,000 ft^2, and 50,000 ft^2. All three buildings modeled were two-story office buildings, north facing, with window to wall ratios of 40%. Infiltration rates and internal loads were based on the default values generated by eQuest for each building size. Baseline insulation values were set to ASHRAE accepted structural values, and models were run for the baseline and upgrade case using each insulation type. Simulations were also performed to compare energy savings between buildings with ducted return systems versus plenum return systems, and buildings with constant air volume (CAV) systems were compared against those with variable air volume (VAV) systems. Programmatic savings were then calculated by averaging the savings from the four different systems that were modeled over the three different building sizes together.

Natural Gas-Heated Buildings

Each building size modeled used a packaged single zone DX coil with gas furnace HVAC system, using eQuest default efficiencies. 80% heating efficiency, and a cooling EER of 9.3 were assumed.

Electrically-Heated Buildings

Electric savings for buildings using electric resistance heat were converted from gas savings estimates generated by the natural gas eQuest models. Electric savings for buildings using a heat pump system were converted from gas savings values using a COP of 2.5, and the electric resistance systems were assumed to have a COP of 1.

Several assumptions over building operation were made to keep model runs consistent and reflective of what the program has seen in the past.

- Room temperature setpoints - heating season: 72F (occupied), 69F (unoccupied)
- Room temperature setpoints - cooling season: 76F (occupied), 79F (unoccupied)
- Outside temperature for heating/cooling: 60F/65F
- Occupied Hours: Mon-Sat 8am-5pm, Sun unoccupied (40-48 hours - CBECS Table B3, Census Region, Number of Buildings and Floorspace for Non-Mall Buildings, 2003) meant to capture average building operating hours for various building types coming through the program
- Holidays: New Year’s, Memorial, Independence, Labor, Thanksgiving, Day after Thanksgiving, Xmas, MLK, President's, Veterans Day
- Cooling EER: 9.3
- Gas heating efficiency: 80%
- Electric resistance COP: 1
- Heat pump COP: 2.5
- Building EUI: Determined by eQuest default values for internal loads and infiltration for office buildings

- For a zero insulation baseline condition, ASHRAE accepted R-values for structural components were used resulting in adjusted R-value baseline estimates of:

1. Wall: R-4
2. Attic: R-2.2
3. Roof: R-2

Fan Savings and Cooling Penalties

As expected, model results showed that cooling energy increased in all cases with the addition of insulation, as internal heat loads are relatively constant throughout the year and essentially become trapped heat during summer months. Analysis of the 50,000 ft^2 building model revealed significant cooling energy increases with respect to the heating savings realized. It is therefore suggested that insulating buildings 50,000 ft^2 or larger are at risk for non-cost effectiveness. Because larger buildings contain more complex cooling and heating systems, and inherently contain more parameters that affect energy savings, from an implementation perspective insulation savings for these larger buildings are better served through the custom program approach.

Electric savings from reduced fan load were found when wall or attic insulation was added, and negligible savings were realized when roof insulation was added. On average, positive fan energy savings coupled with a negative cooling energy penalty resulted in an overall electric energy increase for roof and attic insulation, and a net energy decrease for wall insulation. On a sqft basis, the kWh impact is small and averages less than -0.3kWh/sqft for roof and attic insulation, and a positive 0.02kWh/sqft for wall insulation.

System Type and Return Air Path

Deemed savings were calculated by averaging the savings from the four different systems that were modeled over the three different building sizes. The four systems were a CAV duct return system, a VAV duct return system, a CAV plenum return system, and a VAV plenum return system. Results from the model showed negligible difference with respect to CAV or VAV systems in terms of fan kWh or heat savings. Therefore the system type is not expected to impact savings estimates and for purposes of the analysis, VAV and CAV systems are essentially treated the same.

Results from modeling plenum return systems versus ducted return air systems did however indicate differences in savings estimates for certain insulation cases. Most notably, savings stemming from plenum return systems were consistently higher than savings from ducted return systems, presumably because of the reduced heat loss in the unconditioned plenum space on the return air stream. The only case where this differs is with attic insulation, where only a ducted return system was used in the analysis, since it would not make sense to insulate above a drop ceiling with a plenum return. For purposes of a single deemed estimate for each insulation type, savings estimates were averaged together since the persistence of one return air path over another is not yet known. (See exceptions below)

Existing Insulation

In 2014, the models were re-run with several new scenarios using the same methods outlined above.

Baseline models were created with Roof insulation at R-5, which is the former code, and compared to an increase to R-20, which is the Oregon Code. This tiered level of insulation addition proved cost effective for all heating systems.

Baseline models were created with Attic insulation at R-11, and compared to an increase to R-38, which is the current Oregon code. The modeled baseline of R-11, corresponds to a minimum program requirement of R-19, as the program expects to see insulation levels between R-0 and R-19. R-19 was a code requirement for many years so it is expected that many buildings were built to R-19. However, it is known that in older buildings attic insulation may be damaged or otherwise degraded to have a lower effectiveness. A minimum requirement of R-19 also allows for buildings that may have differing levels of insulation in different parts of the building to participate easily. This tiered level of insulation was cost effective only for electric resistance heating. To avoid confusion, this measure will not be offered in Oregon. It will be offered in Washington where the TRC is not a requirement.

Measure life

To align with the regionally accepted lifetime for commercial weatherization measures, a lifetime of 30 years was used in the cost-effective analysis. This lifetime is shorter than for residential insulation (given a measure life of 45 years) because of the possibility of building turnover, added penetrations, and a higher chance of deterioration within a commercial setting. Measure life for wall insulation is higher than roof and attic insulation due to less chance for deterioration.

Incentive Structure

The present value of the utility benefit for each measure is indicated in the table above. The maximum incentive is the lesser of the cost of the measures or the amount of the utility benefit. The program currently plans to offer an incentive of $0.30 per square foot for all of the measures, with a $0.30 per square foot bonus in 2014, exclusive of the multifamily sector, where it is not cost effective. The expected incentive on the tiered insulation measures is $0.30 per square foot.

Cost

Data collected from Existing Buildings projects completed in program year 2011 were used in calculating the average installed cost for insulation, and were compared with vendor quotes collected over the past 2 years. In general the costs from trade allies were in very close agreement to the costs collected in FastTrack. These costs, along with the associated R-values, were averaged separately for wall, roof, and attic insulation to arrive at the values shown in the cost-effectiveness table above. Costs for projects with existing insulation is assumed to be the same as projects without insulation.

Exceptions

Although savings differences between plenum return systems and ducted return systems were found, detailed participant data does not exist to indicate which system may be more prevalent in the marketplace. For purposes of developing a single prescriptive offering, a simple average of the two return systems was made. However, because the savings impact can be large in certain cases depending on the return air system type, it is suggested that the program track this as an attribute for roof insulation measures and review the installed measures to determine if one return air system type is more prevalent and adjust the savings as necessary.

Though past program data suggests that warehouses and retail spaces make-up a significant portion of the building types that have received insulation incentives, because of historical uptake and targeted marketing efforts going forward, these measures are expected to be utilized most often in office buildings. When comparing EUI's between the three building types, warehouses exhibit the lowest EUI and therefore, the lowest savings potential, Retail has the highest EUI, and therefore the highest savings opportunity, and savings for Office buildings fall between these other two building types. Insulation was shown in a follow-up analysis to be cost-effective even at the lowest estimate of savings associated with a warehouse building. However, because very few insulation jobs occur each year, a tailored offering for different building types is not feasible for the program, and offices fall in the middle of the 3 most prevalent building types to receive this measure historically, a single deemed savings estimate associated with an office space was used in the analysis. If future work indicates that insulation jobs are becoming heavily weighted towards one particular building type, it is suggested that savings be adjusted to reflect that building type specifically instead of an average.

The higher tier of attic insulation does not pass the TRC. This measure is only blessed for use in Washington. In Washington, the 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.

Program	Measure	Description
Existing Buildings	Boiler < 300 kBtuh input	Minimum 90% thermal efficiency, with electronic ignition
Existing Buildings	Boiler > 2,500 kBtuh input	Minimum 90% thermal efficiency, with electronic ignition
Existing Buildings	Boiler ≥ 300, ≤ 2,500 kBtuh input	Minimum 90% thermal efficiency, with electronic ignition

BLESSING MEMO FOR COMMERCIAL HOT WATER CONDENSING GAS BOILERS

Updated 6/9/14 – Listed maximum incentive and updated to current avoided costs. No other changes.

Updated 9/6/23- Nick and I really struggled to both get a meaningful analysis of this one and to describe it correctly. Please let me know if there are ways this can be clarified. I'm pretty confident in the analysis, although you could quibble with some of the assumptions; it's the description that's gnarly. Nick figured out a consistent way to look at part load efficiency and part load field conditions for both condensing and non-condensing boilers and I think this improves the reliability of our savings estimates for all sizes of boilers. This both provides savings estimates for small boilers and revises estimates for larger boilers. Normally we wouldn't revise the estimates until the beginning of the next year's program, through the true-up. So I think maybe we add the small ones now, revise the big ones later. Does that make sense?

End Use: Gas-Fired Condensing Boilers

Scope: Measures are "Blessed" in new, and replacement markets for commercial installations using centralized gas-fired condensing boilers. This updates the existing single measure which currently utilizes a prescriptive incentive of $4/kbtuh for 500 kbtuh and larger condensing boilers.

Program: Based on the referenced analysis and associated cost-effectiveness screening, the 3 measures described below are "blessed" as cost effective on a prospective basis for inclusion in the Existing and New Buildings program.

Details: The current offering for a commercial boiler is based on a 2003 analysis which at the time concluded that the savings from a boiler below 500 kbtuh input was not cost-effective because of the large incremental cost relative to savings incurred for smaller sizes. Data from the 2001 DEER database showed that $/kbtuh for smaller sized boilers were roughly twice what they were for larger size boilers (500 kbtuh and above). Recently however the PMC received requests for prescriptive incentives for smaller size boilers used in a commercial setting, and so they contracted with Nexant to update the 2003 analysis using the most recent savings and cost data available from a 2009 DOE analysis.

The previous cost-effectiveness screening relied upon the average estimate of Equivalent Full Load Hours (EFLH) for various building types to calculate savings, as well as the efficiency gain seen when upgrading from an 80% AFUE baseline to a 90% AFUE target. To update this gas boiler analysis and get a better estimate for EFLH, hourly weather data was utilized to determine the seasonal efficiency expected from both a non-condensing and condensing boiler, as well as the potential EFLH for this climate based on expected seasonal run times. (See below under "Explanation of EFLH Analysis".) The difference between the code and target efficiency levels coupled with the EFLH estimate is the basis for calculating savings.

Similar to the 2003 analysis, the updated analysis uses a code baseline of 80% AFUE for the smaller boiler size class. Larger boiler sizes are measured in Thermal Efficiency (Et) or Combustion Efficiency (Ec), and the minimum level for these two size classes was set at 0.8 Et and Ec as well. (See exceptions below for more detail.) In this update, the measure is broken apart into three size classes to correspond to the current code level requirements in an effort to clarify efficiency ratings among consumers.

Nick and I really struggled to both get a meaningful analysis of this one and to describe it correctly. Please let me know if there are ways this can be clarified. I'm pretty confident in the analysis, although you could quibble with some of the assumptions; it's the description that's gnarly. Nick figured out a consistent way to look at part load efficiency and part load field conditions for both condensing and non-condensing boilers and I think this improves the reliability of our savings estimates for all sizes of boilers. This both provides savings estimates for small boilers and revises estimates for larger boilers. Normally we wouldn't revise the estimates until the beginning of the next year's program, through the true-up. So I think maybe we add the small ones now, revise the big ones later. Does that make sense?

Incremental cost was also determined using the 2009 DOE study and broken down into $/kbtuh for each size class. Initially the PMC sought to provide incentives for a near-condensing 85% AFUE efficient boiler for the smaller size class in an effort to increase market uptake without the added install costs of a condensing boiler. However, the primary issue affecting the installed cost of an 85% AFUE boiler is the venting considerations. All boilers in the 85%-88% range require a Category III, high-pressure, high-temperature venting arrangement to prevent condensation problems, which costs significantly more than other venting arrangements (i.e. sealed and made from stainless steel). For condensing boilers 90% and above, a Category IV vent is suitable, which is significantly cheaper since it is a low-pressure, low-temperature venting strategy that can be made from PVC. As a result, retail costs of the equipment rise with increases in efficiency, but installation costs fall with increases in efficiency. Because of these costs, 85% AFUE near-condensing boilers do not pass cost-effectiveness when compared to the code baseline of 80%.

Measure life was kept at 20 years to align with the previous measure lives of boilers across programs.

Using the 2009 analysis from Nexant, the cost effectiveness screening for the 3 measures is given below based on a per kbtuh input.

Measure #	Energy Efficiency Measure Name	Measure Lifetime (Maximum 70 yrs)	Annual Natural Gas Savings (therms)	Total Incremental Cost of Measure	MAX Potential Incentive	Combined Utility System BCR	Combined Societal BCR
1	Condensing Boilers < 300 kbtuh 0.9 AFUE	20	2.21	$15.99	$15.60	1.0	0.98
2	Condensing Boilers ≥ 300 kbtuh, ≤ 2,500 kbtuh 0.9 Et	20	2.19	$15.70	$15.50	1.0	0.99
3	Condensing Boilers > 2,500 kbtuh 0.9 Ec	20	2.17	$12.12	$15.40	1.0	1.3
Total			**7**	**$44**	**$12**	**5.3**	**1.4**

Program Requirements:

- The efficiency rating must be the published rating at 130°F return water temperature to qualify for the incentive.
- Rating type (AFUE, Et, Ec) must correspond to ratings established for size class (e.x. AFUE for boilers under 300 kbtuh input, Ec for boilers greater than 2,500 kbtuh, etc.)

Exceptions: Oregon Code requires that boilers that are ≥ 300 kbtuh and ≤ 2,500 kbtuh have a minimum efficiency level of 0.75 Et. However as stated above, Nexant has used 0.80 Et as a baseline for this size class. The assumption behind using this higher baseline is that market data has shown that almost all boilers sold in that size class have a minimum published efficiency level of 0.80 Et. In addition, DOE regulations proposed to change in 2010 will use 0.80 Et as the new baseline for this size class.

However, as explained below in the EFLH analysis, a new seasonal efficiency rating was calculated for both a condensing and non-condensing boiler. Because this calculated efficiency level was based on climate only and not on any particular boiler make or size, it is applicable across all boiler size classes (normally, larger boilers are tested differently than smaller boilers and therefore use different metrics to evaluate efficiency, but this does not bear on the EFLH calculation. The calculated seasonal efficiency predicts the operational efficiency of the boiler over a typical heating season rather than a standalone efficiency rating based on specific boiler performance.

Therefore to calculate annual savings in the cost-effectiveness test, we used the calculated seasonal efficiency for the non-condensing boiler (closer to 73%) compared to the condensing boiler (closer to 92%) instead of the code level minimums based on size classes. This finding is in sync with the 2006 ASHRAE journal's finding of seasonal operating efficiencies for boilers, (which is referenced in the analysis) and should yield a more accurate depiction of annual savings over a steady-state test.

Explanation of EFLH analysis: In order to estimate the EFLH for a heating season in the Oregon climate, (Portland focused) a calculation was made of seasonal boiler loading and capacity. This was accomplished using charts from ASHRAE journals, presentations, and several papers written about boiler efficiency and its relationship to boiler loading. By determining the relationship between outside air conditions and boiler efficiency, we were able to use annual weather data to predict the overall seasonal efficiency for both a condensing and non-condensing boiler. Then, by relating this efficiency to boiler capacity, (essentially as capacity decreases, so does efficiency, but not linearly) we were able to determine the overall seasonal boiler capacity which indicates the percent of partial loading a boiler would experience in a typical heating season. By dividing the reduced boiler load by the maximum expected seasonal boiler run time, a modified boiler run time percentage can be established which indicates how often the boiler will actually operate. Once this is corrected for expected oversizing (here, assumed to be 10%) this operational reduction percentage is applied to the seasonal hours of operation and a final corrected EFLH estimate can then be determined.

Using this method, the theoretical load hours for the Portland climate would be 2272 hours for the heating season. Using the above capacity and loading reductions, an EFLH estimate was determined to be 766 EFLH for a typical heating season in the Portland area. To arrive at this modified value, several assumptions associated with a typical building were made. They were:

70°F occupied temperature

60°F unoccupied setback temperature

Building only operates boiler Sept. – May

Building occupied hours set at 7am – 7pm

Building balance point (point where heating above this temp is hot required) was set at 49.999°F

Program	Measure	Description
Existing Buildings	Convection Oven - Gas - Full Size	Energy STAR
Existing Buildings	Gas Combination Ovens	Energy STAR
Existing Buildings	Gas Fryer	Energy STAR
Existing Buildings	Gas Griddle	Energy STAR
Existing Buildings	Steam Cooker – Gas	Energy STAR

August 7, 2014

UPDATED BLESSING MEMO FOR COMMERCIAL FOODSERVICE MEASURES

July 2014 updates:

- Updated incremental costs for all measures based on Energy Star Documentation. Many measures' incremental costs are assumed to be zero
- Electric Vat Fryers and Electric Griddles had been not cost effective. They are now cost effective and newly "blessed".
- Gas and Electric Combination ovens are a new measure.

End Use: Energy Star rated electric and gas foodservice cooking equipment

Scope: These measures are proposed for existing and new commercial kitchen applications, for new use or replacement purchases.

Program: Based on the referenced analysis and associated cost-effectiveness screening, the measures described below are "blessed" on a prospective basis for inclusion in the New Buildings and Existing Buildings foodservice programs and in the PE and MF programs where these programs serve commercial kitchens.

Details:

Energy Trust contracted with the FoodService Technology Center (FSTC) in California to analyze a suite of measures for the commercial kitchens program. The analysis provides an update in savings, cost, and measure lives to the existing foodservice measures already included in the program. Additionally, it aligns our current program offerings with the recently revised Energy Star criteria for select pieces of foodservice equipment.

Savings were calculated through the FSTC testing of various pieces of baseline and Energy Star rated pieces of equipment. In many cases, the newly established Energy Star qualifications represent the previous target efficiency case over the older, less efficient ENERGY STAR product specifications. This adds support to the prior assumption that Energy Star was becoming baseline and a new tier needed to be developed. Workpapers have been written by FSTC for each piece of equipment that chronicle baseline energy use, idle energy rate, production capacity, and numerous other equipment attributes in an attempt to establish an average energy consumption rate. These baseline energy consumption rates are then compared to Energy Star energy consumption rates and the savings are calculated as the difference between the two. For the steamer measures, expected annual water savings have also been included and entered into the non-energy benefits column in the cost-effective calculator below.

Update 2013: The savings and incentive for Large Gas Fryers has been changed from per fryer to per vat. In the past, there was concern that split-vat fryers, where a single large vat has a divider and is used as 2 smaller vats, would cause confusion in the programs and result in overstating savings. However, as the programs see more true multi-vat fryers there has been a lost opportunity to claim the increased savings. The new incentive for gas fryers is cost effective at up to $1500/full size vat, although at this time the programs expect to set the incentive between $500 and $800. A full size vat is a minimum of 12 inches wide, more typically 14 or 16 inches. Each split-vat will count as one single vat. The programs will make this change at their convenience, likely the start of the 2014 program year.

Update 2014: As a result of the cost updates mentioned below, Electric Vat Fryers and Electric Griddles are now cost effective and may be included in the programs. In late 2013, Energy Star released a specification for qualifying combination ovens. Savings for combination ovens are based on the Energy Star Commercial Cooking Equipment Worksheet and assume operation at 50% in steam mode and 50% in convection mode and 360 days per year operation. This is a new measure for Energy Trust.

Costs and Incentives:

Incentives are listed in Table 1 as the maximum cost-effective incentive (defined as an incentive which makes the Utility BCR equal to 1.0 or the incremental or base cost of the measure.) **These incentives are meant to be the maximum possible incentive that a program could provide for the measure, and are NOT representative of actual incentives or incentive recommendations**. Planning recommends that the new and existing buildings programs continue to offer the same or similar incentives to each other to avoid market confusion.

Update 7/13: After finding that average installed gas fryers in the programs were 47% of the costs used in the original cost effectiveness analysis, a new cost study was performed of fryers at five online retailers and the food service equipment cost aggregator aqnet.com and compared to the costs seen by the programs in 2011 and 2012 for efficient fryers.

Update 7/14: Further cost research indicates that the cost of commercial cooking equipment is determined by many features in addition to efficiency and Energy Star models may not be more expensive than new baseline models. Energy Trust used the Energy Star Commercial Cooking Equipment Worksheet to update incremental costs. The Energy Star data indicates no incremental cost for several measures (listed as $1 in the CEC calculator to avoid errors). However, we understand that our baseline and efficient cases are not the only options available. Restaurant owners frequently purchase used equipment. Used equipment is much less expensive than new and our incentives may be necessary to move those customers to efficient equipment, therefore we will continue to offer incentives that appear to be above incremental cost. Because used equipment is highly variable, savings will continue to be based on a baseline of new non-Energy Star equipment.

Measure Life:

An estimated useful equipment life of 12 years is based on the industry-standard assumption for equipment life span and is consistent with estimates in the California Database for Energy Efficiency Resources (DEER) for commercial cooking equipment.

Table 1 – Benefit / Cost screening showing cost-effectiveness for Electric & Gas Foodservice measures

Measure #	Energy Efficiency Measure Name	Measure Lifetime	Annual Electricity Savings (kWh)	Annual Natural Gas Savings (therms)	Total Incremental Cost of Measure	Annual Non-Energy Benefits $ (if any)	MAXIMUM Potential Incentive If Measure is Cost-effective	Combined Utility System BCR	Combined TRC BCR
1	Electric Large Vat Fryers / Vat	12	2,249		$1		$1,681	1.0	1682
2	Electric Griddles	12	1,860		$1		$1,331	1.0	1391
3	Electric Convection Ovens Full-Size	12	1,853		$1		$1,385	1.0	1386
4	Electric Convection Ovens Half-Size	12	1,961		$1		$1,465	1.0	1466
5	Hot Food Holding Cabinets Full Size	12	5,184		$1		$2,529	1.5	3877
6	Hot Food Holding Cabinets Half Size	12	2,592		$1		$1,499	1.3	1938
7	Electric Steam Cookers	12	2,652		$630	$1,181	$1,982	1.0	20
8	Electric Combination Ovens	12	6,139		$1		$4591	1.0	4592

9	Gas Large Vat Fryers / Vat	12		569	$1,120		$1,502	**1.8**	**2.4**
10	Gas Griddles	12		147	$360		$688	**1.0**	**1.9**
11	Gas Convection Ovens Full-Size	12		302	$1		$1,011	**1.0**	**1012**
12	Gas Steam Cookers	12		1,308	$870	$1,181	$6,148	**1.0**	**19**
13	Gas Combination Ovens	12		290	$1		$1363	**1.0**	**1364**

Measure Requirements:

- Product must appear on the most current Energy Star criteria list under the Commercial Foodservice Equipment program or meet criteria listed in Energy Star specifications.
- Fryer vat must be a minimum of 12 inches wide. Smaller vats are likely split vats, with 2 sections constituting a single large vat.

Program	Measure	Description
Existing Buildings	MF Domestic Tank Water Heaters	Minimum 91 percent AFUE

BLESSING MEMO FOR BOILER AND WATER HEATER MEASURES FOR MULTI-FAMILY

End Use: Gas-Fired Boilers, Gas-Fired Tank and Gas-Fired Tankless Water Heaters

Scope: Measure is "Blessed" in new, replacement, and retrofit markets for multi-family installations using centralized gas-fired boilers, tank-type and tankless water heaters. This updates the existing measures which currently utilize the prescriptive incentive structure of single family installations.

Program: Based on the referenced analysis and associated cost-effectiveness screening, the 3 measures described below are "blessed" as cost effective on a prospective basis for inclusion in the Existing and New Multi-Family buildings program.

Details: Currently the savings and incentives structure for multi-family is set up to use the same path as single family installations. However, some multi-family properties utilize a centralized hot water or heating distribution system, and in these cases single family incentives and savings are not reflective of expected costs and the higher usage associated with a larger centralized system. Because of their size, these installs tend to require commercial grade equipment, and are therefore more expensive than residential grade units. The lower incentives that are based off single family homes are not reflective of the larger upfront cost required to purchase or operate a commercial grade unit and so the commercial incentive structure provides a better opportunity to capture expected cost and savings for the larger, centralized distribution systems.

To screen multi-family installs for cost effectiveness using commercial savings estimates, we referred to the commercial gas savings analysis done in 2003 by Jim Volkman of Aspen systems. The 2003 analysis relied upon Full Load Hours (FLH) of different building types to determine savings estimates (which are numbers Ecotope has established for use in equipment sizing). This analysis was modified to reflect a reduction in FLH from common commercial building types to that of a motel building, which was seen as an equivalent comparison to a multi-family installation. This reduction to 468 FLH for each measure more accurately depicts the usage of the multi-family property, as opposed to a single family residence or a common commercial building.

Using the 2003 analysis and reducing the FLH as described above, the cost effectiveness screening for the 3 measures is given below based on a per btuh input:

Measure #	Energy Efficiency Measure Name	Measure Lifetime (Maximum 70 yrs)	Annual Natural Gas Savings (therms)	Total Incremental Cost of Measure	Total Potential Incentive If Measure is Cost-effective	Combined Utility System BCR	Combined Societal BCR
1	Condensing Tank WH	20	0.644	$6.06	$2.5	2.4	**0.990**
2	Condensing Boiler	20	0.585	$5.07	$4	1.5	1.183
3	Tankless WH (Electronic Ignition)	18	0.780	$4.00	$2	3.5	1.8

As can be seen, based on the predicted gas savings, the condensing tank type water heater is slightly non-cost effective. However, as stated above, this is based off 2003 full load hours of expected use in a motel, and may not be exactly reflective of an actual multi-family installation of full time residents. Additionally, levelized costs are expected to increase in January 2009 at which point this measure will pass the cost-effective societal test. It is therefore recommended to include condensing type WH in the multi-family program to maintain consistency with offerings in the commercial program.

Additional Steps: It is suggested that because of upcoming requirements in the EnergyStar code, as well as the advent of new technologies since 2003, that the water heating analysis be updated to reflect more current and future costs and savings estimates. If it is determined through this updated analysis that FLH or costs for multi-family installations have decreased from those used above, the measures will be revisited to determine if they are still cost-effective. We should also double-check to makes sure avoided costs go up as strongly expected sometime early next year.

Program	Measure	Description
Existing Buildings	Thermostatic Radiator Valves (TRVs), central hydronic or steam systems only (MF only)	Replace manual, non-thermostatically controlled valves at dwelling unit radiators

BLESSING MEMO FOR BOILER AND WATER HEATER MEASURES FOR MULTI-FAMILY

End Use: Gas-Fired Boilers, Gas-Fired Tank and Gas-Fired Tankless Water Heaters

Scope: Measure is "Blessed" in new, replacement, and retrofit markets for multi-family installations using centralized gas-fired boilers, tank-type and tankless water heaters. This updates the existing measures which currently utilize the prescriptive incentive structure of single family installations.

Program: Based on the referenced analysis and associated cost-effectiveness screening, the 3 measures described below are "blessed" as cost effective on a prospective basis for inclusion in the Existing and New Multi-Family buildings program.

Details: Currently the savings and incentives structure for multi-family is set up to use the same path as single family installations. However, some multi-family properties utilize a centralized hot water or heating distribution system, and in these cases single family incentives and savings are not reflective of expected costs and the higher usage associated with a larger centralized system. Because of their size, these installs tend to require commercial grade equipment, and are therefore more expensive than residential grade units. The lower incentives that are based off single family homes are not reflective of the larger upfront cost required to purchase or operate a commercial grade unit and so the commercial incentive structure provides a better opportunity to capture expected cost and savings for the larger, centralized distribution systems.

To screen multi-family installs for cost effectiveness using commercial savings estimates, we referred to the commercial gas savings analysis done in 2003 by Jim Volkman of Aspen systems. The 2003 analysis relied upon Full Load Hours (FLH) of different building types to determine savings estimates (which are numbers Ecotope has established for use in equipment sizing). This analysis was modified to reflect a reduction in FLH from common commercial building types to that of a motel building, which was seen as an equivalent comparison to a multi-family installation. This reduction to 468 FLH for each measure more accurately depicts the usage of the multi-family property, as opposed to a single family residence or a common commercial building.

Using the 2003 analysis and reducing the FLH as described above, the cost effectiveness screening for the 3 measures is given below based on a per btuh input:

Measure #	Energy Efficiency Measure Name	Measure Lifetime (Maximum 70 yrs)	Annual Natural Gas Savings (therms)	Total Incremental Cost of Measure	Total Potential Incentive If Measure is Cost-effective	Combined Utility System BCR	Combined Societal BCR
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As can be seen, based on the predicted gas savings, the condensing tank type water heater is slightly non-cost effective. However, as stated above, this is based off 2003 full load hours of expected use in a motel, and may not be exactly reflective of an actual multi-family installation of full time residents. Additionally, levelized costs are expected to increase in January 2009 at which point this measure will pass the cost-effective societal test. It is therefore recommended to include condensing type WH in the multi-family program to maintain consistency with offerings in the commercial program.

Additional Steps: It is suggested that because of upcoming requirements in the EnergyStar code, as well as the advent of new technologies since 2003, that the water heating analysis be updated to reflect more current and future costs and savings estimates. If it is determined through this updated analysis that FLH or costs for multi-family installations have decreased from those used above, the measures will be revisited to determine if they are still cost-effective. We should also double-check to makes sure avoided costs go up as strongly expected sometime early next year.

Program	Measure	Description
Existing Buildings	Greenhouse controllers	Per square foot, max greenhouse size 15,000 Sq ft

June 30, 2014

BLESSING MEMO FOR GREENHOUSE CONTROLLER
Updated 6/27/2014 – updates in blue

- Updated CEC with current avoided costs
- Added Existing Buildings Washington to Program Applicability
- Included Max Potential Incentive in the cost effectiveness table and discussion in Incentive Structure section

End Use
Installation of greenhouse controllers where none exist presently to coordinate multiple HVAC equipment schedules and implement night setback.

Scope
Measures are "Blessed" as cost-effective for use in the following market segments:

- Retrofit

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

- Production Efficiency
- Existing Buildings Washington

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

- Greenhouses

TABLE 1 – Table showing cost-effectiveness of installing temperature controllers in a weighted average sized greenhouse.

Measure #	Energy Efficiency Measure Name	Measure Lifetime (Maximum 70 yrs)	Annual Natural Gas Savings (therms)	Total Incremental Cost of Measure	MAX Potential Incentive	Combined Utility System BCR	Combined Societal BCR
7	Greenhouse Controller Weighted average size/schedule (per square foot)	15	0.28	$0.58	$1.64	1.0	2.9

Program requirements

- Must use a single sensor or an average of multiple sensors
- Must have a minimum of two temperature stages in a 24 hour period (i.e. allow for night setback)
- Heating and ventilation appliances must be controlled by the same sensor or same average sensor value if multiple sensors are used
- Must allow for a dead-band zone of 5°F or greater between heating and ventilation events

- Must force a delay between heating and ventilation events
- Must have the ability to temporarily override set program temperatures
- Must control all active heating devices in the given greenhouse including all fans and automated ventilation systems when applicable
- Limited to a maximum size of 15,000 sqft. per controller
- House must be heated to at least 50 degrees for 30 or more days in a year

Details

Heated greenhouses are often controlled by mechanical thermostats which are manually set to maintain the desired temperature in the greenhouse at all times. Often, there are three separate thermostats in a greenhouse controlling the heater, the ventilation fans, and the rooftop vents. This setup is problematic for two primary reasons:

1. The three thermostats can easily be out of calibration, commonly allowing the heat to be “on” while the ventilation fan is running, or an overhead vent is open.
2. The space temperature is fixed, even though plants require less heat at night.

The purpose of this measure is to offer an incentive for greenhouse controllers that operate from a single control temperature (which could come from one temperature sensor or more than one sensor where the multiple temps are averaged). These relatively simple controllers would control heaters, fans, and vents and also allow for an automatic night-setback temperature.

Savings

To determine savings from installing a greenhouse controller, three greenhouse sizes and three heating schedules were defined, based on an analysis from the Program Delivery Contractor’s local greenhouse expert. They are separated out as:

Greenhouse Sizes:
Small: 20’ x 96’ (1920 ft^2)
Medium: 30’ x 96’ (2880 ft^2)
Large: 60’ x 96’ (5760 ft^2)

Heating Schedules:
Minimum: 50 degrees, January only
Medium: 65 degrees, February thru May
Maximum: 70 degrees, Year Round

Assuming the grower implemented night setback, an estimate of natural gas savings was found for each size and heating schedule. For this analysis, a 5 degree temperature difference was used to represent a reasonable set point that would not be considered detrimental to plant growth. In essence, the controller would use a time clock to automatically decide when to reduce the greenhouse temperature by 5 degrees at night, and then automatically return to the daytime set point in the morning. For this analysis, the assumption was that the temperature would be set back starting at 8pm and return to normal operating temperature at 8am.

To determine the overall expected savings given the population of greenhouses within Energy Trust’s service territory, an assumption over the mix of greenhouse sizes needs to be made. The analyst estimated that in Oregon, 30% of the greenhouses were small, 45% were medium, and 25% were large. However, because small to medium-sized greenhouses are considered the primary targets of this measure (larger greenhouses are more likely to use complex control systems) only the population of small-medium size greenhouses needed to be quantified. Based on the overall population of greenhouses within those size classes, 40% were found to be small and 60% were found to be medium.

To predict an average heating schedule for this measure, the analyst assumed from field knowledge that the distribution of greenhouse heating schedules would be around 40% heating to the minimum schedule, 35% to the medium schedule, and 25% to the maximum schedule. However, because it is more common to use smaller greenhouses for high temperature plant propagation, and then move those plants to larger (somewhat cooler) houses later on, and adjusted weighting of 58% medium heat and 42% maximum heat was used in the analysis to represent only the small to medium-sized greenhouses. For cost-effectiveness purposes, savings were still estimated for each individual greenhouse size and heating schedule, but was then also weighted by the percentages indicated above to predict what the program would typically encounter for a single measure offering across all greenhouse sizes and heating schedules.

Measure life

The equipment controller life was set at 15 years in the analysis which is consistent with the regionally accepted useful life of hardware controls for HVAC systems.

Incentive Structure

At the time of this memo, the program has an incentive of $0.03/sqft for installation of the controller. This incentive is consistent with other offerings for greenhouse controllers around the country and is cost effective, with a Utility System BCR of 54.7. The maximum cost effective incentive is $1.64, although this exceeds the expected cost of the retrofit. In the unlikely event that the programs choose to increase incentives so dramatically, incentives and bonuses must be capped at the appropriate project cost.

Cost

On average, controllers may range from $400 - $1,200 depending on the complexity of the system and the controllers' ability to manage multiple aspects of an HVAC system, in addition to night setback. For purposes of evaluating the cost-effectiveness of this measure, the less expensive controller (multi-stage digital) was used for the smaller greenhouses where smaller, less complex HVAC systems are typically employed. The more expensive controller (Integrated type) was used for the medium sized greenhouses, which because of the larger area, may utilize more units and therefore require more complex controllers. To obtain a single weighted average incremental cost for the measure, the costs for each controller type were then weighted by the make-up of each greenhouses size, as discussed above. Finally, in all cases an additional $500 installation cost was added to the weighted average equipment cost on a square foot basis.

Exceptions

As stated above, large greenhouses (60'x96') are excluded from this blessing. Since large greenhouses typically employ much more complex and robust control systems, they are not the target of this measure and are therefore not blessed under the analysis shown above. It should be noted that the requirement for a maximum size of 15,000 sqft per controller is meant to account for and include as eligible the cases where several small-medium sized greenhouses are "gutter connected" together. In these cases, a single controller can still adequately handle the simple operation of HVAC systems within each greenhouse. Although it is not expected to occur frequently, this type of setup is highly cost-effective because a single controller is handling a greater amount of square footage.

Program	Measure	Description
Existing Buildings	Thermal Curtains Installed on Greenhouses	Energy Savings rate 40% or better
Existing Buildings	Infrared (IR) polyethylene greenhouse cover	Must be replacing non-IR cover
Existing Buildings	Agricultural Under-bench heating per square foot	"Hydronic heat distribution located directly on or under plant bench, on the floor or in the floor. Must replace unit heaters as the primary heat source"

REVISED Slightly to correct minor error.

Blessing Memo Greenhouse Measures

Update 9/18//2014

- Updated all measures
- Add Existing Buildings Washington as an applicable program
- Removed Unit Heater as it is not a current offering

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

- Production Efficiency
- Existing Buildings WA

Applicability to the following building type:

- Greenhouses

TABLE 1 BCR Calculator

Energy Efficiency Measure Name	Measure Lifetime	Annual Natural Gas Savings (therms)	Total Incremental Cost of Measure	MAX Potential Incentive	Combined Utility System BCR	TRC BCR
IR Poly Film	4	0.23	0.02	0.40	**1.0**	**20.0**
Thermal Curtain	10	0.41	1.50	1.81	**1.0**	**1.2**
Under Bench Heating	12	1.25	3.00	5.94	**1.0**	**2.1**

Program requirements
IR Film Polyethylene Greenhouse cover

- Must be infrared polyethylene plastic with an anti-condensate coating.
- Must be upgrading from a non-IR cover.
- Must have a life expectancy of 4 years.
- Minimum thinness of 6 mil.

Thermal Curtain

- Must be installed above heated space and drawn closed automatically at night

- Must be designed primarily to be a heat curtain
- Must have a rated energy savings rate of 40% or higher
- Must have a minimum life expectancy of 5 years.

Under-Bench Heating

- Heating system must use hydronic heat distribution located directly on or under plant bench, on the floor or in the floor.
- Must replace unit heaters as the primary heat source
- Remaining unit heaters must be controlled to turn on only as an emergency backup

Details and Savings
All savings are based on research conducted by ICF for Energy Trust completed in 2007. The eQUEST hourly simulation tool was used to model energy consumption for a baseline greenhouse. An additional 13 scenarios were modeled representing various combinations of the energy efficiency measures. Key modeling parameters included:

- Baseline Greenhouse – Single bay, 8,192 sf, 80% efficient unit heater, no thermal curtain, no IR film
- Heating System Options – 80% efficient unit heater (baseline), 86% efficient unit heater, under bench heating system with 80% efficient hot water boiler
- Climate Zones – Willamette Valley and Bend/Redmond were modeled, but just one combination of measures was done at the Bend/Redmond climate zone. All savings are based on Willamette Valley climate zone. This results in conservative savings. Projects in the Bend/Redmond climate zone will experience 30% to 40% higher savings.

Combining these measures in the same greenhouse will yield lower savings than the sum of the individual savings, particularly the combination of IR Film and Thermal Curtain. The interactive effects were modeled and used in the measure analysis, but deemed savings assume each measure is installed independently. Energy Trust plans to revisit these savings in 2015 to align with the latest knowledge, best practices and technology in the greenhouse sector.

IR Film
IR film on inner walls reduces heating loads in greenhouses by reducing heat loss through the walls and ceiling. The greenhouse modeled had a double layer inflated polyethylene roof and walls. Both the inner and outer layers were assumed be 6 mill clear polyethylene for the baseline case. For modeling scenarios with IR film, the inner film was assumed to be IR enhanced (outer layer remained clear polyethylene).

Modelling showed the addition of IR film reduces consumption approximately 27%. In 2007, the measure savings were not adjusted for the difference between floor space and film surface area, which the incremental cost is based on and is how the measure is booked. For this update, a floor area to film area ratio of 60% was applied to correlate the savings to the film surface area. Also in 2007, the measures analysis savings assumed a 50% reduction in savings due to the belief that a large number of growers would install IR film at the in a base case. That rate of efficient base case has been reduced for this update to 16.8% based on analysis completed by Cascade Energy in 2009. In combination, these updates reduce the savings for IR film to 0.23 therms/sf of film from 0.27 therms/sf, a reduction of 15%. The new value is still higher than the 0.13 therms predicted by the DOE's Virtual Grower tool for Oregon. This difference with be further researched for the measure update in 2015.

Thermal Curtain
Greenhouse thermal curtains are typically designed to be deployed horizontally above the growing zone within a greenhouse. Side wall curtains, although less common, are also used. For horizontal curtains, energy is saved in three ways. First, horizontal curtains trap air above the curtain and below the roof line. This trapped air forms an insulating barrier that reduces heat losses due to conduction through the roof. Second, curtains reduce the volume of air inside the greenhouse that needs to be heated, and effectively contain the conditioned air within the desired heated space. Third, curtain fabrics are often constructed with aluminum strips or other reflective materials. These reflective curtains help reflect heat back into the greenhouse, thereby reducing the amount of radiation that escapes through the roof or side walls.

Modeling showed the impact of adding thermal curtains and IR film as separate measures to the baseline greenhouse, as well as adding both measures. Alone, the addition of a thermal curtain reduced energy consumption in the models approximately 24%, 0.41 therms/sf. This is an 16% decrease from the 2007 value of 0.49 therms/sf due to the earlier calculations referencing an incorrect table. Modeled savings was significantly less than the savings claimed by thermal curtain manufacturers. This difference with be further researched for the measure update in 2015.

Under-Bench Heating
Bench heating systems are an alternative to unit heaters for keeping plant root zones warm. With under-bench heating systems, pipe or tubing is located below the bench, and hot water is circulated through the system to keep the plant beds warm. Depending on the water temperature, either plastic or metal materials can be used for the water circulation loop. Bench heating systems are known to reduce energy use compared to unit heaters because these systems offer a more efficient means of keeping plant root zones at the desired temperature. With bench systems, the volume of greenhouse air that is heated to achieve a desired root zone temperature is reduced compared to unit heaters, thereby reducing natural gas consumption. One contributing factor to the reduced natural gas consumption for under bench heating systems is that the greenhouse setpoint temperature can typically be reduced for an under bench system compared to a unit heater.

For the eQUEST modeling it was assumed that the setpoint temperature can be reduced 7° F for an under bench system, while still maintaining the same root zone. This setpoint reduction contributes to 74% gas use reduction, 1.25 therms/sf. This is a 4% increase from the 2007 memo value of 1.20 therms/sf due to the earlier memo referencing an incorrect table and including interactive effects.

Measure life

- IR film is generally sold with a 1-year or 4-year lifetime expectation, the program requires products to have a 4-year expected life. The measure life has been updated from 3 years to 4 years.
- Thermal curtains are expected to have an average measure life of 10 years. Eligible products must be rated for at least 5 years.
- Under-bench heating systems are expected to have a measure life of 12 years, although some components, such as the boilers are expected to persist much longer.

Incentive Structure
The current (as of Summer 2014) Production Efficiency Streamlined incentive structure is listed below. Planning suggests that Existing Buildings WA align with these levels and with any future incentive changes made by the Streamlined program. Table 1 provides maximum cost-effective incentives, *to be used as a reference only*. Incentives for these measures should not exceed applicable project cost.

- IR Polyethylene Film – $0.02/sf of film
- Thermal Curtain - $0.09/sf of heated floor space
- Under-Bench Heating - $1.05/sf of heated floor space

Cost
Costs are based on the ICF study. The incremental cost for thermal curtains has been updated due to an error in the previous version of the blessing memo.

Follow-up
A refresh of the analysis related to greenhouse measures is planned for 2015.

PROGRAM	MEASURE	DESCRIPTION	UES	INCENTIVE	2015 STATUS
RESIDENTIAL PROGRAMS					
Existing Homes	1.0gpm Bath Aerator	"Build Your Own" Kit, 65% installation rate	6.87	$ 1.35	update
Existing Homes	1.5gpm Kitchen Aerator	"Build Your Own" Kit, 65% installation rate	4.50	$ 1.85	update
Existing Homes	1.75gpm Showerhead	"Build Your Own" Kit, 75% installation rate	11.01	$ 3.38	update
Existing Homes	Whole Home Air Sealing	Home must be built 1982 or earlier	25.53	$ 150.00	
Existing Homes	SF Gas Boiler	88% AFUE or better	44.44	$ 200.00	
Existing Homes	Ceiling/Attic Insulation per SQFT	Updated maximim pre-treatment R value of R19, treat to R38	0.05	$ 0.25	change
Existing Homes	Wall Insulation per SQFT	Maximum pre-treatment R4, treat to R-11 or fill wall cavity	0.05	$ 0.30	
Existing Homes	Knee Wall Insulation per SQFT	Maximum pre-treatment R4, R-15 for 2x4 cavities; R-21 for 2x6 cavities;	0.05	$ 0.30	
Existing Homes	Floor Insulation per SQFT	Maximum pre-treatment R4, treat to R-30 or fill floor cavity	0.04	$ 0.30	
Existing Homes	Duct Insulation	Maximum pre-treatment R2, R-11; must be sealed before insulation is applied	12.30	$ 100.00	
Existing Homes	Gas Hearth - Intermittent Pilot Light	new incentive designed to phase out standing pilot light gas hearths	34.50	$ 100.00	new
Existing Homes	Gas Hearth 70 to 74 FE and intermittent ignition	updated FE tier	79.40	$ 200.00	update
Existing Homes	Gas Hearth 75+ FE and intermittent ignition	new FE tier	90.90	$ 300.00	change
Existing Homes	Gas Hearth 65 to 69 FE Intermittent ignition	updated FE tier	59.50	$ 100.00	update
Existing Homes	Gas Furnace $100 Incentive (90% to 94%)	updated tier	60.50	$ 100.00	change
Existing Homes	Gas Furnace $350 Incentive (95%+)	new high efficiency tier	80.50	$ 350.00	change
Existing Homes	Direct Vent gas unit heater	80% AFUE or better	47.50	$ 100.00	
Existing Homes	Water Heater, Gas .67	Tank Water Heater	31.50	$ 150.00	
Existing Homes	Windows U .28-.30 perSQFT	High Efficiency Windows New Tiers	0.20	$ 1.00	change
Existing Homes	Windows, U <= .27 perSQFT	High Efficiency Windows New Tiers	0.48	$ 4.00	change
Existing Homes	Furnaces in Rentals	Midstream pilot targeting rental properties	79.50	$ 550.00	new/pilot
New Homes	Gas Hearth .70+ FE with Intermittent Pilot Light	Proposed Measure for New Construction	73.60	$ 200.00	new/provisional
New Homes	Gas Hearth .75+ FE with Intermittent Pilot Light	Proposed Measure for New Construction	73.20	$ 300.00	new/provisional
New Homes	Washington Energy STAR Performance Path	Updated to 2012 WA Energy Update	114.00	$ 500.00	change
Products	NWNWA 1.5 gpm Showerhead	Simple Steps, Smart Savings Retail Program	12.28	$ 7.00	
Products	NWNWA 1.75 gpm Showerhead	Simple Steps, Smart Savings Retail Program	10.05	$ 7.00	
Products	NWNWA 2.0 gpm Showerhead	Simple Steps, Smart Savings Retail Program	7.64	$ 7.00	
Products	Clothes Washer MEF 2.4 or higher	Updated MEF, incentive is for customers with gas fired dryers. Administered in conjunction with Clark PUD	3.72	$ 25.00	change
Products	Washington Showerhead, 1.6 gpm	Simple Steps, Smart Savings Retail Program	11.77	$ 7.00	
COMMERCIAL PROGRAMS					
Existing Buildings	Aerator Bathroom 0.5 GPM or less	15 unit minimum	17.90	$ 3.00	
Existing Buildings	Aerator Kitchen 1.5 GPM or less	15 unit minimum	7.40	$ 5.00	
Existing Buildings	Showerhead - 2.0 GPM	15 unit minimum	7.80	$ 6.00	
Existing Buildings	Showerwand 1.5 gpm		16.20	10	
Existing Buildings	Assisted Living Showerhead 1.5 GPM - White	Direct Install Offering For Assisted Living Facilities	20.60	$ 4.24	
Existing Buildings	Assisted Living Showerhead 1.5 GPM - Chrome	Direct Install Offering For Assisted Living Facilities	20.60	4.65	
Existing Buildings	Assisted Living Showerhead 1.75 GPM - White	Direct Install Offering For Assisted Living Facilities	16.70	4.24	
Existing Buildings	Assisted Living Showerhead 1.75 GPM - Chrome	Direct Install Offering For Assisted Living Facilities	16.70	4.65	
Existing Buildings	Assisted Living Shower wand 1.5 GPM - White	Direct Install Offering For Assisted Living Facilities	20.60	$ 10.40	
Existing Buildings	Assisted Living Shower wand 1.5 GPM - Chrome	Direct Install Offering For Assisted Living Facilities	20.60	11.1	
Existing Buildings	Attic Insulation per SQFT	no existing insulation, must insulate to R19	0.25	$ 0.30	updated
Existing Buildings	Attic Insulation R-19 to R-38 gas heat perSQFT	pre-existing insulation up to R19, must insulate to R38	0.05	0.3	new
Existing Buildings	Roof Insulation - Gas heating per SQFT	no existing insulation, must insulate to R19	0.25	$ 0.30	

PROGRAM	MEASURE	DESCRIPTION	UES	INCENTIVE	2015 STATUS
Existing Buildings	Roof Insulation R-5 to R-20 gas heat perSQFT	pre-existing insulation up to R5, must insulate to R20	0.09	0.3	new
Existing Buildings	Wall Insulation - Gas heating perSQFT	no existing insulation, must insulate to R11	0.16	$ 0.30	
Existing Buildings	Pipe Insulation - Hot water - Pipe Diameter > 1.5"	Min Required insulation thickness 2"	4.00	2	
Existing Buildings	Pipe Insulation - Hot water - Pipe Diameter ≤ 1.5"	Min Required insulation thickness 1.5"	4.00	$ 2.00	
Existing Buildings	Pipe Insulation - Low-Pressure Steam (< 15 psig) - Pipe Diameter > 1.5"	Min Required insulation thickness 2"	9.30	4	
Existing Buildings	Pipe Insulation - Low-Pressure Steam (< 15 psig) - Pipe Diameter ≤ 1.5"	Min Required insulation thickness 1.5"	9.30	$ 4.00	
Existing Buildings	Pipe Insulation - Med-Pressure Steam (15–200 psig) - Pipe Diameter > 1.5"	Min Required insulation thickness 2"	5.00	6	
Existing Buildings	Pipe Insulation - Med-Pressure Steam (15–200 psig) - Pipe Diameter ≤ 1.5"	Min Required insulation thickness 1.5"	5.00	$ 6.00	
Existing Buildings	Boiler < 300 kBtuh input	Minimum 90% thermal efficiency, with electronic ignition	2.21	6	updated
Existing Buildings	Boiler > 2,500 kBtuh input	Minimum 90% thermal efficiency, with electronic ignition	2.17	$ 6.00	updated
Existing Buildings	Boiler ≥ 300, ≤ 2,500 kBtuh input	Minimum 90% thermal efficiency, with electronic ignition	2.19	6	updated
Existing Buildings	Boiler Vent Damper	minimum 1000 kBtuh input	270.00	$ 1,000.00	
Existing Buildings	Commercial Clothes Washer-Gas Water Heat	full or partial gas water heating, Energy STAR	38.70	200	
Existing Buildings	Dishwasher - Single Tank Conveyor - gas high temp	Energy STAR	508.00	$ 500.00	
Existing Buildings	Dishwasher - Single Tank Conveyor - gas low temp	Energy STAR	520.00	500	
Existing Buildings	Dishwasher - Single Tank Door/Upright - gas high temp	Energy STAR	405.00	$ 400.00	
Existing Buildings	Dishwasher - Single Tank Door/Upright - gas low temp	Energy STAR	554.00	400	
Existing Buildings	Dishwasher - Under counter - gas high temp	Energy STAR	217.00	$ 200.00	
Existing Buildings	Domestic Tank Water Heaters	>75 kBtuh input, minimum 91% AFUE	1.37	2.5	
Existing Buildings	Domestic Tankless Water Heaters - Coin Op Laundries	Minimum .738 EF, with electronic ignition	2.58	$ 2.00	
Existing Buildings	Domestic Tankless Water Heaters - Food service	Minimum .738 EF, with electronic ignition	0.57	2	
Existing Buildings	Domestic Tankless Water Heaters - Lodging	Minimum .738 EF, with electronic ignition	1.11	$ 2.00	
Existing Buildings	Convection Oven - Gas - Full Size	Energy STAR	302.00	300	updated
Existing Buildings	Gas Combination Ovens	Energy STAR	290.00	$ 500.00	updated
Existing Buildings	Gas Fryer	Energy STAR	569.00	800	updated
Existing Buildings	Gas Griddle	Energy STAR	147.00	$ 150.00	updated
Existing Buildings	Steam Cooker - Gas	Energy STAR	1308.00	1300	updated
Existing Buildings	Turbo Pot with Lid	Energy STAR	108.00	$ 40.00	
Existing Buildings	HVAC Unit Heater	Minimum 86% thermal efficiency, with electronic ignition	0.61	1.5	
Existing Buildings	MF Domestic Tank Water Heaters	Minimum 91 percent AFUE	2.21	$ 2.50	new
Existing Buildings	Multifamily Steam Traps	Low-pressure (< 15 psig) systems only	99.00	100	new
Existing Buildings	Steam Traps--schools & laundry facilities	Boiler pressures ≤ 15 psig in schools and >15 psig in laundry facilities.	111.70	$ 200.00	new
Existing Buildings	Ozone Laundry - Correctional facility - per lb/capacity	100 lb capacity minimum, not to exceed 35% of project cost	23.99	$40	
Existing Buildings	Ozone Laundry - Health club - per lb/capacity	100 lb capacity minimum, not to exceed 35% of project cost	24.13	$40	
Existing Buildings	Ozone Laundry - Hospital - per lb/capacity	100 lb capacity minimum, not to exceed 35% of project cost	16.93	$40	
Existing Buildings	Ozone Laundry - Hotel - per lb/capacity	100 lb capacity minimum, not to exceed 35% of project cost	19.19	$40	
Existing Buildings	Ozone Laundry - Hotel w/lease - per lb/capacity	100 lb capacity minimum, not to exceed 35% of project cost	19.19	$40	
Existing Buildings	Ozone Laundry - Motel - per lb/capacity	100 lb capacity minimum, not to exceed 35% of project cost	21.44	$40	
Existing Buildings	Ozone Laundry - Nursing home - per lb/capacity	100 lb capacity minimum, not to exceed 35% of project cost	18.34	$40	
Existing Buildings	Ozone Laundry - University - per lb/capacity	100 lb capacity minimum, not to exceed 35% of project cost	25.40	$40	
Existing Buildings	Radiant Heater, Modulating	Minimum 82% efficiency; Indoor use only, 5,000 - 20,000 SF	11.20	10	

PROGRAM	MEASURE	DESCRIPTION	UES	INCENTIVE	2015 STATUS
Existing Buildings	Radiant Heater, Non-Modulating Infrared Natural Gas-Fired Radiant Heater	Minimum 80% efficiency; Indoor use only, 5,000 - 20,000 SF	4.30	$ 6.50	
Existing Buildings	Warm-Air Furnace < 225 kBtuh input	Minimum 91 percent AFUE	0.97	3	
Existing Buildings	Thermostatic Radiator Valves (TRVs), central hydronic or steam systems only (MF only)	Replace manual, non-thermostatically controlled valves at dwelling unit radiators	55.00	$ 100.00	new
Existing Buildings	Greenhouse controllers	Per square foot, max greenhouse size 15,000 Sq ft	0.28	0.03	new
Existing Buildings	Thermal Curtains Installed on Greenhouses	Energy Savings rate 40% or better	0.41	$ 0.09	updated
Existing Buildings	Infrared (IR) polyethylene greenhouse cover	Must be replacing non-IR cover	0.27	0.02	new
Existing Buildings	Agrigultural Under-bench heating per square foot	Hydronic heat distribution located directly on or under plant bench, on the floor or in the floor. Must replace unit heaters as the primary heat source	1.20	$ 1.05	new

Program	Measures	TRC	Notes
Existing Homes	Furnace 90-94	0.8	
Existing Homes	Furnace 95+	0.6	Program forecast >75% submissions will be for the high efficiency tier
Existing Homes	Insulation Ceiling	0.6	Amended to allow pre-treatment R levels up to R19, returning to 2012 program guidelines
Existing Homes	Insulation wall	0.3	
Existing Homes	Insulation floor	0.4	
Existing Homes	Smart Thermostat Pilot	0.4	Pilot program, projected TRC.
existing Homes	Air Sealing	0.3	Energy Trust is currently piloting a combined air sealing/attic insulation measure in Oregon.
Products	Clothes Washer	0.8	Final year measure will be offered due to change in federal appliance standard
New Homes	Energy STAR Home Incentive	0.6	TRC reduced due to updated building code requiring low-flow water fixtures
Commercial Existing Buildings	Insulation Tier 2	0.5	Amended to allow pre-treatment R levels up to R19
Commercial Existing Buildings	Custom-Path	0.7	Projects are screened individually, and may be approved with TRC screening ≥.7 Proposed measures screening <.7 will be evaluated on a case by case basis

Savings Within Reach On-Bill Repayment

Existing Homes | Form 321MITa

Bill Impact Estimator

Customer name:		Trade Ally Company:	
Customer site address:	Wilsonville	321MITa completed by:	
Customer primary heating utility	NW Natural		
Customer Current Heating Fuel	Gas	[redacted]	

Eligible Improvements	Zone	Sq. Ft. or Count	Bid[1]	Incentive	Net Install Cost
Air Sealing		-		$ -	$ -
Attic Insulation	1	897	$ 699.99	$ 448.50	$ 251.49
Wall Insulation	1	1,016	$ 1,920.24	$ 508.00	$ 1,412.24
Floor Insulation	1	897	$ 1,763.08	$ 358.80	$ 1,404.28
Gas Furnace		-		$ -	$ -
Ductless Heat Pump - replacing electric zonal heat	[redacted]				
Ductless Heat Pump - replacing electric forced air					
Heat Pump replacing existing heat pump or non-electric heat - minimum HSPF 9.0					
Heat Pump upgrade replacing electric resistance heat - minimum HSPF 9.0					
Heat Pump replacing existing heat pump or non-electric heat HSPF 9.5					
Heat Pump upgrade replacing electric resistance heat - minimum HSPF 9.5					
Heat Pump Commissioning					
Seasonal Bonus Incentive					
Totals			**$ 4,383.31**	**$ 1,315.30**	**$ 3,068.01**

[1]Includes the cost of labor and materials

Term of the Loan	**10**
Downpayment if required	**$ -**
Principal Loan Amount	**$ 3,068.01**
Total interest paid over the life of the loan	**$ 1,017.49**
Total Cost	**$ 4,085.50**

Estimated Monthly Energy Cost Savings	$ 12.92
[redacted]	
Monthly Loan Payment	$34.05
Estimated Net Monthly Utility Bill Impact: Higher Bill	**$21.13**

[redacted]	
Simple Payback in years	26.4