Regional Technical Forum

Methodology for Estimating Energy Efficiency Savings in the Northwest

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Executive Summary

Every five years the Northwest Power and Conservation Council develops a 20-year plan for the region that outlines a strategy for meeting the future load requirements of the electricity system. To develop this plan, the Council creates an electricity demand forecast, develops a suite of resources, and then analyzes a number of possible resource scenarios to identify an optimal least cost, least risk strategy to meet future load. The Council considers many resources in this process, including gas plants, renewable resources, and conservation, and aims to compare these resources on an "apples to apples" basis.

For conservation, the Council creates a conservation supply curve built up from individual measures based on the energy savings potential and cost of each measure. The Council uses assumptions in the frozen efficiency demand forecast as a starting point for estimating savings. For retrofit measures (discretionary measures that may be purchased at any time), the Council uses a pre-conditions baseline from which to estimate savings. This pre-condition is built into the demand forecast as the consumption of existing stock buildings and equipment. For lost opportunity measures (those replacing a product on failure or new load on the system), the Council uses a current practice baseline. The current practice looks at the average efficiency of equipment being purchased in the market today. This aligns with the demand forecast, which assumes that as products fail and are replaced, they are replaced by the current practice equipment. This alignment with the assumptions in the demand forecast is critical to not overcount or undercount efficiency potential.

To develop the individual measure savings for the conservation potential forecast, the Council depends heavily on the analysis of the Regional Technical Forum (RTF), an advisory committee to the Council. The RTF develops and maintains energy savings estimates and protocols as a resource for the region to support planning (both at the Council and individual utilities), program implementation, program evaluation, and claiming savings against the Council's target. Consistent with the Council's methodology, the RTF uses pre-conditions baselines for retrofit measures and current practice baselines for lost opportunity measures. The RTF also develops savings estimates for early replacement measures. These are measures where equipment is replaced prior to failure, but would have required replacement at some point in the future. The RTF uses a dual baseline approach for these, starting with the pre-condition and switching to current practice at the point in time at which the replaced equipment was expected to have failed and required replacement naturally.[1]

Regional utilities can use RTF estimates to support their energy efficiency program efforts. Similar to how the Council uses these estimates in its planning work, regional utilities may leverage RTF estimates for their own supply curve development. Additionally, these savings estimates are useful for program planning to guide limited dollars. Finally, the RTF estimates may be used to support evaluation of programs and claimed by utilities as savings against the Power Plan target. In this last use case, there are some inconsistencies between program claims and the target. One common place for misalignment is different assumptions in the baseline. The RTF updates its assumptions between plans and may update the baseline based

[1] The Power Plan does not estimate potential for early replacement measures, as it assumes all measures are replaced upon failure.

on new data, resulting in a different savings than assumed in the Power Plan potential and target. Additionally, when using RTF estimates for early replacement measures, there is a misalignment in the baseline for those early years of savings.

Additionally, in the Power Plan conservation potential forecast all units in the market (efficient and inefficient) are considered. This allows the Plan target to represent total market or stock change into the future; in other words, a shift in the region's stock of equipment to more efficient options or a shift in the region's purchasing practices to buying more efficient equipment. However, the RTF estimates and related program claims only reflect the efficient units in the market. The Power Plan target recognizes that some products purchased in the future may be less efficient than the baseline (for current practice measures). This results in program claims being biased high, relative to total market savings represented in the target, for current practice measures.

Despite these issues, the Council believes this is methodology has and continues to work well for the region. Importantly, it ensures that potential estimates align with assumptions in the demand forecast, avoiding the over or undercounting of efficiency savings. If the RTF were to choose a different method (such as forecasting market change or assuming no efficiency in the baseline), there would be misalignment in the demand forecast. Additionally, if the region attempted alternative approaches to estimating program claims, such as net-to-gross studies, this would result in significantly more cost without any greater clarity. The only way to arcuately track change relative to the target is to conduct studies on the full market. The region is doing this for significant markets, such as lighting. Given this, and the lack of better alternatives, the RTF estimates continue to be sufficient tools for tracking program accomplishments against the Power Plan targets.

Introduction

The Regional Technical Forum (RTF) develops regional savings estimates for use by energy efficiency program planners and evaluators.[2] The energy savings estimates are used in the Northwest as a means of claiming savings and tracking progress against the Northwest Power and Conservation Council's regional power plan conservation targets, for utility program planning, and to streamline program evaluation practices. One of the critical components for determining energy savings estimates is first establishing the baseline—the point from which conservation potential or savings are estimated. The selection of a baseline has implications for what the resulting energy savings estimates represent. This paper aims to provide clarity on how the Council and RTF develop regional savings estimates for conservation program planning and savings claims, and what the resulting savings estimates mean for regional stakeholders.

The Council was created out of the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Power Act). One of the Council's primary roles is to develop "a regional conservation and electric power plan."[3] The Council develops a Power Plan approximately every five years, with the latest plan (the Seventh Power Plan) being adopted by the Council in February 2016. The Power Plan is a 20-year integrated resource plan, which is defined by the Regulatory Assistance Project as "a plan for meeting forecasted annual peak and energy demand … through a combination of supply-side and demand-side resources." The Power Plan's goal is to select a resource mix that ensures "an adequate, efficient, economical, and reliable power supply"[4] for the Pacific Northwest. As part of the Power Plan, the Council establishes a regional target for conservation acquisition.

The RTF is a scientific advisory committee to the Council. The RTF was established in 1999 out of a directive from Congress that sought the development of a forum to establish standard methods for estimating and verifying energy savings.[5] The purpose of this forum was to ensure consistent and reliable estimation of conservation as a resource in the region, which was of particular importance as the Bonneville Power Administration sought to shift responsibility for acquiring this resource to its utility customers, resulting in more tailored and diverse approaches. The Comprehensive Review of the Northwest Energy System supported the Congressional directive and added a recommendation that the RTF should track the region's achievements in conservation and renewable development against the Council's goals.[6]

Core to the RTF's work today is the development and maintenance of a library of energy efficiency measures for use in the region. These measures are defined by the energy efficient product, system, or service and the savings are determined by estimating the difference in

[2] The RTF operates in accordance with the Northwest Power Act, which defines "conservation" as "any reduction in the electric power consumption as a result of increases in the efficiency of energy use, production, or distribution" [§3(3), 94 Stat. 2698.] The RTF uses the term energy efficiency interchangeably with conservation.

[3] Northwest Power Act, §4(a)(1), 94 Stat. 2700.

[4] Northwest Power Act, §2(2), 94 Stat. 2697.

[5] Senate Report 104-120. Energy and Water Development Appropriations Bill, 104th Congress, 1996.

[6] Comprehensive Review of the Northwest Energy System. Final Report: Toward a Competitive Electric Power Industry for the 21st Century. December 12, 1996. Available at: https://www.nwcouncil.org/reports/96-26/.

energy consumption between the efficient opportunity and the baseline. The RTF develops these measures, and related savings estimates, with the intent of supporting program planning and the tracking of conservation acquisition against the regional goals.

Key Definitions for Measure Development

The following are the definitions of key terms used in the development of RTF measures when discussing measure baselines.

Baseline

The baseline, or the point from which savings are estimated, depends on the type of measure implemented. These are split into lost opportunity and retrofit (including early replacement) measures, and each type has its own baseline condition. Per the Council's policies on fuel switching and fuel choice, a switch from a fuel other than electricity does not qualify as conservation. Therefore, equipment using alternate fuels are not included in the baseline from which energy efficiency savings are estimated.

Lost Opportunity Measures

Lost opportunity measures are those that are available only during a specific window of time at a cost specific to the circumstances surrounding that instance of implementation, for example the replacement of equipment on failure of equipment or the addition of new equipment or facilities. The Council and RTF use a *current practice* baseline for these measures. This is represented by either (1) efficiency required by codes and standards or (2) market-average efficiency, whichever is more efficient.[7] For example, when a refrigerator dies and needs to be replaced, the efficiency is determined by the more efficient option of either the Federal minimum standard or the average efficiency of refrigerators being purchased in the region in the current year. For a new home or facility, the baseline would be the more efficient of either the code or average building practice for new construction today.[8,9]

Retrofit Measures

Retrofit measures are improvements to, or replacements of, systems that are discretionary; i.e. measures that do not need to occur at the time of actual improvement or replacement. One example is insulation in an existing home. Once a home is built with its existing levels of insulation, there is nothing in the home itself that requires insulation to be added at a specific point in time (insulation does not "burn out" and require replacement at a specific interval).[10] Another example is the addition of a ductless heat pump to an existing house with zonal electric resistance baseboard heat. In this case, the addition of a ductless heat pump is supplemental to

[7] It is important to note that this market snapshot is attempting to capture items currently selling in the market, rather than the existing stock.

[8] The Council and RTF conduct its analysis at the regional (Pacific Northwest) level.

[9] For measures where customers have a choice in fuel (for example water heating equipment in a new home), the RTF follows the Council's policy on fuel choice. In short, as a starting point, the RTF assumes that there is no equipment using other fuels in the baseline when estimating energy efficiency savings.

[10] The Council and RTF typically think in terms of the 20-year planning horizon. Insulation may need replacement at some point, but it is generally beyond the 20-year planning period.

the existing baseboard heat that rarely requires replacement because of failure or obsolescence. For such measures, the baseline is established by looking at the existing equipment and is considered to be a *pre-conditions* baseline.[11] In these two examples, the baseline would be the existing insulation levels in the home or the existing zonal electric resistance system, respectively.

Early Replacement Measures

Other retrofit measures are those considered to be “early replacements”. These are discretionary changes in the sense that the change does not need to occur at that time, but rather the measure represents a voluntary change prior to the unit or system naturally requiring replacement. For example, upgrading a lighting system before the system fails or adding a more efficient motor to a pump system. For these cases, the Council and RTF use a dual baseline approach. The first baseline is a *pre-conditions* baseline. This is used for the remaining useful life of the baseline equipment, i.e. the time the existing lighting system was expected to continue working. The second baseline is a *current practice* baseline that is applied to the balance of measure life, or the period of time after the existing equipment would have been expected to be replaced naturally through the remainder of the measure life. For example, the estimated lifetime of a motor is 15 years. If the facility owner chose to upgrade that motor early (10 years into the life of the motor), the RTF would consider this to have two streams of savings. The first would be estimated from a pre-conditions baseline that is based on the existing motor efficiency and would last for 5 years (the number of remaining years that the existing motor was expected to last). The second period of savings, starting in year six, is determined from a current practice baseline, which would last 10 years, or the balance of the measure life.

Council’s Use of Baselines to Develop Conservation Potential and Targets

As stated above, one of the Council’s primary roles is to develop a regional Power Plan to provide the least cost, least risk strategy of meeting the region’s power generation needs over the next twenty years. To do this, the Council’s Plan first models supply side and demand side resources based on their specific attributes, such as their costs and ability to meet energy and capacity adequacy needs. The Council then competes these resources on an “apples to apples” basis under a variety of conditions that account for uncertainty. In the Seventh Power Plan, the Council tested resource portfolios[12] against 800 different futures[13] that account for uncertainty in wholesale electricity market prices, natural gas prices, load growth, hydro conditions, carbon regulation, and other conditions. The Council also tests resource portfolios under a variety of

[11] The Council and RTF do not consider measures where the pre-condition equipment uses a fuel that is different from the efficiency measure, as this is not considered conservation under the Council’s fuel switching policy. For example, the RTF will not estimate efficiency savings of moving from an existing gas furnace (pre-condition) to an efficiency electric air source heat pump.

[12] A *resource portfolio* is defined by the Council as actions and policies over which the decision maker has control that will affect the outcome of the analysis, specifically the amount, timing, and type of resources to be developed.

[13] In the context of the Council’s analytical framework, *futures* are circumstances for which the decision maker has no control that will affect the outcome of the analysis.

policy scenarios.[14] These range from an “existing policy” scenario where current policies regarding such issues as carbon regulation and renewable resource development remain unchanged, to scenarios that specifically consider carbon reduction strategies or sustained, low gas prices. The Council weighs the results of all the futures across all the scenarios it tests to determine the desired resource strategy that ensures an economic, efficient, and reliable electric system to meet the needs of consumers in the Pacific Northwest.

Conservation is a priority resource, as defined under the Act, and determining the total regional conservation potential and cost is a critical element of the Power Plan.[15] To compete conservation against other resources, the Council develops conservation supply curves that represent the conservation potential for the region at various levels of cost. To be included in the conservation supply curve, the conservation resource must be similarly “reliable and available within the time it is needed”[16] as other competing resources. Once a conservation resource is determined to be reliable and available, the Council determines the individual energy savings potential for each measure and its associated total cost. The purpose of looking at conservation as a resource is to compare all resources options for meeting future need. When evaluating conservation as a resource, is it imperative that supply of conservation available and the forecast of electric demand in the region use the same baselines for forecast energy consumption. The baseline load forecast and conservation assessment must have the same embedded conservation going forward. Otherwise the cost comparison between resources would be askew.

Lost Opportunity Measures in the Council Power Plan

As stated above, for lost opportunity measures, the Council determines savings potential and costs based on a *current practice* baseline. The current practice baseline is determined by the current codes and standards, or the average efficiency level of new items being purchased in the Northwest market (sales, common practices) at a point in time, whichever is more efficient

To establish a baseline, the Council’s demand forecast (which is the baseline for measuring conservation potential) assumes that over the 20-year planning period, the market efficiency mix remains constant. For a simple example, if the market snapshot shows that 50 percent of refrigerators being purchased are standard efficiency and the remaining 50 percent are ENERGY STAR®, this ratio of standard efficiency and ENERGY STAR sales is held constant throughout the 20 years as refrigerators naturally die and are replaced by new ones in the demand forecast. By holding the current practice mix constant the Council aligns its demand forecast and conservation baseline and assures no double counting of available potential. Because the demand forecast already assumes an efficient saturation of 50 percent, the remaining conservation potential is determined by further penetration of efficient units. For

[14] In the Council’s analytical framework, *scenarios* are combinations of resource strategies and futures used to “stress test” how well what decision makers control (i.e., resource portfolios) perform in world they don’t control (i.e. futures).

[15] As stated in the Power Act, “… the ‘estimated incremental system cost’ of any conservation measure or resource shall not be treated as greater than that of any non-conservation measure or resource unless the incremental system cost of such a conservation measure or resource is in excess of 110 percentum of the incremental system cost of the nonconservation measure or resource.” Northwest Power Act §3(4)D, 94 Stat. 2699. In other words, a 10 percent credit is applied to the incremental cost of conservation measures before comparing to other resources.

[16] Northwest Power Act, §3(4)(A)(i), 94 Stat. 2698.

example, shifting the purchase of ENERGY STAR refrigerator sales from 50 to 85 percent of the market.

Retrofit Measures in the Council Power Plan

For retrofit measures, the Council uses a *pre-conditions* baseline to determine the conservation potential and cost. A pre-conditions baseline is intended to reflect the physical efficiency that was in place just prior to measure installation. This is typically determined by taking a snapshot of the efficiency of existing stock at a point in time, for example by determining the efficiency of the existing levels of insulation in residential homes. The Council's demand forecast assumes that the current conditions of the stock are held constant over the 20-year planning period. That is, it is assumed that these systems are not improved or replaced over the planning period since there is no physical need to replace or upgrade their efficiency. With these conditions held constant, the Council determines the resulting conservation potential by estimating savings from moving the building stock from its existing efficiency point to an improved efficiency level. For example, for residential insulation, the Council would determine conservation potential for converting attics in the existing stock of homes that currently do not have insulation to attics that are well-insulated.

It is important to note that the Council's Power Plan does not include early replacement measures. Instead of assuming these measures are replaced "early," the Council Power Plan assumes that these products or systems are replaced upon burnout, and the conservation potential is included as part of the lost opportunity measures.

Council Targets for Cost-Effective Conservation

As defined by the Power Act, for a measure or resource to be cost-effective it must be forecast to be reliable and available within the time needed, and to meet or reduce electrical power demand of consumers at an estimated incremental system cost no greater than that of the least-costly, similarly reliable and available alternative or combination of alternatives. When considering the cost-effectiveness of individual conservation measures, calculations of costs and benefits are used as a determinant of cost-effectiveness, where the incremental costs of measure implementation are weighed against measure "benefits". Here benefits represent the avoided costs of the "similar alternative or combination of alternatives" resources in the Power Plan.

Not all potential in the conservation supply curve is ultimately cost-effective conservation. The amount of cost-effective conservation is determined by the Council through its optimization of a resource strategy in the Power Plan. Based on the resource needs over the many futures and scenarios, the Council will establish a "plan" for the resource strategy that it determines to be cost-effective. This resource strategy includes a target for conservation acquisition. In the Seventh Power Plan, this target was set at 1400 aMW over the first six-year period, meaning there are 1400 aMWs of cost-effective conservation available in the Pacific Northwest that should be developed by the end of 2021 to provide the region a least-cost and low-risk power system. Over the 20-year planning horizon, the Council found 4300 aMW of cost-effective conservation. Once the Council establishes the target amount of cost-effective conservation, the Council and other bodies can then determine which specific measures are cost-effective. The methodology for determining specific measure cost-effectiveness is described in Appendix G of the Seventh Power Plan.

As stated above, a primary role of the RTF is to develop savings estimates to be used for claiming savings against the Council's target. Additionally, the RTF supports the tracking of energy efficiency savings relative to Power Plan targets. This is done through an annual Regional Conservation Progress (RCP) survey. Through the RCP, Council staff collect data on program achievements and expenditures directly from Bonneville and its public utility customers, mid-Columbia utilities, Investor Owned Utilities in the region, the Energy Trust of Oregon, and the Northwest Energy Efficiency Alliance (NEEA). Reported data from these entities are counted as program achievements against Power Plan targets.[17] The Council's target includes savings across the entire regional market, whether captured in utility-funded programs, through NEEA's activities, or other mechanisms. Therefore, where possible, the RCP also attempts to capture conservation achievements resulting from improvements in state codes, Federal standards, and other market change.[18] Council staff tallies all the data, avoiding double counting where possible, and reports those achievements to the Council and the region on an annual basis.

The Power Plan and Attribution

In the Council's definition of cost-effectiveness, it does not matter who pays for the resource. Whether an efficiency program pays, or an individual pays; if a measure passes the Council's cost-effectiveness test, it is cost-effective for the region to install that measure. Under this definition of cost-effectiveness, the concepts of "free-riders" and "spillover" are irrelevant because all benefits and all costs are considered, and their attribution is not.

Given this, it is important to note that when estimating the conservation potential, the Council does not address causation or attribution of efficient choices in the baseline assumption. As described above, the demand forecast essentially sets a baseline for the conservation potential. Therefore, the Council's approach focuses on internal consistency between the demand forecast and the assessment of conservation potential, rather than attempting to determine the influence of previous energy-efficiency programs or other factors that might motivate consumers to improve efficiency. It may be true that efficiency assumed in the baseline demand forecast was, at least in part, due to previous program activity. It is also possible that the average efficiency in the baseline is driven by non-program factors. Regardless of the driver, the Council does not attempt to distinguish efficiency gains resulting from programs and remove it from the forecast. Rather, each Council plan starts fresh by reflecting past efficiency progress from programs or other market effects in the demand forecast. Typically, these adjustments between plans reflect improvements in efficiency, accounting for both program driven and independent consumer efficiency upgrades between plans. In cases where the market backslides (i.e. less efficient purchases are being made than in previous plans), those downgrades in efficiency are also captured in the updated demand forecast. This approach ensures that the Council only

[17] The Council recognizes that program savings, whether relying on the RTF or other analysis, do not always align with the Power Plan assumptions. Despite this, the Council does not make any adjustments to reported program achievements. This is discussed in more detail later in the paper.

[18] Total market change is meant to capture savings in the market as a whole, as compared to the Power Plan baseline. This includes savings for program accomplishments, NEEA savings, state codes, federal standards, and other market change. Bonneville's Momentum Savings research provides information on codes and standards and other market change by quantifying total market change.

considers the remaining potential above what is currently occurring in the market today and assumed in the baseline demand forecast.

Development of RTF Estimates

The RTF develops and maintains energy savings estimates and protocols to support planning (both at the Council and individual utilities), program implementation, program evaluation, and claiming savings against the Council's target. As with the Power Plan work, these savings estimates are intended to be forward-looking by providing an estimation of savings incremental to the baseline conditions today. The RTF library includes two types of measures: Unit Energy Savings measures (UES) and Standard Protocols. UES measures are those for which the energy savings can be determined on a per unit basis across a variety of sites. Common examples are residential insulation or appliances. Standard Protocols apply to measures where the savings per site will vary, but there is a standardized calculation methodology to determine savings. Examples of this are non-residential lighting systems and industrial compressed air systems.

A primary role of the RTF is to develop savings estimates to support claims against the Power Plan targets. Given that, the RTF provides technical analysis under the Council framework, which is directly useful to the Council, Bonneville and its utilities, and utilities in Washington.[19] In addition to these entities, the RTF serves other stakeholders with different regulatory environments. To support their needs, the RTF also aims to provide transparency in its analysis, which includes the building blocks that can be used by stakeholders as needed to meet their specific regulatory needs. This section describes the various estimates provided by the RTF for stakeholders' use.

Unit Energy Consumption

One of the key building blocks in RTF analysis is the development of unit energy consumption (UEC) estimates for measures. The UEC represents the annual energy consumption, per unit, for a defined technology, system, or service. For example, the energy consumption of an LED lamp or a standard efficiency air source heat pump. Where possible, the RTF will publish all the relevant UECs to support program use of RTF work products.[20] For UES measures, this analysis will be captured and published in the UES workbook. For Standard Protocols, the calculators themselves include the UECs required to support the calculation methodology.

A UEC and its definition often depend on many factors. To ensure a manageable list of measures, the RTF applies judgment to determine which factors can be "aggregated" or averaged within a particular UEC definition and which trigger separately defined UECs. Generally, the RTF will develop separate UECs if the underlying factors result in significant

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[19] The Council's approach to estimating the potential for energy efficiency must also be followed by Washington utilities that are subject to state law (RCW 19.285). This statute requires the use of "*methodologies consistent with those used by the Pacific Northwest electric power and conservation planning council.*" Additionally, Washington utilities are expected to use an RTF measures and analysis where available, unless a utility can justify an alternative methodology. Full text available at: [http://apps.leg.wa.gov/RCW/default.aspx?cite=19.285&full=true.](http://apps.leg.wa.gov/RCW/default.aspx?cite=19.285&full=true)

[20] The RTF may not be able to develop UECs for all measures. For example, measures for which savings are estimated directly through a random control trial, or other similar evaluation method, would not have a UEC. In such cases, the RTF strives to provide as much detail as possible to inform utility programs use of the measure analysis.

differences in the energy consumption and can be quantified.[21] For example, the UECs for residential heating systems will depend on the type of equipment, climate zone, house size, insulation levels, internal gains in a house, and occupant behavior. While variations in occupant behavior, house size, and internal gains can cause significant differences in consumption, the RTF does not use these factors to disaggregate the UEC because they may be difficult or impossible for programs to directly observe or verify. On the other hand, the RTF is likely to define separate UECs for each heating system type (heat pump, forced air, zonal, etc.), climate zone, and house insulation level since the differences in these factors could significantly affect energy consumption and are easily observable.

To keep the number of UECs manageable, the RTF also makes decisions on how granular specific UECs should be. For example, the RTF uses showerhead rated flow rate categories of (>1.75 gpm, ≤ 2.0 gpm), (>1.5 gpm, ≤ 1.75 gpm), and (≤ 1.5 gpm), rather than something more or less granular because it reflects the grouping of products available in the market around flow rates of 1.5 gpm, 1.75 gpm, and 2.0 gpm.

Market and or Stock Data

Another building block to the RTF's analysis is the market and stock data required to develop a regional savings estimate. The RTF will often require a mix of sales (or other proxy data) and stock data to support its measure analysis. These data are provided in the UES workbook or Standard Protocol calculator for utility programs to use, along with the UEC estimates, to develop savings estimates relevant to their specific conditions.

Savings Estimates for Lost Opportunity Measures

As in the Council work, the RTF uses a *current practice* baseline for lost opportunity measures. The RTF uses the average efficiency of new equipment and services being purchased in the measure-eligible market to determine the current practice. Ideally, the RTF is able to use actual sales data to define a sales-weighted UEC for the baseline. For example, RTF will use screw-in lamp sales data, combined with the UECs for the specific screw-in lamp technologies, to develop a sales-weighted average UEC to represent the current practice baseline for screw-in lamps.[22] The resulting savings for an LED lamp would be computed as the difference between the UEC of an LED and the sales-weighted average UEC baseline.[23]

Savings Estimates for Retrofit Measures

For retrofit measures, the RTF uses a *pre-conditions* baseline to develop energy savings estimates.[24] Often, this pre-conditions baseline is determined directly from one of the UECs

[21] The RTF's typical rule of thumb is whether a factor (such as heating zone) will change the savings by more than plus or minus 10 percent. If so, the RTF will strive to develop separate UECs to account for those differences.

[22] Sales data are not always available, in which case the RTF defaults to the use of other data. For example, availability of models on a products list or retail shelving data might be used as a proxy for sales.

[23] No adjustment is made to remove the effects of prior program activity from the baseline estimate. Similarly, the RTF does not make adjustments to remove non-program efficiency improvements from the baseline (except for known codes and standards). The RTF provides forward-looking savings estimate to inform future savings relative to where the market is today.

[24] Retrofit measures are those for which the impacted system has remaining useful life.

provided. For example, for the addition of a ductless heat pump in an existing zonal electric resistance heated house in heating zone 3, the RTF uses the UEC for a zonal electric resistance heated home in heating zone 3 for the baseline that reflects the average UEC for the stock of electric baseboard homes in zone 3. The resulting savings would then be determined by taking the difference in consumption from the zonal electric resistance system and the ductless heat pump plus zonal electric resistance system (i.e. the UEC of the zonal electric resistance system minus the UEC of the combined ductless heat pump and zonal electric resistance system in heating zone 3).

At times, the RTF may need to use stock data to develop a pre-conditions baseline that represents a stock-weighted average UEC. For example, the RTF uses a stock-weighted average to inform the pre-condition for residential showerheads. The energy consumption of a showerhead will depend on the showerhead flow rate and water heating equipment. Even when the program is directly installing a new showerhead, it may not be practical to collect both the flow rate of the existing showerhead and the water heater type to determine savings. For such cases, the RTF develops a pre-conditions baseline that reflects the regional average existing showerhead flow rate and water heater type based on regional stock data. The same stock data will inform the regional average UEC for the efficient case technology, for example a 1.5 gpm showerhead where the water heating equipment is unknown. The resulting RTF savings estimate would represent the difference in energy consumption from the regional average pre-condition showerhead and the efficient, 1.5 gpm, showerhead.

Unlike in the Council's Power Plan, the RTF also estimates savings for "early replacement" measures. For these measures, the RTF uses a dual baseline approach resulting in two savings streams, as described above. The first savings stream, which lasts for the remaining useful life of the existing equipment represents the savings between the measure and the *pre-conditions* baseline. The second savings stream, which is estimated for the balance of the measure life, is determined from a *current practice* baseline.[25]

Estimation of Measure Cost-Effectiveness

While providing savings estimates is the focus of RTF work, the RTF also calculates regional cost-effectiveness for UES measures.[26] The RTF uses the Council's defined methodology to calculate cost-effectiveness and publishes the results in the UES workbook. This methodology looks at the total resource costs and benefits, where both the numerator (the benefits) and denominator (the costs) are treated consistently for each measure. For example, the costs and benefits for retrofit measures are both determined from a *pre-conditions* baseline, whereas a *current practice* baseline is used in both the numerator and denominator for lost opportunity measures. The cost-effectiveness indicates whether it makes economic sense with respect to the Power Plan for the region to acquire that efficiency opportunity, not whether it is cost-effective for any particular end-user or whether it is cost-effective to implement or continue a specific efficiency program. End-user-specific cost-effectiveness and programs-specific cost-

[25] With the frozen efficiency assumption, the RTF uses the average efficiency being purchased in the market today (or as of the time of measure development) as a proxy for the typical market practice at the end of the RUL period.

[26] The RTF does not calculate costs and benefits, lifetime, or resulting cost-effectiveness for standard protocols.

effectiveness is beyond the scope of the RTF's analysis.[27] The RTF's analysis is limited to the determination of whether, when all quantifiable and monetizable costs and benefits are taken into consideration, a measure's regional benefits outweigh the regional costs.[28]

Use of RTF Savings Estimates

As described above, the RTF was established to support standardized verification of conservation savings as a means of tracking progress against the Council's Power Plan and to ensure that the region met regional targets for cost-effective conservation. To that end, RTF savings estimates are designed to be regional average estimates that test whether it remains cost-effective for the region to invest in a measure and to be used by programs to track their program savings against the Power Plan targets. Today, RTF-published estimates are used widely across the region to support analysis, including the development of the Council's Power Plan, as well as by energy-efficiency programs in program planning and evaluation. The primary uses of RTF estimates are described in more detail below.

Use in Integrated Resource Plans

Whether developing a regional integrated resource plan (i.e., the Council's Power Plan) or individual utility conservation potential assessments, RTF savings estimates can support the development of conservation supply curves. In developing conservation supply curves for the Power Plan, Council staff leverage existing RTF analysis where possible. The estimated savings are updated where data are available to reflect changes in the market and stock, as well as any other parameters. These estimates are then used to determine the total regional potential as described above.

Similar to the Power Plan, utilities can use RTF analysis to estimate utility-territory savings potential. When leveraging RTF estimates directly for this purpose, it is important to note that the RTF publishes regional energy savings estimates, based on regional assumptions, including snapshots of regional data on stock, sales, and other market characteristics. The savings potential for a specific

Program Effectiveness

Understanding whether programs are making effective use of their rate-payer dollars to develop energy efficiency is an important question. This question, however, is outside the scope of RTF work, and therefore not addressed in the development of RTF savings estimates. Under the Council's definition of cost-effectiveness, the concepts of program spillover and free-ridership are not relevant. The Power Plan and RTF savings estimates are focused on whether it is cost-effective for the region as a whole to improve the efficiency of a market beyond where it is today, not whether it is cost-effective for a specific program or whether savings claimed by a program are directly attributable to that program. Additionally, as the RTF does not design programs, it cannot know *a priori* how efficacious a program will be in targeting those in the market that, without the program, would choose the inefficient option. That being said, the RTF recognizes that it is critical to understand program effectiveness and refine programs as needed to better focus efficiency funding. The RTF provides the building blocks to its analysis to support programs in developing more targeted savings estimates based on their specific program design.

[27] Because the RTF uses regional assumptions, utility specific cost-effectiveness calculations may vary.

[28] The intent of the total resource cost test is to account for all costs and all benefits. It is important to note that this is not always practical. RTF analysis only accounts for those deemed to be quantifiable, monetizable, and feasible to quantify and monetize for all conservation and non-conservation resources.

utility or program administrator territory may differ from the regional average. Program planners can leverage the RTF published UECs to combine with service territory specific stock and sales data to develop more localized energy savings estimates.

Program Strategies for Achieving Council Plan Conservation Targets

The RTF intends for its estimates to be useful in developing strategies to meet Power Plan and other regulatory targets. For example, UES estimates can be used directly by an efficiency program to estimate how programs might achieve conservation targets. This would be done by taking the appropriate savings estimate for the measure and applying it to the portion of their market that they anticipate touching through their program in the near-term (for example during the six-year Action Plan period of the Seventh Power Plan). Additionally, testing regional cost-effectiveness consistent with the Power Plan methodology provides a signal as to whether the region should invest in a specific measure.[29]

While the RTF does not specify program design, the RTF estimates are intended to provide information to support program design. For example, as markets become more efficient, the current practice baseline for lost opportunity measures improves and the resulting savings decrease. The underlying market and stock data can help programs target the less efficient portions of the market and/or provide a signal about shifting resources to other measures with greater future savings potential.

Program Evaluation and Tracking Program Savings

Program evaluation is a critical component of rate-payer funded energy efficiency programs. There are three main types of program evaluation: impact, process, and market. Impact evaluations seek to determine how effective a specific program was at achieving energy savings. Process evaluations provide assessment of the program itself, including effectiveness and participant satisfaction. Market studies take a broader look at the entire market, capturing effects like codes and standards or other supply chain improvements. Collectively, evaluations provide valuable information for continuous improvement of the programs.[30]

RTF estimates are intended to ease the burden of impact evaluations. Specifically, RTF estimates determined to be “Proven” are considered to be sufficiently reliable for direct use in evaluations and multiplied by verified delivered units to represent a program’s savings achieved relative to the Power Plan targets.[31]

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[29] The RTF recognizes that regional cost-effectiveness does not directly correlate to the cost-effectiveness for a specific program. This information is merely meant to provide the signal for the regional consideration of a measure.

[30] For more information on program evaluation, see SEE Action Energy Efficiency Program Impact Evaluation Guide. Full text available at:
https://www4.eere.energy.gov/seeaction/system/files/documents/emv_ee_program_impact_guide_0.pdf

[31] RTF also categorizes estimates as Planning or Small Saver. For each of these measures picked up in an impact evaluation, additional research is required for claiming program savings. It is important that utilities ensure consistency between planning and evaluation functions. If RTF estimates are used directly for planning, then it would be important to use the same estimates in program evaluation. If a utility or program develops their own estimates using the RTF building blocks, then it would want to use the same building blocks for evaluations and program claims.

Inconsistency between Power Plan Target and RTF Savings Estimates

While the Council supports using RTF estimates for tracking program savings, there are a handful of inconsistencies between the Power Plan target and RTF estimates. These include (1) potential differences in baseline and (2) the potential to be biased high relative to total market targets in the Power Plan.

Baseline inconsistencies, can occur for a variety of reasons, many of which are related to utilities tailoring programs to best meet local needs. The first example is when programs implement early replacement measures. As described above, for these measures the RTF estimates two savings streams. Programs typically claim savings from the first year, which is estimated from a pre-conditions baseline. The Power Plan, however, does not include early replacement measures and therefore the target only represents the savings from the current practice baseline (the second stream of savings). Another example of baseline inconsistency is when the RTF or programs update their baseline between Power Plan periods, resulting in programs using a baseline that is more (or less) efficient than what was assumed by the Power Plan. Finally, programs may choose to develop a baseline that is more representative of their local utility area than the regional assumptions in the Power Plan. All three of these examples can result in reported program savings that are misaligned with respect to the Power Plan target.

The second issue is that program savings have the potential to be biased high relative to total market savings.[32] In the Power Plan, all units in the market (efficient and inefficient) are considered. This allows the Plan to represent total market change; in other words, shift in the region's stock of equipment to more efficient options or a shift in the region's purchasing practices to buying more efficient equipment. Impact evaluations, however, are limited to only counting program units, which also happen to be only efficient units. This program-limited perspective results in savings that may be biased high relative to total market targets in the Power Plan.[33]

To demonstrate, consider a residential lighting measure where there are only two kinds of lamps: inefficient lamps (halogen using 60 kWh per year) and efficient lamps (LED using 15 kWh per year). Assume that in the entire regional market 18 lamps burn out and replaced every year (Figure 1). Also assume that sales data show that currently 33 percent of products sold in the market are the efficient lamp. In calculating the potential in the Power Plan, the demand forecast would assume that every year when units die and are replaced, that 33 percent (or six of eighteen units) are the efficient option. The RTF would use the same assumption of 33

[32] See presentation to the Northwest Power and Conservation Council's Power Committee, "Primer on Reported Efficiency Savings" for more detail: https://www.nwcouncil.org/sites/default/files/2018_0710_p4.pdf.

[33] This inconsistency between the market (or Power Plan) energy savings and the savings when only efficient units are counted (as through a program) exists regardless of who is doing the counting, whether it be a program or the broader "region."

percent efficient in the baseline to develop its savings estimate. Based on the assumed consumption of each lamp, the RTF would estimate per lamp savings at 30 kWh per year.[34]

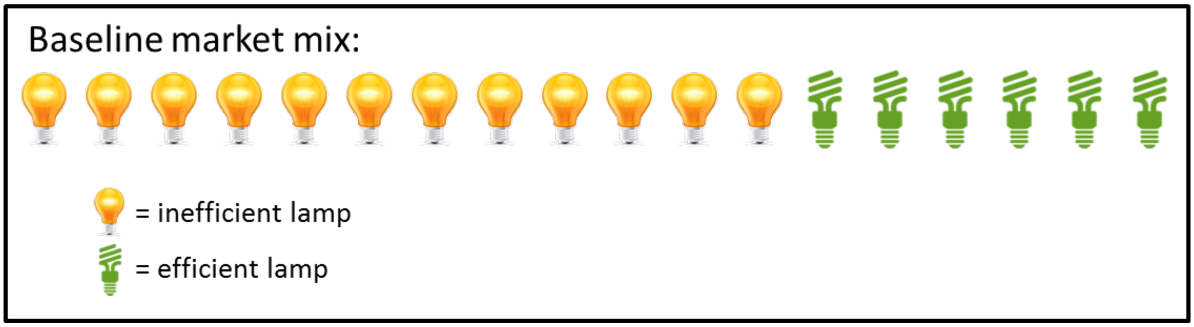

Figure 1: Example market mix for baseline demand forecast

One year later, new sales data show that 33 percent of lamps purchased are efficient, which is the same percentage in the baseline (Figure 2). Since the Power Plan baseline already assumed that 33 percent of the lamps sold that year would be the efficient option, there is no change in the market. In other words, savings from total market change is zero. The program perspective is different, as programs might claim anywhere from one to all six of the efficient lamps sold that year. Assuming the estimate of 30 kWh per year for each lamp, program savings could range from 30-180 kWh per year and be reportable against the Plan target. This example shows an extreme case of program savings being biased high relative to a total market perspective, where the program savings are going to only those individuals who were already assumed to be the purchasers of efficiency in the baseline. In this example, the program may have supported efficient purchases, but it did not result in an improvement in efficiency in the market over the baseline. This example, with no market improvement, is an extreme example.

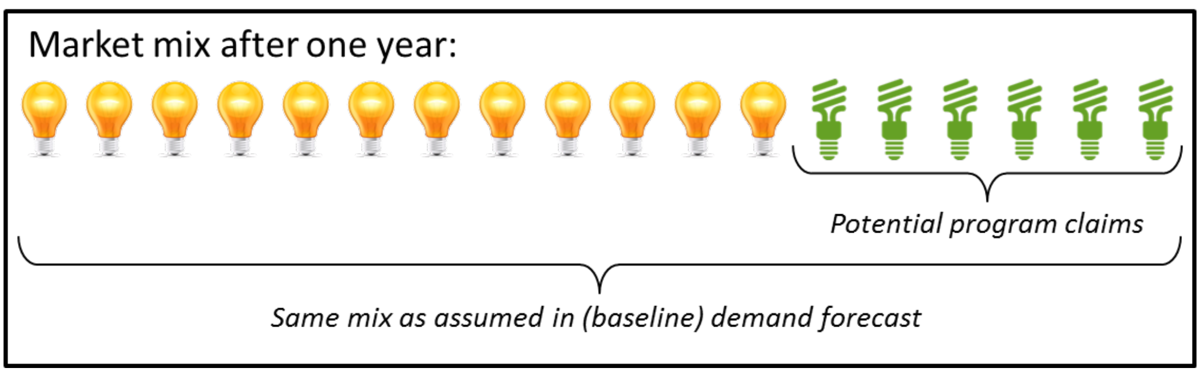

Figure 2: Example with no market change

To see savings above the demand forecast and UES estimate, at least some individuals that were *not* expected to purchase the efficient option in the demand forecast must ultimately decide to make an efficient purchase. For example, if after one year, the sales data show that 78 percent of the market purchased the efficient lamp. In other words, of the 18 lamps sold that year, 14 were the LED (Figure 3). In this example, there is market change of 360 kWh per

[34] This assumes a baseline consumption of 45 kWh/year based on the following equation: (60 kWh/year x 67%) + (15 kWh/year x 33%).

year.[35] As with Figure 2, programs may claim savings for any of the efficient lamps sold that year. This would result in program savings ranging between 30 kWh per year to 420 kWh per year. The more lamps claimed by programs, the more likely that program savings are overstated relative to total market change.

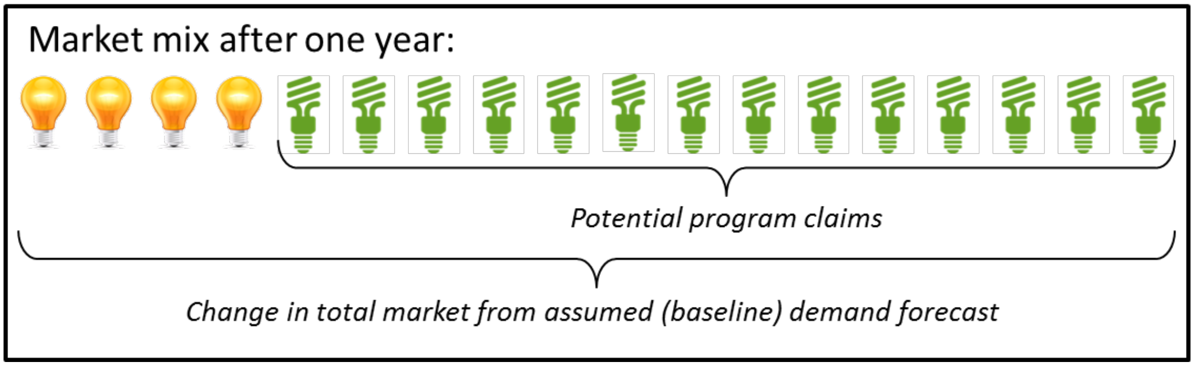

Figure 3: Example with partial market change

It is important to note that there are a few special cases where the RTF estimate multiplied by the number of efficient units counted by a program is equivalent to the energy savings from shifting the market for the current efficiency mix to the efficient case. The first is when the RTF estimate does not include any efficient products in the baseline. The second is when the market fully transforms to the efficient option.

The whole point of efficiency programs is to be this positive influence and help to overcome market barriers and provide incremental improvement such that some individuals that were not expected to purchase the efficient case actually do make the efficient choice. Over the past 35 years, the region has seen many increases in market penetration of efficient products, demonstrating that programs have been largely successful. While the examples above show the gap between program savings claims and the Power Plan cost-effective savings target in the near-term, it is important to note that these gaps diminish over the long-term as programs break market barriers and the market shifts.

Ultimately, understanding total market change is the best metric for tracking progress against Power Plan targets. The only true way to measure whether a shift in the market has occurred is through full market studies, which count every unit in the market, efficient and inefficient. Market studies must be completed once all data are available, and therefore cannot be completed until after the time period of interest. While the best metric, getting sufficient data for all markets is challenging and impractical for real-time tracking of program achievements against targets. That being said, market studies are being done for several markets, such as residential and non-residential lighting, residential HVAC, residential water heating, and several consumer products. These studies inform how much energy efficiency the region as a whole, program activities and other market activities included, has developed and are useful for understanding the factors in the market affecting the adoption of efficiency.

[35] Total market change is estimated by taking consumption of the full market in the second year (60 kWh/year x 4 lamps) + (15 kWh/year x 14 lamps) minus the consumption of the full market in the baseline year (60 kWh/year x 9 lamps) + (15 kWh/year x 6 lamps).

Where total market change is not available, Council staff continue to believe that the use of RTF savings estimates to track program accomplishments is sufficient. Alternative approaches to get at program savings have added cost while not providing any greater consistency with the Council Plan.[36] Additionally, attempts to adjust program savings to align with the Power Plan is overly burdensome. For example, many programs report savings to other entities based on metrics other than the Power Plan. Adjusting these savings to align with the Council target will require significant resource and may require data not readily available. Furthermore, data from market studies and economic analysis have indicated that only counting program savings claims using RTF estimates or other methods has historically underestimated total savings in the region.[37]

Conclusion

The RTF develops savings estimates intended to provide consistency and reliability for efficiency programs with program planning and tracking savings against the Council's Power Plan targets. The Council's Power Plan targets are formulated through analysis that compares a conservation potential forecast to a demand forecast. This conservation potential forecast is made up of individual conservation measures akin to RTF savings estimates. The baseline chosen for a measure depends on the type of measure. For lost opportunity measures, the RTF uses a *current practice* baseline to represent where the market efficiency is today (including all previous program activity and other market effects) and determines savings for the measure incremental to that point. For retrofit measures, including early replacement, the RTF develops estimates that represent the savings between the measure and a *pre-conditions* baseline, or essentially the existing unit or system (or a stock average of existing equipment). The RTF uses this approach as a way to estimate potential future energy savings, relative to where the region is today, and inform whether it remains cost-effective for the region to continue to invest in a particular measure as an energy system resource. These estimates are intended to be useful in the region for integrated resource planning to estimate remaining potential, by efficiency program planners to develop plans for meeting targets and evaluating programs to estimate savings and track progress relative to the Power Plan targets.

As this paper points out, RTF savings estimates used in a retrospective manner do not directly represent market change expressed in the Council target. There may be differences in baselines resulting from tailoring of programs or advancing markets. Additionally, the Council's targets are based on changes to the total market, whereas programs only track efficient units that they touch. Despite this, RTF savings estimates are a sufficient proxy for this metric. Due to

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[36] There are a couple alternatives to the current practice approach used by the Council and RTF. The first would be to assume no efficiency in the baseline for lost opportunity measures, resulting in higher savings estimates per measure. This essentially means that programs are 100 percent successful at targeting only those individuals that would have not chosen the efficient unit in the baseline. This alternate approach would overstate savings relative to the Council's demand forecast, which does assume some individuals would naturally purchase the efficient option. Another option is to attempt to better estimate program savings relative to the target attribution studies. These methods, such as net to gross studies, require added expense, are consistently fraught with uncertainty and error, and do not necessarily result in a better estimate of program savings.

[37] Northwest Power and Conservation Council, September 18, 2018. Recent Trends in Energy Consumption and Their Impact on the Northwest Economy. Available at: https://www.nwcouncil.org/reports/recent-trends-energy-consumption-and-their-impact-northwest-economy-0.

the different regulatory environments, difficulty and expense of estimating market change for every measure, different program planning cycles, and other nuances across the programs in the Northwest, there is no framework that provides direct alignment with the Council target. Fortunately, each Power Plan starts with a fresh look at the region, including a fresh look at the regional demand, which is the ultimate true-up mechanism to understand how the region is meeting its electric power needs.