Long Term Energy Efficiency Forecasting

Board Learning Paper

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Preface

This paper is part of a series that describes a variety of topics identified by the Energy Trust of Oregon's Board of Directors as potentially influential to the organization during the time period of its next strategic plan (2020-2024). This series of papers will educate and inform the Board about the potential impact of these topics and enable its Directors to better to assess risk, identify opportunity and guide the direction and goals of Energy Trust.

Remaining current on potentially significant and influential developments in the clean energy industry is critical to the fundamental role of the Board. These topics have been identified because of their potential to influence, impact or otherwise affect Energy Trust's ability to serve the ratepayers of Oregon and Southwest Washington. **These papers should not be interpreted as policy proposals or recommendations for roles in which Energy Trust intends or desires to be directly involved.**

Introduction

Energy Trust is an administrator of Oregon energy efficiency programs for PGE, Pacific Power, NW Natural, Cascade Natural Gas and Avista Corporation; and Washington energy efficiency programs for NW Natural. For these funding utility partners, Energy Trust forecasts the potential future electricity and gas savings from energy efficiency, which can be used for budgeting, annual performance tracking, identifying long-term savings potential and informing utility Integrated Resource Plans (IRP). Efficiency forecasting through utility IRP processes is a major determinant of Energy Trust's goals and budgets. This paper describes how Energy Trust develops the 20-year forecasts that utilities use for their IRPs and how it relates to Energy Trust's budgets, goals and program planning. The following sections cover the purpose of these forecasts, the methodology to create them, what the forecasts means and limitations of the forecasts.

Purpose of the 20-Year Forecast

Energy Trust provides 20-year forecasts of potential energy efficiency savings and costs to utilities as part of their IRP process. Energy Trust forecasts both annual energy savings and energy savings during peak energy use periods. The PacifiCorp website provides a helpful overview of IRPs and its usage of them:

> "The Integrated Resource Plan (IRP) is a comprehensive decision support tool and road map for meeting the company's objective of providing reliable and least-cost electric service to all of our customers while addressing the substantial risks and uncertainties inherent in the electric utility business. The IRP is developed with considerable public involvement from state utility commission staff, state agencies, customer and industry advocacy groups, project developers, and other stakeholders. The key elements of the IRP include: a finding of resource need, focusing on the first 10 years of a 20-year planning period; the preferred portfolio of supply-side and demand-side resources to meet this need; and an action plan that identifies the steps needed over the next two to four years to implement the plan.
>
> "PacifiCorp prepares its integrated resource plan on a biennial schedule, filing its plan with state utility commissions during each odd numbered year. For five of its six state jurisdictions, the Company receives a formal notification as to whether the IRP meets the commissions' IRP standards and guidelines, referred to as IRP acknowledgement. For even-numbered years, the Company updates its preferred resource portfolio and action plan by considering the most recent resource cost, load forecast, regulatory, and market information.
>
> "The IRP uses system modeling tools as part of its analytical framework to determine the long-run economic and operational performance of alternative resource portfolios. These models simulate the integration of new resource alternatives with our existing assets, thereby informing the selection of a preferred portfolio judged to be the most cost-effective resource mix after considering risk, supply reliability, uncertainty, and government energy resource policies.[1]"

In summary, an IRP assesses a utility's demand and load over 20 years to identify years where there may be a deficiency of supply to meet load. The IRP model then identifies the 'preferred' supply (generation) or demand side resource to meet that deficiency (Energy Efficiency is considered a demand-side resource).

The PacifiCorp description above is representative of the IRP process at each of Energy Trust's partner utilities. Energy Trust's 20-year potential savings forecast quantifies the available, cost-effective achievable energy efficiency potential to inform and reduce a utility's load forecast over the IRP period, so they can accurately plan their generating mix to meet their customers' projected loads.[2]

Historically, Energy Trust works with utilities to update these forecasts about every two years, coincident with the utilities' obligation to provide a refreshed IRP to the Oregon Public Utility Commission (OPUC) and the Washington Utility and Transportation Commission (WUTC). To keep the resource model up-to-date, Energy Trust's Planning team makes continual updates to the model according to the most current information available, including updated market trends, program trends and measure level input data (e.g. savings, costs and efficiency saturations).

The 20-year forecast does not dictate annual savings goals or set incentive levels for Energy Trust. Instead, annual IRP targets that emerge from the 20-year efficiency forecasts inform the two-year Energy Trust budget and vice versa.

The processes for forecasting IRP targets and setting savings goals for budgets typically occur at different times. For example, previous IRP savings targets for a respective two-year period are taken into consideration when developing savings goals for a two-year budget. Similarly, Planning uses the savings goals from the last two-year budget as a starting point for developing a 20-year savings deployment for the IRP process.

In some cases, the IRP process for a utility coincides neatly with Energy Trust's budget process, resulting in the closest alignment between annual savings goals and IRP targets. However, due to resource constraints, Energy Trust does not have the ability to synchronize our budget process with the production of energy efficiency forecasts for all utility IRPs. Annual savings projections for early years in the 20-year forecast may be limited by planning that Energy Trust does with each utility to assure that associated revenue requirements are relatively smooth over the respective years. Erratic revenue requirements are disruptive to the utility rate-setting process because of the related impacts on utility ratepayers.

The importance of Energy Trust's 20-year efficiency forecast has grown over time as Energy Trust's achievements have increased. In the early years of Energy Trust, when savings achievements were still modest, utilities incorporated Energy Trust savings in the simplest possible way, by deducting a fixed amount of savings from the load forecast prior to forecasting the need for other resources. However, as time progressed, Energy Trust's results increased to have significant impacts on overall utility loads. For example, Energy Trust's 20-year forecast for the 2018 NW Natural IRP shows a 15.9 percent cumulative reduction in the load the utility would otherwise forecast in absence of Energy Trust efficiency programs. Similarly, Energy Trust's

20-year forecast for the 2018 PGE IRP shows a 19.9 percent cumulative reduction in the load the utility would otherwise forecast in absence of Energy Trust efficiency programs. These recent projections illustrate the important role that energy efficiency plays in helping utilities optimize their resource mix to meet their loads. The outcome is that the forecast that Energy Trust provides for utility IRP planning has become more important to utilities, OPUC and other stakeholders.

20-Year Forecasting Process

Until 2015, Energy Trust used an Excel-based system for producing the 20-year forecast. At that time, Energy Trust migrated to a Resource Assessment model in Analytica®[3] that was developed by a consultant. This Resource Assessment model is currently being used to produce 20-year energy efficiency forecast for our funding utilities' IRPs. The Resource Assessment model is an object-flow-based modeling platform that is designed to visually show how different objects and parts of the model interrelate and flow throughout the modeling process. The model utilizes multidimensional tables and arrays to compute large, complex datasets in a relatively simple user interface. The current model simplifies the complex interrelated stacking of variables required in the forecasting process. Compared to the previous Excel-based spreadsheet model, one significant advantage of the Analytica platform is that it can house all the data for every utility within one model, rather than having to maintain a separate spreadsheet model for each. This greatly reduces the upkeep cost to model energy efficiency potential for each utility.

Resource Assessment Model Methodology

While there are a large number of variables and inputs that must be managed in the model, the Resource Assessment model is essentially one large multiplication matrix. The model utilizes a 'bottoms-up' framework, where individual measure-level data are the base inputs for the model. These base inputs are scaled up to quantify cost-effective achievable 20-year energy efficiency potential for each utility in relation to other inputs provided by each utility. In addition, the model is also able to project demand savings for each utility according to each utility's defined peak periods. Figure 1 below is a flowchart of the 20-year energy efficiency forecast development process.

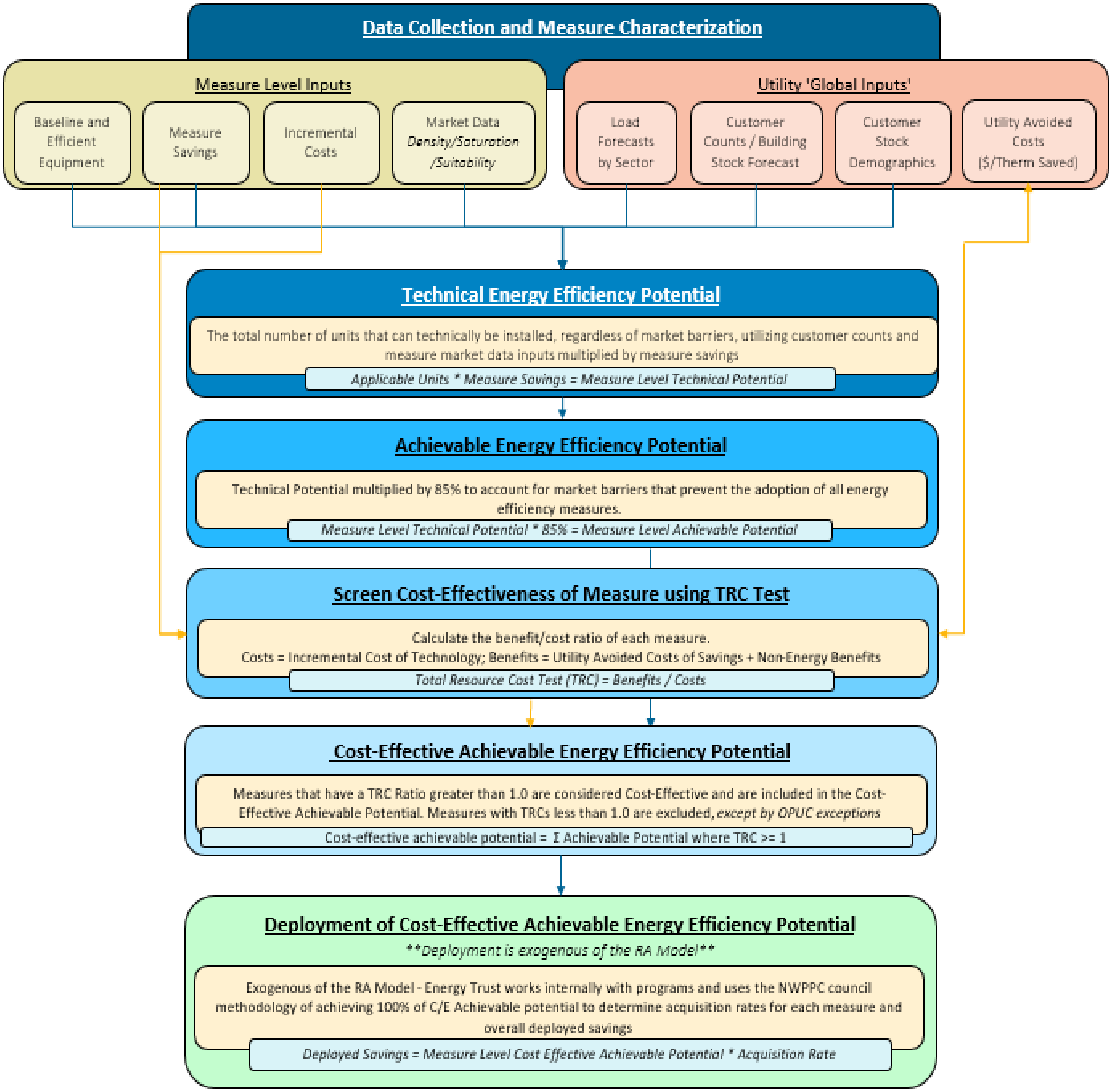

Figure 1: 20-year Energy Efficiency Forecast Development Process

As shown in Figure 1, there are a number of inputs necessary for this model, including inputs at the measure level and utility level (often referred to as 'global' inputs). Below is an overview of some of the inputs that go into the model:

- Utility/'Global' inputs
  - Customer counts, 20-year load forecasts, by customer type
  - Avoided costs, line losses and discount rate
  - Demographic statistics
    - Heating and hot water fuel splits
    - Energy use intensity for commercial and industrial
- Measure level assumptions
  - Savings, costs, operations and maintenance costs and savings, measure life, load profile, end use, baseline information, measure densities[4], baseline vs. efficient saturations, technical applicability, achievability rates
- Emerging Technologies (Figures 2 and 3 illustrate the total cumulative forecast for the 2018 NW Natural and PGE IRPs. This cumulative forecast is made up of savings from emerging technologies.)
  - The model includes a suite of emerging technologies that are not currently offered by Energy Trust programs, but offer the potential for significant savings in the future if they become viable in the market.
  - Emerging technologies are subject to a risk factor that functionally reduces forecast savings based on market risk, technical risk and data source risk.

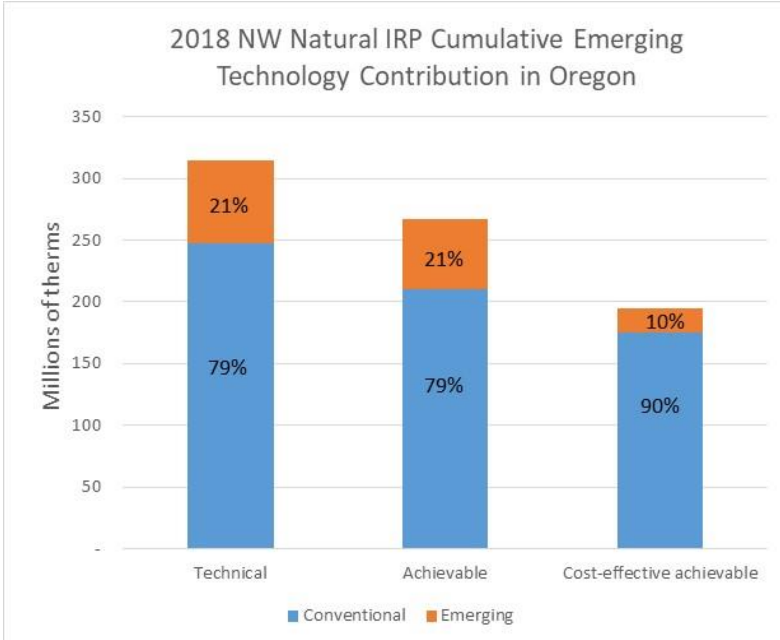

Figure 2: 2018 NW Natural IRP Cumulative Emerging Technology Contribution in Oregon

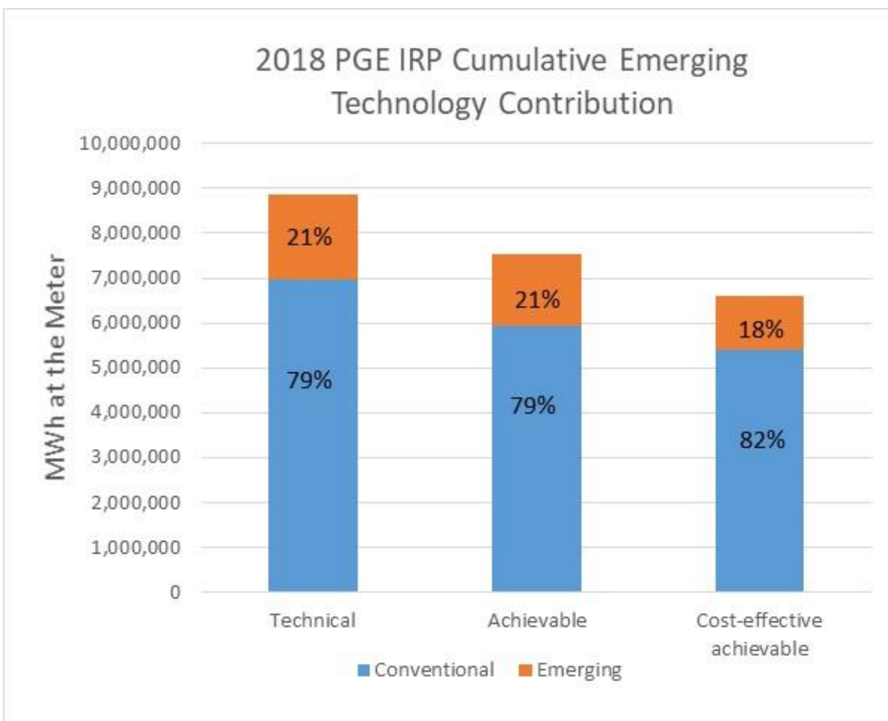

Figure 3: 2018 PGE IRP Cumulative Emerging Technology Contribution

There are several assumptions embedded in the Resource Assessment model as well:

- Program forecasts for years 1-5 are aligned with program measure assumptions and uptake and saturation adjustments, and are based on prior program activity.
- Cost-effective potential may come from programs or codes and standards efforts.
- Federal and state equipment standards, appliance standards, code changes and the forecasted impact of regional market transformation efforts are factored in. (E.g. assumptions about transforming retail lighting markets via regional efforts and Federal lighting manufacturing efficiency standards.)
- The model assumes utilization of energy use intensities per square foot in the commercial sector from regional surveys (NEEA's Commercial Building Stock Assessments). This data is used to translate utility load forecasts to estimates of building square footage, which is the typical units for efficiency resource modeling in the commercial sector.
- The model factors in deployment rates that are calibrated to Northwest Power and Conservation Council's 20-year total deployments from its 7th Power Plan.
    - The model assumes 100 percent acquisition of cost-effective retrofit potential at the end of 20-year periods in service territories where Energy Trust has had a sustained active presence, unless the representative measures are being offered via a cost-effectiveness exception from the OPUC and are notoriously hard to reach (e.g. insulation).
    - In service territories where Energy Trust has had a sustained active presence, the model assumes that by the end of 20-year period, acquisition rates for replacement on burnout and new construction measures will approach 100 percent acquisition, regardless of whether the savings come through programs or codes and standards.

Model Outputs and Final Savings Projections

Energy Trust's Resource Assessment model combines the inputs and assumptions described above to assess savings opportunities at the measure level. The model then scales these measure level savings to a utility's service territory. Using the utility and global inputs, savings outputs falls into several categories (described below and illustrated in Figure 4). Different utilities require different modeling outputs from Energy Trust based on the way that their own modeling uses Energy Trust inputs.

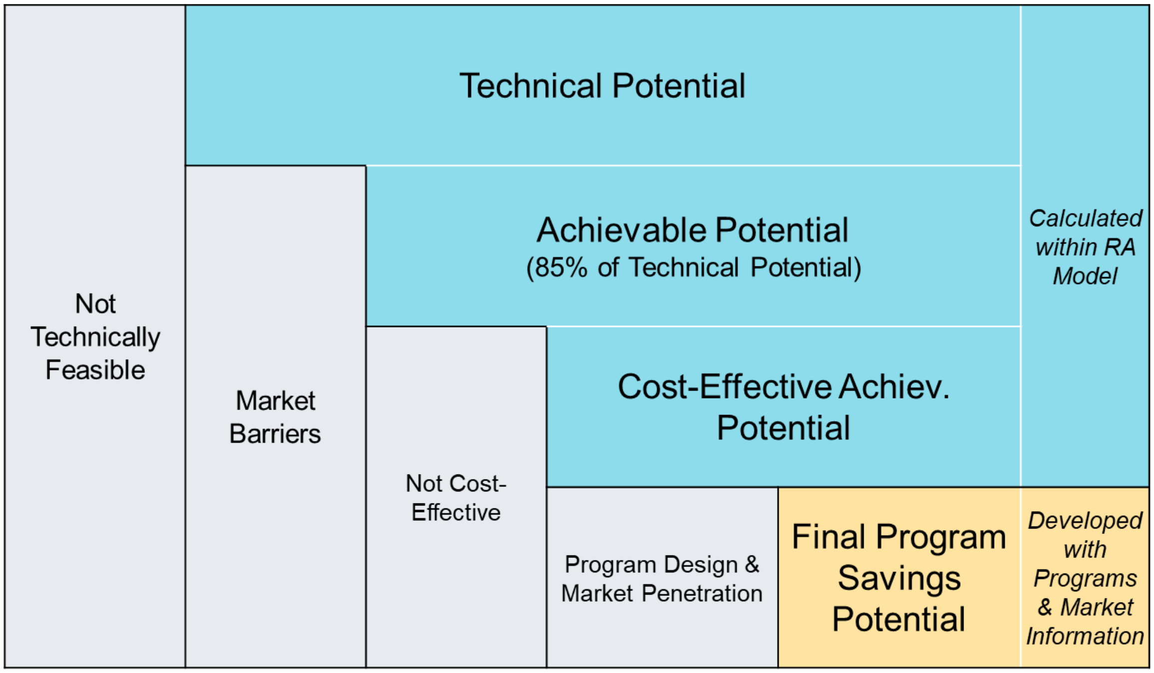

Figure 4: Types of Energy Savings Potential to Come out of Resource Assessment Modeling Process

1. There are some measures that are **Not Technically Feasible** because the measure is not a natural fit in some locations (e.g. a gas boiler in a commercial building in an area that is not served by gas).
2. **Technical Potential is total potential where measures can technically be installed,** regardless of market barriers or cost (e.g. a gas boiler in a commercial building in an area that is served by gas).
3. **Achievable Potential** is the portion of savings that Energy Trust can acquire if the customer can be successfully reached and influenced. Energy Trust assumes that a certain portion of customers will never install energy efficiency measures regardless of how Energy Trust attempts to reach these customers. To quantify Achievable Potential, multiply Technical Potential by 85 percent under the assumption that 15 percent of potential customers will never move to install energy efficiency measures due to **Market Barriers,** a commonly applied assumption in the Pacific Northwest.[5]
4. **Cost-Effective Achievable Potential** is the portion of Achievable Potential that has passed a cost-effectiveness screen using the Total Resource Cost (TRC) test. The TRC test compares the cost of an efficiency measure to the financial benefits of a measure, including the avoided costs that are specific to the utility conducting the IRP and quantifiable non-

energy benefits. Some special situations occur when calculating cost-effective achievable potential:

- ***Competition Groups***: There are some measures that could each individually be installed in the same singular location, but in practice, installation is mutually exclusive, and either one or the other can be installed in that singular location. The Resource Assessment model addresses this by screening these measures against each other in "competition groups" and the most cost-effective measure is selected to be installed first. If other measures within the competition group still pass the TRC test and the less cost-effective measures have incremental savings, then these savings are incrementally added to the 20-year forecast, as illustrated in Figure 5.

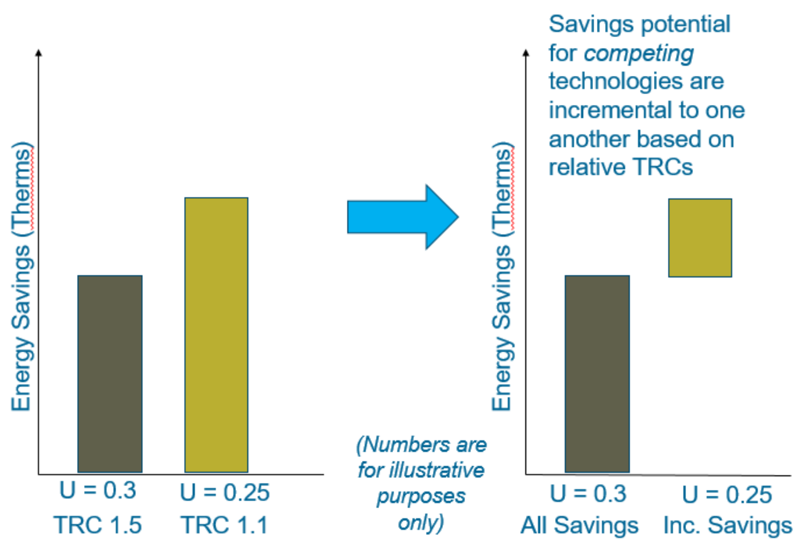

Figure 5: Incremental Savings Approach within Competition Groups

- ***C/E Overrides***: In some cases, measures are not cost-effective in an individual utility's IRP, but the measures are still offered by Energy Trust programs. This can occur because the measures are: a) cost-effective if screened using blended all-utility avoided costs[6] or b) the measures have a cost-effectiveness exception from the OPUC. In these instances the measures are forced into cost effective potential using a cost-effectiveness override within the model.

5. Deployed savings or the **Program Savings Projection** consists of cost-effective savings that have been "deployed" using market penetration curves (also referred to as ramp rates)

that reflect Energy Trust's best assumptions about what is achievable over time. For illustrative purposes, Figure 6 is the final savings deployment Energy Trust provided to PGE for its 2018 IRP and Figure 7 is the final savings deployment Energy Trust provided to NW Natural for its 2018 IRP.

Projecting the rate of savings acquisition in a deployment is more of an art than a science. Energy Trust currently uses different methods for near-term and long-term forecasting, resulting in a forecast that combines insights from the Planning group, Programs and model outputs. Planning staff works with programs to generate a five-year forecast and juxtaposes this forecast with the 20-year cost-effective achievable potential from the model to generate the final deployed forecast. The final deployed 20-year forecast consists of results assembled for the following respective time periods:

- The first two-years are based on the most recent budget exercise with some adjustments. The process to develop the most recent two-year budget is the most comprehensive and detailed assessment of what savings can be acquired by individual programs through their go-to-market mechanisms and offerings.
- Years 3-5 are based on projections of what programs expect based on market and program trends. These 3-5 year forecasts are compared to the overall cost-effective achievable potential that results from the forecast model and are sometimes adjusted if they don't otherwise seem to fit logically into the larger 20-year pattern that emerges in the deployment.
- Longer-term forecasts are projected using curves that start at the end of the five-year projection and lead to acquiring the largest feasible share of the resource at the end of 20 years. Adjustment are made to reflect quirks in the model or data which appear to be producing implausible results.

To meet utility IRP schedules, this forecasting work often happens out of synch with Energy Trust's annual budget cycle. The forecast for the first five years reflects our best attempt to anticipate what can be achieved without having the depth of review of the early years that emerges from the budget process.

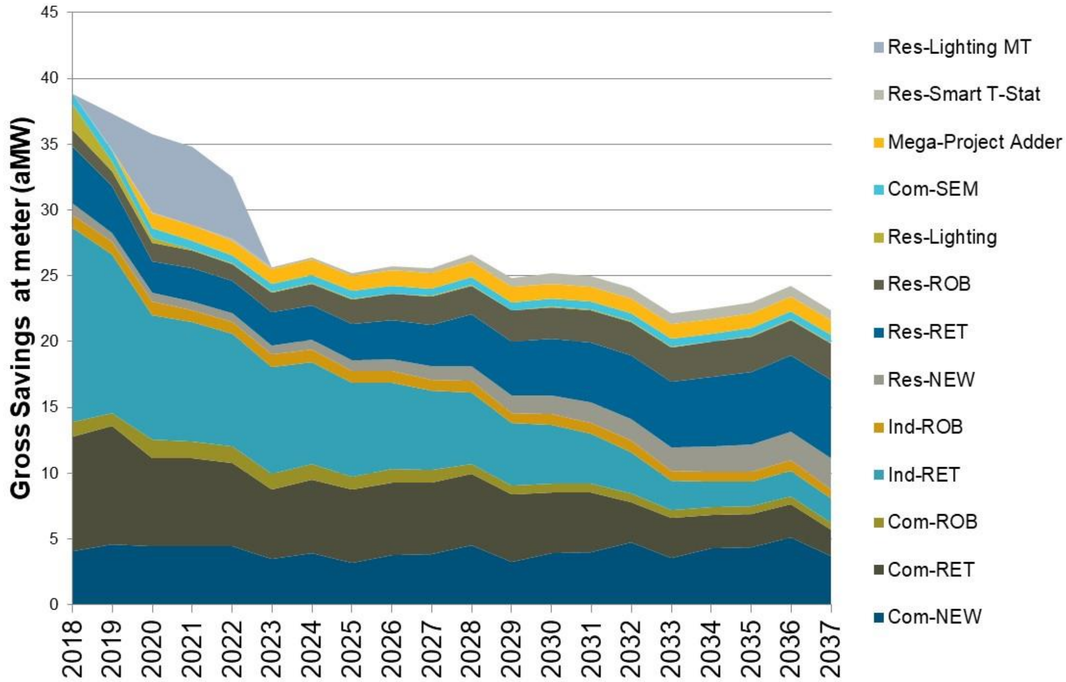

Figure 6: Final Deployment Curves for PGE's 2018 IRP by Sector and Type

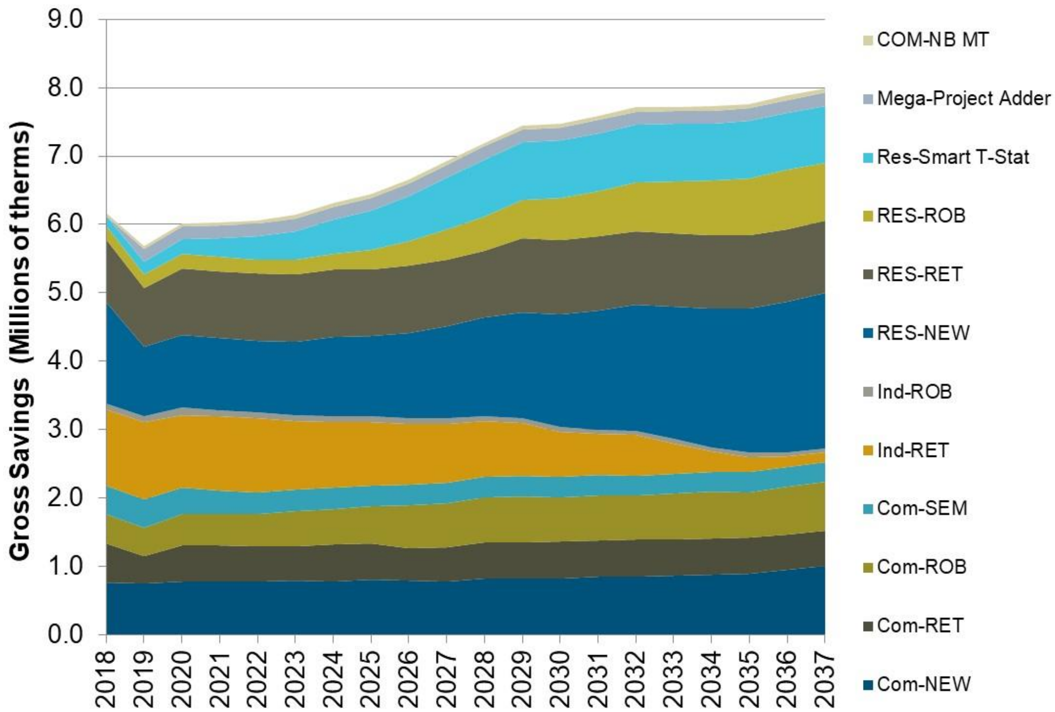

Figure 7: Final Deployment Curves for NW Natural's 2018 IRP by Sector and Type (Oregon)

A Process of Continuous Improvement

The Resource Assessment modeling process is always a work in progress. The model itself is a living instrument that is subject to constant iterative improvements to all measure level and utility level inputs and assumptions, such as savings, costs, and market data. It is a significant effort for Energy Trust staff to keep the model's measure assumptions current. This is an iterative and expanding process as the number of measures that Energy Trust offers continues to grow and as more emerging technologies come onto the market.

Energy Trust hosted a stakeholder meeting in September 2017 to solicit feedback on the Forecast Process and improvements to the model. Themes that emerged from this workshop included:

- Energy Trust achievements have been regularly exceeding IRP targets.
- Utilities and stakeholders are interested in receiving a forecast based on more than just "firm" resources.
- Utilities are interested in the best projection that can be provided. Achievements should fluctuate on both sides of the forecast over time.
- Short-term forecasts are most important to utilities and the OPUC in the following order:
    - 1-2 years
    - 3-5 years
    - 6-10 years
    - 11-20 years
- Advocates are still interested in long-term forecasts in context with the rest of the IRP process.
- A bottom-up approach (building up from measures to a portfolio) is the correct approach.
- The prior forecast has been missing some estimation of the resources that can't readily be seen.
    - New large single loads that utilities and Energy Trust have difficulty forecasting.
    - Emerging technology of the future that has not yet been developed to the point where it can be included in the model.
- Advocates request a standardized approach across utilities.
- Savings with high capacity benefits are of great value to utilities.
- There are complications that arise because utility IRP schedules do not align with Energy Trust's budgeting process.

As a result of prior experience and this feedback Energy Trust is making efforts to improve its IRP forecasts. Recent incremental improvements to the forecast include:

- 2015: Migration to the Analytica platform
- 2015: Inclusion of emerging technology with risk factors
- Ongoing: Iterative updates to measures, baselines and emerging technology
- 2017: Inclusion of additional behavioral savings and near net-zero homes and buildings
- 2017: Focused forecasting improvements in three time period segments:
  - 1-2 years (short-term)
    - Made modifications to savings from most recent budget, programs know best
  - 3-5 years (mid-term)
    - Programs and Planning worked together to extend program trends from years 1-2
  - 6-20 years (long-term)
    - Planning forecasted long-term acquisition rate
- 2017: Addition of forecast “megaproject adder” to account for large unidentified projects. These have previously not been forecast as loads or opportunities and have resulted in significant forecasting error. The addition is based on past large project savings averages.
- 2017: Adoption of deployment rates that calibrate to Northwest Power and Conservation Council’s 20-year total deployments from its 7th Power Plan as follows:
  - Assumes 100 percent acquisition of cost-effective retrofit potential at the end of the 20-year period in service territories where Energy Trust has had a sustained active presence.
  - In service territories where Energy Trust had had a sustained active presence, assumes that by the end of the 20-year period acquisition rates for replacement on burnout and new construction measures will approach 100 percent acquisition regardless of whether the savings come through programs or codes and standards.

These improvements and other factors have resulted in Energy Trust increasing the total resource projections in forecasts that have been recently submitted to utilities for their IRPs. Figure 8 illustrates the increase from the 2016 to 2018 cost-effective deployment for PGE.

Likewise, Figure 9 illustrates the increase from the 2016 to 2018 cost-effective deployment for NW Natural. Key drivers for these increases include the improvements described above, as well as increases in avoided costs, especially in NW Natural avoided costs, which resulted in more measures passing the cost-effectiveness test in the model.

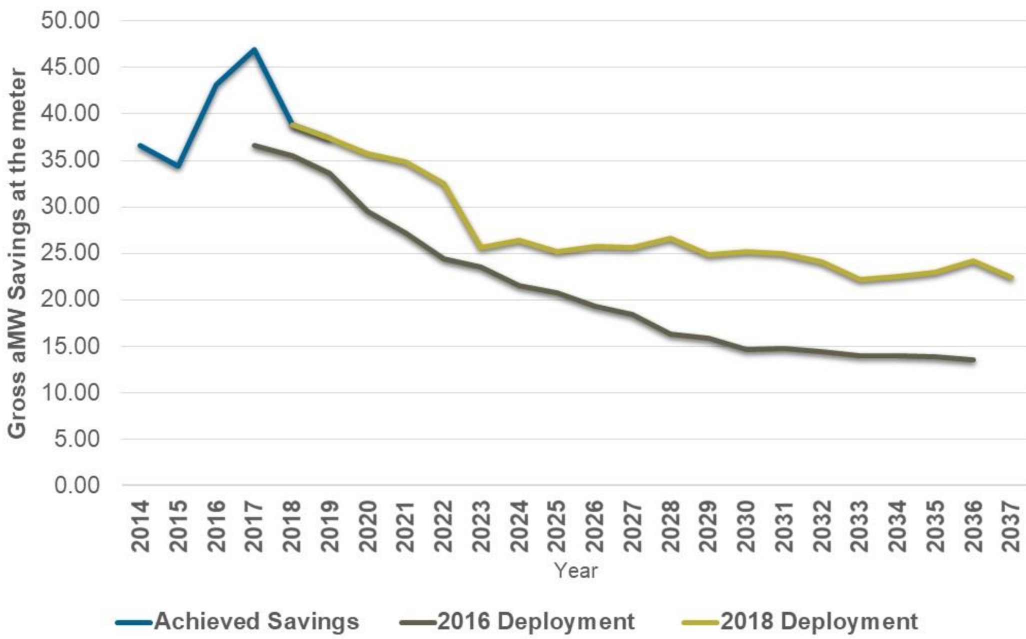

Figure 8: 2016 vs 2018 PGE Cost-effective Gross Savings at The Meter – Projections and Actuals

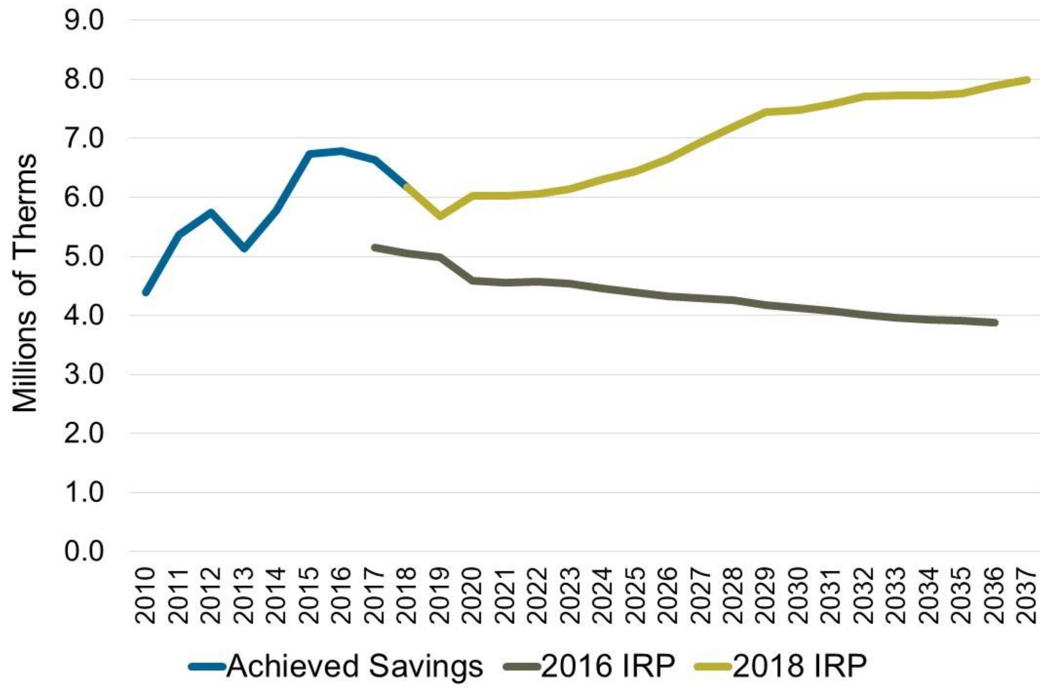

Figure 9: 2016 vs 2018 NW Natural Cost-effective Gross Savings at The Meter – Projections and Actuals (Oregon)

Even with these forecasting improvements, there are remaining challenges that contribute to forecast uncertainty. Forecasts are forecasts, not predictions. Despite best attempts to make forecasts accurate, actual results are subject to a multitude of unpredictable factors. Energy Trust will continue to strive to enhance the accuracy of forecasts by looking for creative approaches to overcome these unpredictable challenges:

- Difficult-to-predict economic conditions and weather.
- Uncertain utility load, population growth and building forecasts.
- Difficult-to-predict pace of market uptake for some measures.
- Unforeseeable emerging technologies and solutions.
- Industrial facilities which tend to have highly customized energy efficiency projects which are difficult to generalize in our Resource Assessment model.

Key Takeaways

Energy Trust puts together 20-year efficiency savings and cost forecasts for utilities that are designed to assess the energy efficiency resource based on quantifying savings potential that will result from a wide variety of energy efficiency measures installed in suitable end-use locations. These forecasts are used for utility Integrated Resource Plans and Energy Trust planning. Energy Trust recognizes that forecasts are uncertain by nature. Regardless, Energy Trust strives to make continuous improvements to forecasts to make them as useful as possible.

These forecasts provide a view of the energy efficiency resource available in the short, medium and long-term. This view, while uncertain, is useful for directional thinking about Energy Trust strategy and the forecast should be referenced in the 2020-2024 Strategic Planning Process.

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[1] https://www.pacificorp.com/es/irp.html

[2] Renewable energy is considered in electric IRP's. However, Energy Trust's work in this area is considered as part of a larger portfolio of available renewable resources and is generally not singled out. In general, renewable generation potential is much larger than the financial resources available to Energy Trust, and the major determinants of market deployment include government tax and incentive policy, policy regarding other benefits of projects such as water conservation, grid management developments, innovation in program delivery, and rapid changes in technology and product cost. This creates a very different environment for forecasting.

[3] http://www.lumina.com/why-analytica/what-is-analytica1/

[4] Measure densities are defined as the number of units per the scaling basis of the sector. A scaling basis is how the measures are scaled from the measure level to a utilities service territory – it is the link between measure data and utility data. For example, in the residential sector, the scaling basis is almost always 'number of homes' so that measure level data can be scaled up based on the number of homes that a utility serves. However, most measure savings are given 'per unit' such as per light bulb and in order to properly scale the savings, the average number of light bulbs per home is a necessary measure level data point for the model. This average number of measure units per the scaling basis (homes in this case) is the 'density' of a measure. For example: Measure is an LED bulb, there are an average of 35 screw-in lighting sockets per Single Family home (the density), and a utility serves 500,000 Single family customers resulting in 17.5 million total screw in lighting sockets in that utility's service territory.

[5] https://emp.lbl.gov/sites/default/files/lbnl-3960e-hrcp.pdf Back in the 80's, a $20 million program was run by Bonneville Power Administration and Pacific Power and Light in Hood River, Oregon to test the limits of energy efficiency potential. Results of the program demonstrated that 85 percent of all eligible participants would install energy efficiency measures when installation of the measures was offered free of charge. The converse result is that 15 percent of potential participants withheld from the program; and this has resulted in the widely accepted assumption that it is not possible to influence 15 percent of the market regardless of how enticing you make the deal. Since then the Northwest Power and Conservation Council has conducted a follow-up study to vet the 15 percent number and came up with a similar result. Admittedly, the 15 percent number is imprecise, but the Hood River experiment has never been repeated and seeing that it is the best estimate available, the number is widely used around the region to convert Technical Potential to Achievable Potential.

[6] Energy Trust offers the same measures throughout Oregon because this is a more effective and efficient approach to delivery than offering slightly different portfolios of measures for each utility. This is particularly important to ensure effective engagement of contractors, distributors and retailers who work across multiple utility service territories.