Agenda

• Purpose and background
• Modeling Process
• Considerations for improvements
About

• Independent nonprofit
• Serving 1.6 million customers of Portland General Electric, Pacific Power, NW Natural, Cascade Natural Gas and Avista
• Providing access to affordable energy
• Generating homegrown, renewable power
• Building a stronger Oregon and SW Washington
Purpose and Background
Resource Assessment Overview

What is a resource assessment?

- Estimate of cost-effective energy efficiency resource potential that is achievable over a 20-year period

Energy Trust uses a model in Analytica that was developed by Navigant in 2015
Background – How is RA used?

• Informs utility IRP work & strategic planning / program planning
• Does not dictate what annual savings are acquired by programs
• Does not set incentive levels
Modeling Process
Inputs

• Utility service territory data
  • Customer counts, 20-year load forecasts
  • Avoided costs, line losses, discount rate

• Building characteristics
  • Heating and hot water fuel, measure saturations

• Measure assumptions
  • Savings, costs, O&M, NEB's, measure life, load profile, end use, baseline, technical suitability, achievability rates
## Outputs

<table>
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<tr>
<th>Not technically feasible</th>
<th>Technical Potential</th>
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<tr>
<td>Not technically feasible</td>
<td>Market barriers</td>
</tr>
<tr>
<td>Not technically feasible</td>
<td>Not cost-effective</td>
</tr>
<tr>
<td>Not technically feasible</td>
<td>Program design, market penetration</td>
</tr>
<tr>
<td>Not technically feasible</td>
<td>Program Savings Projection</td>
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</table>
Cost-Effectiveness Testing

Total Resource Cost (TRC) test BCR

- TRC benefit cost ratio (BCR) = NPV of Benefits / Total Resource Cost

Benefits

- Savings x Avoided Costs
- Quantifiable non-energy benefits

Total Resource Measure Costs

- Full cost of EE measure or incremental cost of installing efficient measure over baseline measure
Cost-Effectiveness Override in Model

Energy Trust applied this feature to measures found to be NOT Cost-Effective in the model but are offered through programs.

Reasons:
1. Blended avoided costs may produce different results than utility specific avoided costs
2. Measures expected to be cost-effective in the future are sometimes offered under an OPUC exception
Model Assumptions

• Uses incremental measure savings approach for potential instead of market shares
• Includes known emerging technologies
• Factors in known codes & standards
• Uses CBSA EUI data to translate utility load forecasts to stock forecasts
• Utilizes 3rd party research and survey work to inform measure saturation and density (e.g. RBSA)
Incremental Measure Savings Approach (competition groups)

Energy Savings (therms)

(U = 0.3)  
Cost: $3

(U = 0.25)  
Cost: $5

Energy Savings (therms)

(U = 0.3)  
Cost: $3

(U = 0.25)  
Cost: $2

Savings potential for technologies are incremental to one another

(Numbers are for illustrative purposes only)
Emerging Technologies

• Includes some emerging technologies
• Factors in changing performance and cost over time
• Uses risk factors to hedge against uncertainty
<table>
<thead>
<tr>
<th>Risk Category</th>
<th>10%</th>
<th>30%</th>
<th>50%</th>
<th>70%</th>
<th>90%</th>
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<td>Market Risk (25% weighting)</td>
<td><strong>High Risk:</strong></td>
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<td><strong>Low Risk:</strong></td>
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<tr>
<td></td>
<td>• Requires new/changed business model</td>
<td></td>
<td></td>
<td></td>
<td>• Trained contractors</td>
</tr>
<tr>
<td></td>
<td>• Start-up, or small manufacturer</td>
<td></td>
<td></td>
<td></td>
<td>• Established business models</td>
</tr>
<tr>
<td></td>
<td>• Significant changes to infrastructure</td>
<td></td>
<td></td>
<td></td>
<td>• Already in U.S. Market</td>
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<tr>
<td></td>
<td>• Requires training of contractors. Consumer acceptance barriers exist.</td>
<td></td>
<td></td>
<td></td>
<td>• Manufacturer committed to commercialization</td>
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<tr>
<td>Technical Risk (25% weighting)</td>
<td><strong>High Risk:</strong></td>
<td>Low volume manufacturer. Limited experience</td>
<td>New product with broad commercial appeal</td>
<td>Proven technology in different application or different region</td>
<td><strong>Low Risk:</strong></td>
</tr>
<tr>
<td></td>
<td>Prototype in first field tests. A single or unknown approach</td>
<td></td>
<td></td>
<td></td>
<td>Proven technology in target application. Multiple potentially viable approaches.</td>
</tr>
<tr>
<td>Data Source Risk (50% weighting)</td>
<td><strong>High Risk:</strong></td>
<td>Manufacturer case studies</td>
<td>Engineering assessment or lab test</td>
<td>Third party case study (real world installation)</td>
<td><strong>Low Risk:</strong></td>
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<tr>
<td></td>
<td>Based only on manufacturer claims</td>
<td></td>
<td></td>
<td></td>
<td>Evaluation results or multiple third party case studies</td>
</tr>
</tbody>
</table>
Define Emerging Tech. Measures Incrementally in Their Competition Groups

Energy Savings (therms)

U = 0.3
U = 0.25
U < 0.2

(Numbers are for illustrative purposes only)
## Current Emerging Technologies

### Residential
- AFUE 98/96 Furnace
- ER SH to Heat Pump
- Heat Pump (HP Upgrade)
- Window Replacement (U<.20)
- Absorption Gas Heat Pump Water Heater
- Advanced CO2 Heat Pump Water Heater
- Smart Devices Home Automation
- Advanced Heat Pump
- HP Dryer

### Commercial
- AC Heat Recovery, HW
- Advanced Package A/C RTU
- Advanced Refrigeration Controls
- Advanced Ventilation Controls
- Energy Recovery Ventilator
- Gas-fired HP HW
- Gas Fired HP, heating
- High Bay LED
- Highly Insulated Windows
- Smart/Dynamic Windows
- Supermarket Max Tech Refrigeration
- VIP, R-35 wall (vacuum insulated panel)
- Com - Hybrid IDEC- (indirect-direct evap. Cooler)

### Industrial
- Advanced Refrigeration Controls
- Advanced LED Lighting Retrofits
- Gas-fired HP Water Heater
- Switched reluctance motors
- Wall Insulation- VIP, R0-R35
## Emerging Tech. Under Development

<table>
<thead>
<tr>
<th>Residential</th>
<th>Commercial</th>
<th>Industrial</th>
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<tr>
<td>- AFUE 98/96 Furnace</td>
<td>- Rooftop HVAC/ DOAS</td>
<td>- Engineered Compressed Air Nozzles</td>
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<td>- CO2 HPWH update</td>
<td>- High Efficiency Circulation Pumps</td>
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<td>- Deep Behavior Savings</td>
<td>- Path to Net Zero Buildings</td>
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<tr>
<td>- Net Zero Homes</td>
<td>- Smart/Dynamic windows update</td>
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<tr>
<td>- Window Attachments</td>
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<td>- HP Dryer update</td>
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<td>- Window Attachments</td>
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<tr>
<td>- HP Dryer update</td>
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<td></td>
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</tbody>
</table>
Contribution of Emerging Technologies

Cumulative Potential (MWh)

- Technical
  - Conventional
  - Emerging

- Achievable
  - Conventional
  - Emerging

- Cost-effective
  - Conventional
  - Emerging
Example Measure: Residential Heat Pump Water Heater - Tier 1, Heating Zone 1

Key Measure Inputs:

- Baseline: 0.9 EF Water Heater ($590)
- Measure Cost: $1,230-$1,835 ($600 RETC)
- Competing Measures: Tier 2 HPWH, CO$_2$ HPWH
- Lifetime: 12 years
- Conventional (not emerging, no risk adjustment)
- Customer Segments: SF, MF, MH
- Program Type: Replacement on Burnout
- Savings: 1,516-1,530 kWh
- Density, saturation, suitability
- No Non-Energy Benefits or O&M savings
Example Measure: Residential Heat Pump Water Heater- Tier 1, Heating Zone 1

<table>
<thead>
<tr>
<th>Measure</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Res Bathroom Faucet Aerators, 1.0 gpm - Gas</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Res Bathroom Faucet Aerators, 1.5 gpm - Electric</td>
<td>0</td>
<td>0</td>
<td>24.71K</td>
<td>24.53K</td>
<td>24.34K</td>
<td>24.16K</td>
<td>23.98K</td>
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<td>Res Kitchen Faucet Aerators, 1.5 gpm - Gas</td>
<td>0</td>
<td>24.71K</td>
<td>24.53K</td>
<td>24.34K</td>
<td>24.16K</td>
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<tr>
<td>Res Kitchen Faucet Aerators, 2.0 gpm - Electric</td>
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<td>24.71K</td>
<td>24.53K</td>
<td>24.34K</td>
<td>24.16K</td>
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<td>Res Showerheads - Elec DHW</td>
<td>85.68K</td>
<td>85.04K</td>
<td>84.4K</td>
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<td>Res Showerheads - Gas DHW</td>
<td>2545</td>
<td>2526</td>
<td>2507</td>
<td>2489</td>
<td>2470</td>
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<td>Res Smart Devices Home Automation (NEW)</td>
<td>727.4</td>
<td>1441</td>
<td>2148</td>
<td>2841</td>
<td>3464</td>
<td>4096</td>
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<td>Res Smart Devices Home Automation (RET)</td>
<td>46.11K</td>
<td>44.72K</td>
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<td>40.66K</td>
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<tr>
<td>Totals</td>
<td>2.575M</td>
<td>2.636M</td>
<td>2.687M</td>
<td>2.752M</td>
<td>2.822M</td>
<td>2.869M</td>
<td>2.975</td>
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</table>
Example Measure - Tier 1 HPWH

CE Achievable Potential x Deployment Curves = Deployed DSM Savings

<table>
<thead>
<tr>
<th>Cost Effective Achievable Potential from RA model (MWh)</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
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<tbody>
<tr>
<td>Tier 1 HPWH Z1- Manuf.</td>
<td>782</td>
<td>1,500</td>
<td>2,157</td>
<td>2,760</td>
<td>3,312</td>
<td>3,818</td>
<td>4,282</td>
<td>4,708</td>
<td>5,098</td>
<td>5,455</td>
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<tr>
<td>Tier 1 HPWH Z1- Multifamily</td>
<td>3,060</td>
<td>5,865</td>
<td>8,436</td>
<td>10,792</td>
<td>12,953</td>
<td>14,933</td>
<td>16,749</td>
<td>18,413</td>
<td>19,938</td>
<td>21,336</td>
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<tr>
<td>Tier 1 HPWH Z1- Single Family</td>
<td>4,184</td>
<td>8,019</td>
<td>11,535</td>
<td>14,758</td>
<td>17,712</td>
<td>20,420</td>
<td>22,903</td>
<td>25,178</td>
<td>27,264</td>
<td>29,176</td>
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<td><strong>Total</strong></td>
<td><strong>8,026</strong></td>
<td><strong>15,384</strong></td>
<td><strong>22,128</strong></td>
<td><strong>28,310</strong></td>
<td><strong>33,977</strong></td>
<td><strong>39,172</strong></td>
<td><strong>43,934</strong></td>
<td><strong>48,299</strong></td>
<td><strong>52,300</strong></td>
<td><strong>55,968</strong></td>
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<td>Com-NEW</td>
<td>145%</td>
<td>130%</td>
<td>130%</td>
<td>95%</td>
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<td>85%</td>
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<td>85%</td>
<td>70%</td>
<td>90%</td>
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<tr>
<td>Com-RET</td>
<td>10%</td>
<td>9%</td>
<td>9%</td>
<td>8%</td>
<td>7%</td>
<td>6%</td>
<td>6%</td>
<td>5%</td>
<td>5%</td>
<td>4%</td>
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<td>Com-ROB</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
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<td>90%</td>
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<tr>
<td>Ind-RET</td>
<td>9%</td>
<td>9%</td>
<td>10%</td>
<td>9%</td>
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<td>7%</td>
<td>7%</td>
<td>6%</td>
<td>6%</td>
<td>5%</td>
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<tr>
<td>Ind-ROB</td>
<td>85%</td>
<td>85%</td>
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<td>85%</td>
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<td>RES-NEW</td>
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<td>80%</td>
<td>80%</td>
<td>80%</td>
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<tr>
<td>RES-RET</td>
<td>11%</td>
<td>11%</td>
<td>10%</td>
<td>7%</td>
<td>6%</td>
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<td>4%</td>
<td>4%</td>
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<tr>
<td><strong>RES-ROB</strong></td>
<td><strong>90%</strong></td>
<td><strong>90%</strong></td>
<td><strong>90%</strong></td>
<td><strong>90%</strong></td>
<td><strong>90%</strong></td>
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<td><strong>90%</strong></td>
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<tr>
<td>RES-CFL</td>
<td>4%</td>
<td>4%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
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<td>5%</td>
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<table>
<thead>
<tr>
<th>Deployed Savings (MWh)</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
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<tbody>
<tr>
<td>Tier 1 HPWH Z1- Manuf.</td>
<td>704</td>
<td>1,350</td>
<td>1,941</td>
<td>2,484</td>
<td>2,981</td>
<td>3,436</td>
<td>3,854</td>
<td>4,237</td>
<td>4,588</td>
<td>4,910</td>
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<td>Tier 1 HPWH Z1- Multifamily</td>
<td>2,754</td>
<td>5,278</td>
<td>7,592</td>
<td>9,713</td>
<td>11,658</td>
<td>13,440</td>
<td>15,074</td>
<td>16,571</td>
<td>17,944</td>
<td>19,203</td>
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<tr>
<td>Tier 1 HPWH Z1- Single Family</td>
<td>3,766</td>
<td>7,217</td>
<td>10,382</td>
<td>13,282</td>
<td>15,941</td>
<td>18,378</td>
<td>20,612</td>
<td>22,660</td>
<td>24,538</td>
<td>26,258</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>7,224</strong></td>
<td><strong>13,845</strong></td>
<td><strong>19,915</strong></td>
<td><strong>25,479</strong></td>
<td><strong>30,579</strong></td>
<td><strong>35,255</strong></td>
<td><strong>39,540</strong></td>
<td><strong>43,469</strong></td>
<td><strong>47,070</strong></td>
<td><strong>50,371</strong></td>
</tr>
</tbody>
</table>
PGE Supply Curve – 20 year potential

Approximate cost-effectiveness limit: $0.053/kWh
NWN Supply Curve – 20 Year Achievable Potential

Achievable Potential (therms)

Levelized Cost ($/therm)

2014 IRP cost threshold

2016 IRP cost threshold
Comparison to 7th Power Plan

Figure 3. Comparison of Energy Trust and 7th Plan Economic Potential as a Percentage of Forecast Load

- Residential: Energy Trust 16% (2017 - 2036), 7th Plan 22% (2016 - 2035)
- Commercial: Energy Trust 13% (2017 - 2036), 7th Plan 21% (2016 - 2035)
- Industrial and Agricultural: Energy Trust 16% (2017 - 2036), 7th Plan 12% (2016 - 2035)
- Total: Energy Trust 15% (2017 - 2036), 7th Plan 19% (2016 - 2035)
Energy Trust Compared to 7th Power Plan

Energy Trust has

• Higher measure saturations than the region as a whole
• Lower electric space & water heat saturation
• Fewer savings from codes and standards
• More savings in the near term, fewer in out years
Considerations for Adjustments to Energy Trust forecasting
Summary of Issues

• History of performance exceeding IRP targets
• The available resource is expected to decline over time
• Energy Trust needs to refine forecasts
• Energy Trust is seeking feedback on potential refinements
History of Achievements Exceeding IRP Targets
Think About Forecast in Three Time Periods

• 1-2 years (short term)
  • Programs know best
• 3-5 years (mid term)
  • Programs and planning work together
• 6-20 years (long term)
  • Planning forecasts long-term acquisition rate
Drivers of Short Term Forecast Uncertainty

- Large new facilities
- Difficult-to-predict factors
  - Economic conditions
  - Weather
- Uncertain utility load, population growth and building forecasts
- Difficult-to-predict pace of market uptake
- Timing for modeling IRP targets and annual goal setting do not align
Drivers of Mid/long Term Forecast Uncertainty

- Several of those in previous slide
- Practice of producing single line forecasts without error bands
- Unforeseeable new technologies and solutions
Future Savings Potential

- Significant cost-effective potential remains, however;
  - Codes and standards are improving
  - Deep penetration in some markets
    - Residential lighting
    - Water flow restriction devices
  - Indicators of past success
    - Energy Trust exited fridge retirement and other appliance markets
    - More small commercial and industrial projects
  - New construction is unpredictable
Incremental Improvements to Forecasting

- Create more nimble modeling structure (2015)
- Create risk factors for emerging technology (2015)
- Iterative updates to measures, baselines and emerging technology (2016, 2017, ongoing)
- Include additional behavioral savings and near net-zero homes and buildings (2017)
History of Purpose and Pace of Forecast

• Energy Trust has historically developed a single, “firm” estimate of conservation supply
• Energy Trust has been achieving results that exceed the forecast of “firm” resource
• Conservative view as a large % of what was acquired over 5 years was from “non-firm” or unknown resources 5 years previously
Alternative Forecasting Approaches

- Energy Trust acquire known resource more rapidly
- Energy Trust adopt other methods to forecast based on techniques such as:
  - Simplified statistical trending
  - Physical limits approach
- Assume every commercially available technology would eventually be implemented by everyone
Potential Adjustments to Consider - 1

- Should we add 5% to entire resource potential to address unpredicted loads?
- Should we include an incremental resource adder to account for unknown future technologies?
- Should forecasts be based on a range of potential?
- What other emerging tech should we include in the forecast?
Potential Adjustments to Consider - 2

- Should we forecast a more aggressive deployment rate?
- Should we plan a project to pursue a more speculative estimation of supply?
- Is there a role for trending beyond acknowledging trends exist?
- Does it make sense to forecast to acquire all potential in 5 or 10 years?
Thank You

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