MEMORANDUM

TO: Power Committee Members

FROM: Kevin Smit

SUBJECT: Develop Energy Efficiency Supply Curves for 2021 Power Plan

BACKGROUND:

Presenter: Kevin Smit

Summary: In preparation for the 2021 Power Plan, staff will be providing the Power Committee a series of presentations on different aspects to developing the Plan. This presentation will be on the development of energy efficiency (EE) supply curves.

Relevance: Energy efficiency is one of the options considered by the Regional Portfolio Model when determining a low-cost resource mix for the plan horizon. To analyze EE in the Regional Portfolio Model, staff develops a supply curve that provides bundles of the amount of EE available at different price points, with information on seasonal attributes.

Workplan: A.1.1 Prepare EE supply curves for the 2021 Plan

More Info: In 2014, staff provided an overview of EE methodology in the plan for the Seventh Plan:
hits://nwcouncil.box.com/s/nyuapot8l4yd5oen5ep2c0vioyt2a5v2

In 2017, staff provided a review of the definition of EE:
hits://nwcouncil.box.com/s/dsd5y7y7vfzeacif9yl9e1i0qj56h8d2

In 2018, staff summarized the approach to EE Cost-Effectiveness:
hits://nwcouncil.box.com/s/ox4vqgmkggec4bfl7oic58kksqhzgm20
Energy Efficiency Supply Curve Development Methodology

Kevin Smit

June 2019 Power Committee Meeting
What is Energy Efficiency?
Definition of Conservation Under the Power Act

“Conservation” means any reduction in electric power consumption as a result of increases in the efficiency of energy use, production, or distribution.

1. Does the opportunity reduce electric power consumption?
2. Is the reduction in electric power consumption the result of an increase in efficiency of energy use, production, or distribution?

Also, must be “...reliable and available within the time it is needed...”
Develop Methodology for Determining Quantifiable Environmental Costs and Benefits

Develop Energy Efficiency Supply Curves

Forecast Load with Frozen Efficiency

Establish Global, Financial and Economic Assumptions

Develop Methodology for Identifying Cost Effective EE Measures

Develop MCS and Surcharge Methodology

Analyze Resource Strategies

Estimate System Adequacy Requirements

THE 2021 NORTHWEST POWER PLAN
EE Supply Curves

• Conservation resources need to compete along with supply side resources on an “apples to apples” basis

• The energy efficiency supply curves include the electricity savings, levelized cost, and other attributes necessary to compare EE with other supply-side resources

• The supply curves are the result of a region-wide conservation potential assessment

• Eventually leads to EE goals/targets
Supply Curve Example
(Residential Sector Supply Curve from 7th Plan)

![Graph showing supply curve example for the residential sector supply curve from the 7th Plan, with technical achievable potential (aMW) on the y-axis and TRC net levelized cost (2012$/MWh) on the x-axis. The graph is color-coded to represent different cost categories such as Whole Bldg/Meter Level, Appliances, Water Heating, Lighting, HVAC, and Electronics.]
The Basic Formula for Savings

Achievable Savings Potential =
Number Units * kWh savings per Unit * Achievable Penetration

Examples:
- Number Homes
- Floor Area of Retail
- Number of Refrigerators
- Acres Irrigated
- Number transformers

(kWh/Unit at **Baseline** Efficiency – kWh/Unit at **Improved** Efficiency)

Fraction of available or remaining stock that is realistically achievable over time
Process Flow

1. Baseline
   • Identify measures that save electricity
   • Establish the measure’s “baseline” consumption (i.e., what the measure is compared against)

2. Cost & Savings Per Unit
   • Estimate incremental electricity & capacity savings per unit
   • Estimate incremental costs & benefits per unit
   • Estimate measure life

3. Technical Potential
   • Calculate cost per kWh saved
   • Calculate number of units available
   • Multiply unit savings and cost by the number of units

4. Technical Achievable Potential
   • Apply achievability limits
   • Ramp rates
1. Establish Baseline

Diagram:
- Costs & Benefits of Measures
- Baseline
- Cost & Savings per

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8
Identify EE Measures

• Example - Nearly 100 measures categories in Seventh Power Plan (*e.g.*, *Air Source Heat Pump*)
  - Buildings (insulation, windows, heat pumps, etc.)
  - Appliances (refrigerators, dishwashers, ovens, steamers, etc.)
  - Processes (energy management, pump optimization, etc.)
  - Utility distribution system (poles, wires, and transformers)
  - Across residential, commercial, industrial, agriculture, utility

• Over 1600 measure permutations (*e.g.*, *Energy Star Air Source Heat Pump, heating zone 1, new construction*)
  - By heating zone, vintage, heating system type
  - Factors that change incremental cost or savings
Baseline
Depends on Decision Timing

**New**
- New homes
- New buildings
- New equipment
- New additions

**Natural Replacement**
- Burn-out
- Remodel
- Market shifts

**Retrofit**
- Remove & Replace (windows)
- Add-on (insulate attic of older home)

**Decision when new item is built or purchased.**

Baseline is best of minimum code requirement, federal standard, or common practice

**Decision when burnout or obsolescence.**

Baseline is best of minimum code requirement, federal standard, or common practice

**Decision timing is discretionary.**

Baseline is as-found condition, unless subject to code or standard
Sync Baseline with Electricity Load Forecast

• Forecasts of electricity demand AND conservation potential must both use same baseline efficiency
  • Use the same units and growth forecasts
  • Same unit efficiency assumptions
• Frozen Efficiency Forecast
  • (See load forecast presentations)
  • Establish the base year and then “freeze” or fix the baseline
  • Product turnover results in some overall efficiency improvement
2. Develop Measure Data

Costs & Benefits of Measures

Cost & Savings per Unit
## Cost & Savings Per Unit

<table>
<thead>
<tr>
<th>Energy Savings (kWh)</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>kWh per unit at the site (annual)</td>
<td>Capital &amp; Financing</td>
</tr>
<tr>
<td>Line losses from source to site</td>
<td>Labor</td>
</tr>
<tr>
<td>Seasonal &amp; daily shape of savings</td>
<td>Program Administration</td>
</tr>
<tr>
<td>Measure interactions</td>
<td>Operations &amp; Maintenance</td>
</tr>
<tr>
<td>Measure “Take Back”</td>
<td>Reinstallation Cost</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacity Benefits (kW)</th>
<th>Non-Electric Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where coincident with peak:</td>
<td>Water use changes</td>
</tr>
<tr>
<td>Deferred distribution and transmission line expansion cost</td>
<td>Gas use changes</td>
</tr>
<tr>
<td>Quantified in $/kW-yr</td>
<td>Operations &amp; maintenance</td>
</tr>
<tr>
<td></td>
<td>Lamp replacements</td>
</tr>
<tr>
<td></td>
<td>Quantifiable Environmental Impacts</td>
</tr>
</tbody>
</table>

**Measure Life**
- Expected lifetime of the measure
Example: Air Source Heat Pump: Heating zone 1

Measure Savings Shapes

**Daily View**
- Shape1_Weekday
- Shape2_Weekday

**Monthly View**
- Shape1_Monthly
- Shape2_Monthly

% of Total Daily Consumption

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

% of Total Annual Consumption

0.0% 5.0% 10.0% 15.0% 20.0% 25.0%
3. Estimate Technical Potential
Estimate Number of Units

Examples of Units

- Number of replacement clothes washers per year (360,000)
- Number of new single family homes per year (60,000)
- Floor area of Mini Mart groceries (45,000,000)
- Sq.Ft. of attics with no insulation in older homes (540,000,000)

Data Sources:
- Stock assessments (RBSA, CBSA, IFSA)
- Council forecast models
- DOE Rule makings
- Product sales data

Annual Estimates
- Year-by-year for 20-year forecast period
- Existing stock minus demolition & conversion
- New stock added
- New appliances added
- Appliance & equipment turnover
Estimate Number of Units Where Measure is Applicable

**New**
- New homes
- New buildings
- New equipment
- New additions

**Natural Replacement**
- Burn-out
- Remodel
- Market shifts

**Retrofit**
- Remove & Replace
- Add-on

Number of units driven by population or economic growth
Number of units driven by equipment life, turnover rates, consumer preference & obsolescence
Number of units driven by remaining stock not adopting measure

Multiplying measure savings by number of units gives us the Technical Potential
4. Estimate Achievable Potential
Achievable Potential

- Less than 100% adoption generally assumed
  - Assumes not all customers will accept the efficient unit, even if offered at no cost to the consumer

- Achievability Assumes:
  - Utility system can pay all cost (if measure is cost-effective based on power system benefits)
  - Many efficiency requirements can be embedded in codes/standards
  - 20-year time frame

- *Achievable Potential* is Always Less Than *Technical Potential*

- Annual Achievability is limited by “Ramp Rates”
  - Not all energy efficiency can be acquired immediately
  - Identifies the pace of EE adoption over time
  - Developed through advisory committee input
Ramp Rates

Data Sources that inform Ramp Rates:
- Past program performance
- Cost of measure
- Consumer acceptance
- Non-energy impacts
- Physical availability of equipment
- Training & education requirements
Achievable Potential Supply Curve: Add Up Each Measure Cost and Savings

2500 aMW of potential is available at <$30/MWh

4000 aMW of potential is available at <$70/MWh
Annual Potential Including Ramp Rates

Annual Incremental Potential (7th Plan)

- Agriculture
- Commercial
- Industrial
- Residential
- Utility
Hand-off to RPM – Resource Strategy

• Supply curve: amount (aMW) by levelized cost bin ($/MWh)
• Peak impacts: Peak vs off-peak, quarterly
5. Estimate Economic Potential and Cost-Effectiveness
Economic Achievable Potential

• The Economic Potential is determined by the resource strategy analysis
  • Council determines this potential based on analytical results and judgment
  • Results in the regional EE targets/goals

• After the regional EE target is established, we need a method for determining if new measures are cost-effective relative to the Plan results
  • RTF continues to develop measures
  • BPA and utility EE programs
EE Cost-Effectiveness

Based on Resource Strategy from the Power Plan

Benefits
- Avoided Energy
- Avoided Capacity
- Regional Act Credit
- Non-Energy Benefits

Costs
- Capital and Labor
- Annual O&M*
- Program Admin
- Non-Energy Costs

If benefits > costs, measure is cost effective relative to the Plan findings

Additional benefits may include: Other fuel benefits, avoided periodic replacement, risk mitigation

Additional costs may include: Other fuel costs, periodic replacement

The Avoided Energy, Avoided Capacity, and Risk Mitigation benefits are determined based on resource strategy results
An Example: LED Light Bulb

LED General Purpose Lamp Costs and Benefits

- **Costs**
  - Capital Cost
  - Gas Savings (Increased Use)
  - Program Admin Costs

- **Benefits**
  - Electric Savings
  - Avoided T&D Generation
  - Deferred Generation
  - Regional Act Credit
  - Operations and Maintenance

Present Value Costs/Benefits (2012$)
Q&A

• Who Does this Work?
  • Charlie Grist (Commercial, Industrial)
  • Tina Jayaweera (Residential, Ag)
  • Kevin Smit (Commercial, Industrial)
  • Jennifer Light (and RTF Contract Analysts)
  • Mike Starrett (Distribution Efficiency)

• With support from:
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  • Energy Trust of Oregon
  • National Labs, Research Organizations, Universities
  • Individual utilities
  • Consultants