Integrating DSM into Integrated Resource Plans

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(with major credit to the NWPCC for its published materials on IRP)

NORTHWEST ENERGY EFFICIENCY ALLIANCE
Northwest Energy Efficiency Alliance
About NEEA

NEEA Funders
- $37 Million/year (Electric and natural gas)
- Bonneville Power Administration, on behalf of more than 140 utilities
- Energy Trust of Oregon
- Public and investor-owned utilities

Regional EE Investment
- $375 million of utility funding
- 10% directed to NEEA for MT programs including codes and standards.
- MT results in 20% of total regional savings

EE Goal setting
- NWPCC determines baseline and conducts regional IRP every 5 years
- Current plan: 85% of growth met with EE
- Targets exceeded every year since 2005
- Utilities may adjust targets depending on regulatory requirements
What is Market Transformation?

NEEA’s Definition:

“The strategic process of intervening in a market to create lasting change.”
Market Adoption Curve

- Early Adopters
- Early Majority
- Late Majority
- Laggards

Dollars Invested vs. Market Share

Codes & Standards

Natural Baseline

Time
TVs Market Transformation

% Market Share of TVs

- ENERGY STAR 5.3 Baseline
- ENERGY STAR 5.3 Regional

Market Transformation

THE POWER OF PARTNERSHIP

1142 aMW Cumulative Total Regional Savings (1997-2014)

- Cycles 3 (2005-2009)
- Cycles 4 (2010-2014)
a utility…shall submit to the commission an integrated resource plan that assesses a variety of demand side management and supply side resources to meet future customer electricity service needs in a cost effective and reliable manner.
What is IRP?

"integrated resource planning“ means a utility's assessment of a variety of demand-side and supply-side resources to cost-effectively meet customer electricity service needs. The IRP may also include:

(1) A public participation procedure.
(2) An analysis of the uncertainty and risk posed by different resources and external factors.
Why is EE often overlooked in IRP

Barriers:
1. It’s just rounding error
2. You can’t dispatch it
3. Can’t depend on it
4. Don’t have data on baseline use
5. Don’t have data on load shape of measure
6. Desire to sell more electricity
7. It’s complex
8. It’s easier to take a little off the forecast
Integrating energy and the environment in the Columbia River Basin

- Longest running IRP Process in US
- Published six regional plans since 1983
- All Plans have called for significant reliance on energy efficiency
- No regulatory authority over utilities or state PUCs

Council’s plans serve as a reference against which utility specific IRPs are reviewed
Columbia River Basin
Another View of the Columbia River
NW accomplishments through IRP

Since 1980, over half of the NW region’s growth in demand for electricity has been met with energy efficiency. (~100% since 2010)

► Over 5,600 average megawatts saved—enough to power the state of Oregon and western Montana

► Ratepayers spend about $3.5 billion less per year for electricity

► Lower annual carbon dioxide emissions—20.8 million tons less in 2012

► The region has exceeded annual efficiency targets every year since 2005
IRP elements

- A *demand forecast* of at least twenty years
- A forecast of *power* (energy and capacity) resources required to meet forecast demand by resource type
- An *energy conservation “program,”* including *model conservation standards*;
- Regional *reliability and reserve requirements*,
- A *methodology* for determining quantifiable environmental costs and benefits
### Example of analytical tools used in NW

<table>
<thead>
<tr>
<th>Tool</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy 2020</td>
<td>Energy 2020 is an open source model developed by Systematic Solutions, Inc. This model has been customized for and by the Council. Used to forecast the hourly demand for electricity, potential applications for efficiency resources, ensure consistency between the demand forecasts and efficiency assessment.</td>
</tr>
<tr>
<td>Fuel Price Forecasting Model</td>
<td>Council developed model. Used to convert assumptions about fuel commodity prices to regional wholesale prices at various locations, and to convert to estimate retail fuel prices for input to demand forecasts and resource costs estimates.</td>
</tr>
<tr>
<td>AURORA&lt;sup&gt;xmp&lt;/sup&gt; Electricity Market Model</td>
<td>Proprietary model from EPIS, Inc. Production cost model used to forecast hourly wholesale electricity market prices at various pricing points in the western U.S. (WECC area). Can also be used to forecast hourly and total system NOx, SOx, and CO&lt;sub&gt;2&lt;/sub&gt; emissions.</td>
</tr>
<tr>
<td>GENESYS (GENeration Evaluation SYStem)</td>
<td>Council developed model that performs hourly chronological simulation of the Northwest’s resources using many different assumptions for uncertain variables, including 1) river flows (which affect the amount of water for hydroelectric generation), 2) temperature (which affects demand for electricity), 3) forced outage conditions for generating resources and 4) wind generation.</td>
</tr>
<tr>
<td>Regional Portfolio Model (RPM)</td>
<td>Council developed model used to identify low-cost and low-risk resource strategies given uncertain future conditions and policies. It determines cost-effectiveness of alternative generating and efficiency resources. Time resolution is quarterly, with capacity assessments done for peak hour within period.</td>
</tr>
</tbody>
</table>
IRP-High Level View

Plan Development

Analytical Process Flow

- Electricity Demand Forecast
- Load Forecast Range (without efficiency)
- Units & Baseline Unit Use
- Energy Efficiency Resource Potential Assessment
- Energy Efficiency “Supply Curves”

Regional Portfolio Model

- Data to Create Futures
- Generating Resource Cost & Availability
- Generating Resource Potential Assessment

Council Reviews Cost and Risk of Alternative Resource Portfolios


Distributions of Key Drivers (e.g., Fuel prices, wholesale market prices)
Forecasting Demand

Energy 2020 Demand Forecasting Model

- Economic and Demographic Forecast
  - Population
  - Employment
  - Industrial Output

- State Codes and Federal Standards

- Fuel Price Forecast
  - Natural Gas
  - Fuel Oil
  - Coal

- Generating Resource Costs

- AURORAxmp and GENESYS - Hourly Level PNW Electricity Demand

- Energy Efficiency Assessment - Units (e.g., homes, water heaters, sq/ft. office buildings, industrial load, etc.)

- Regional Portfolio Model -
  - Monthly Loads by High and Low Load Period
  - Peak Hourly Load by Quarter
Guidelines for Incorporating EE

Consistency of load forecast and energy efficiency assessment

- Baseline use/efficiency assumptions are equivalent
- Efficiency improvements are treated as resource options that compete against generating resources in supply expansion model
- Load forecast assumes “frozen efficiency” (i.e., no price responsive improvements occur)
- Load forecast is not decremented with assumed EE

Achievable potential is based on all savings from all mechanisms (i.e. gross savings)
- Achievable potential assumes EE is a resource and can be acquired “at cost”
Incorporating EE: Potential

1 - Estimate *Technical Potential* on a per application basis (i.e. savings/unit)
2 – Estimate *Economic Potential* on a per application basis (i.e., levelized cost/unit)
3 - Estimate number of applicable units (account for physical limits, retirements, new construction, etc.)
4 – Estimate *Technical Potential* for all applicable units
5 – Estimate *Achievable Potential* for all realistically achievable units
Achievable EE Potential?

**Achievable Potential** =
Number Units \* Savings per Unit \* Achievable Market Penetration

Examples:
- Number Homes
- Floor Area of Office Buildings
- Number of TVs
- Acres Irrigated
- Pounds of Paper

Use per Unit at Current Efficiency = Use per Unit at Improved Efficiency = Savings (kWh/yr)

**Current Efficiency** is adjusted for adopted codes & standards and stock turnover (Frozen Efficiency)

Fraction of units realistically achievable over time
400 measures considered for buildings, appliances, and processes for residential, commercial, industrial, and agriculture sectors. Measures for the utility distribution system are included as well.

1,400 different permutations of savings opportunities were evaluated incorporating:
- climate zone,
- heating system and building type and vintage, etc,
Incorporating EE: New technologies

- Solid state lighting
- Variable refrigerant flow HVAC systems
- HP clothes dryer
- Advanced power strips
Sixth and Seventh Plan Conservation Supply Curves

Over 5000 aMW identified – 20-year

Levelized Cost Bin ($/MWh)

- 100-110
- 110-120
- 120-130
- 130-140
- >140

7P Preliminary Supply Curve

6P Supply Curve
As the region faces increasing needs for peaking capacity and system flexibility, identifying how energy-efficiency programs affect the system is becoming more important. Data on the hourly, daily, and seasonal patterns of electricity use are over 20 years old. Appliance saturations, improved equipment efficiency, and changing behavior may have significantly altered these patterns. Improved end-use research is needed to understand how these profound changes in electricity use are influencing capacity and flexibility requirements.
What is the “shape” of conservation?

Average Seasonal Rate
High and Low Load Hour Conservation
2029 and <$100 per MWh

MWh per Hour

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

High Load Hours
Low Load Hours
All Resource Supply Curve

Generic coal, gas and nuclear units are shown at typical project sizes - more units could be built at comparable cost.
Energy Efficiency is Still the Cheapest Option

- Emission (CO2) cost
- Transmission & Losses
- System Integration
- Plant costs

Levelized Lifecycle Cost (2006$/aMW)

- Energy Efficiency
- Geothermal
- Combined Cycle
- Columbia Basin Wind
- Canadian Wind
- Advanced Nuclear
- Supercritical Coal
- Integrated Gasified Coal
- Reciprocating Engine
- Wood Residue (No Chip)
- Montana Wind
- Wyoming Wind
- Solar Parabolic Trough
- Utility Photovoltaic
Incorporating EE: integration with Supply RPM

Conservation Inputs

**Retrofit**
- One Supply Curve
- Max Annual Pace Limit
- No Use No Lose Rule
- Shape of Savings

**Lost-Opportunity**
- Twenty Supply Curves
- One Each Year
- Use It or Lose It Rule
- Shape of Savings

RPM

Tests alternative development strategies for conservation, generation, and market purchases using range of market price and risk adders

Conservation Strategy

- Retrofit Build Schedule
- LO Build Schedule
- Market Price Adder
- Risk Adder

Adders produces cost-effectiveness metric for program development

Cost-Effectiveness based on Short-Term Market Price plus Adders
IRP-High Level View

Plan Development
Analytical Process Flow

- Electricity Demand Forecast
- Load Forecast Range (without efficiency)
- Data to Create Futures
- Generating Resource Cost & Availability
- Distributions of Key Drivers (e.g., Fuel prices, wholesale market prices)
- Units & Baseline Unit Use
- Energy Efficiency Resource Potential Assessment
- Energy Efficiency “Supply Curves”

Council Reviews Cost and Risk of Alternative Resource Portfolios
Planning for Uncertainty

*Plans* – actions and policies over which the decision maker *has control* that will affect the outcome of decisions

*Futures* – circumstances over which the decision maker *has no control* that will affect the outcome of decisions

*Scenarios* – Combinations of Plans and Futures used to “stress test” how well what we control performs in a world we don’t control
What if EE costs more than estimates?

- Tested Conservation Uncertainty
  - Assumed Conservation Savings Cost 30% More (or equivalently saved 30% less) than base case

Findings:
- Conservation market adders were unchanged
- Average acquisition of conservation over the 20-year study period was unchanged
- Additional wind generation was optioned
EE outcomes robust under all scenarios

Cumulative Efficiency Development (GWH/YR)

- $20 Carbon Price
- $100 Carbon Price
- Current Carbon Policy Case
- Least Risk Plan
- Least Cost Plan

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Sensitivity Analysis: Efficiency

Energy Efficiency

- All least cost resource strategies rely heavily on conservation to meet both winter capacity and energy needs.
- Under 90 percent of the futures energy efficiency meets all load growth through 2030 and under 60 - 70 percent of the futures all load growth through 2035.
- Under all scenarios and sensitivity studies an average of between 1300 and 1430 aMW are developed by 2021.
- Why
  - Significant amounts are available below projected future market prices (e.g., 1200 aMW by 2021 and 3500 aMW by 2035 <$30/MWh
  - It produces 2.0 MW/MWh saved during winter
  - It has a shorter lead-time and comes in more “modular” sizes than generation
  - It does not have fuel price risk
  - It does not have carbon price risk
  - Its development is essential to attaining carbon emissions reductions, but the quantity developed under least cost resources strategies does not significantly increase when carbon risk is considered.
Example: 6th Plan Selected Portfolio

Sixth Power Plan Resource Portfolio

- Cumulative Resource - Average Megawatts
- 2010 to 2030
- Demand Response
- Natural Gas
- Renewables
- Energy Efficiency
Preliminary Overall Findings: 7th Plan

- Demand Response or Increased Reliance on External Markets are Competitive Options for Providing Winter Capacity
- Replacement of announced coal plant retirements can generally be achieved with only modest new development of natural gas generation
- Compliance with EPA CO2 emissions limits at the regional level, is attainable through resource strategies that do not depart significantly from those that are not constrained by those regulations.
Preliminary EE results for 7th Plan

Energy efficiency plays a critical role in meeting both energy and winter capacity needs.

- Under all scenarios, 1,300-1,430 aMW developed by 2021.
- EE costs less than other resources, even under low electricity and gas prices.
- EE can be "built" relatively quickly, and in the amounts needed, without fuel price and carbon risks.

"Efficiency acquisition isn't driven by the need for new energy," said Tom Eckman, power division director, "but because it's less expensive than operating existing resources and the surplus energy can be sold and exported outside the region at a profit."
Efficiency Goals in the PNW since 1984

Exceeded Council Plan Goals

- Plan Annual Goal
- Actual Annual Achievement

Cumulative Savings (MWh)

- 1984
- 1988
- 1992
- 1996
- 2000
- 2004
- 2008
- 2012

Cumulative Savings (MWh)
Sectors Represented in EE Goals

Note that NW potential assessments included all sectors

- Residential
- Commercial
- Industrial
- Agriculture

Even if a sector is not represented in current utility programs, it is well worth the effort to understand the potential value of the EE resource.
Max Achievable Conservation by Sector at Various Price Bins
(Cumulative)

- Utility
- Residential
- Industrial
- Commercial
- Agriculture

TRC Levelized Cost ($/MWh)

- <40
- <80
- <120
- >120

aMW

Northwest Power and Conservation Council
NW Industrial EE Example: Food Processors

NWFPA Energy Goal:

- To accelerate the implementation of energy efficiency strategies to reduce member-wide energy intensity (energy use per unit of output) by 25% in 10 years and through innovation, new technologies and new resources to achieve a total reduction of 50% in 20 years.
2015: ACEEE awards JR Simplot’s Don Sturtevant (at right) and NEEA represented by Geoff Wickes (2nd from left) as champions of energy efficiency in industry.

*aka “Continuous Energy Improvement”*
Wrap up

IRP is complex, data intensive process
It’s not fast, easy, or cheap
The value of a plan well done is to:
  • Uncover value in demand-side resources
  • Reduce risk of over-building supply-side resources
  • Take advantage of more “modular” investments represented by EE and DR
  • Clarify trade-offs between risk and cost
  • Understand the consequences of alternative futures.
Questions & Comments

Filling the Energy Efficiency Pipeline
Accelerating Market Adoption
Leveraging Regional Advantage

Thank You!

neea.org
Supplemental Slides on EE included

7th Power Plan EE measures by sector

- Residential
- Commercial
- Industrial
- Agriculture
- Utility System
## Residential Measures

### Total Achievable Potential Available by Year (aMW)

<table>
<thead>
<tr>
<th>Residential</th>
<th>2025</th>
<th>2035</th>
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<td><strong>Grand Total</strong></td>
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# Commercial Measures

Total Achievable Potential Available by Year (aMW)

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<th>Commercial</th>
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<td>Exterior Building Lighting</td>
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Northwest Power
# Industrial Measures

Total Achievable Potential Available by Year (aMW)

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<tr>
<td>Wood</td>
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<tr>
<td>Metals</td>
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</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>407</strong></td>
<td><strong>519</strong></td>
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</table>
# Agriculture Measures

Total Achievable Potential Available by Year (aMW)

<table>
<thead>
<tr>
<th>Agriculture</th>
<th>2025</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>87</td>
<td>125</td>
</tr>
<tr>
<td>Irrigation Hardware</td>
<td>47</td>
<td>54</td>
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<tr>
<td>Irrigation Pressure</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>Irrigation Water Mgmt</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Irrigation Efficiency</td>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>Lighting</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Dairy</td>
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<td>0</td>
</tr>
<tr>
<td>Lighting</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Motors/Drives</td>
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</tr>
<tr>
<td>Dairy</td>
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<td>0</td>
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<tr>
<td>Irrigation Motor</td>
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</tr>
<tr>
<td>Refrigeration</td>
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<td>1</td>
</tr>
<tr>
<td>Dairy</td>
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<td><strong>Grand Total</strong></td>
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# Utility System Measures

## Total Achievable Potential Available by Year (aMW)

<table>
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<td>Utility Distribution System</td>
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<td>236</td>
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<tr>
<td>LDC voltage control method</td>
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<td>92</td>
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<tr>
<td>Light system improvements</td>
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<td>53</td>
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<tr>
<td>Major system improvements</td>
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<td>58</td>
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<tr>
<td>EOL voltage control method</td>
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<td>30</td>
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<tr>
<td>SCL implement EOL w/ major system improvements</td>
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<td>2</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>155</strong></td>
<td><strong>236</strong></td>
</tr>
</tbody>
</table>