Beneficial Electrification

Presentation to the Southeast Sustainability Directors Network

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Regulatory Assistance Project

May 13, 2021
1 Introduction
Beneficial Electrification (BE)

1. Introduction
2. Energy Trends: What is Changing?
3. What Makes Electrification Beneficial?
4. Principles for Operationalizing BE
5. Beneficial Electrification in Practice: Initial Steps
Analysis of Consumer and Marginal Costs for Electric and Natural Gas Space and Water Heat in Single Family Residences in Puget Sound Power and Light Company Service Territory

Prepared by: Richard Byers
Washington State Energy Office
809 Legion Way SE
Olympia, WA 98504

September, 1989

DIRECT USE OF NATURAL GAS FOR RESIDENTIAL SPACE AND WATER HEAT COMPARED TO GAS-FIRED ELECTRIC GENERATION FOR HYDRO-FIRMING

THERMODYNAMIC, ECONOMIC, AND ENVIRONMENTAL IMPACTS

PREPARED FOR
ASSOCIATION OF NORTHWEST GAS UTILITIES
Portland, Oregon

Jim Lazar
Consulting Economist
Olympia, Washington
What Makes Electrification Beneficial?

Three Criteria: Achieve At Least One Without Adversely Impacting The Others

1. Saves Customers Money Long-Term; New Services
2. Reduces Environmental Impacts
3. Enables Better Grid Management
2 Energy Trends: What Is Changing?
December 2017: Xcel Bid Median Prices $/kWh

- **SOLAR**: $0.029
- **WIND**: $0.018
Existing Power Plant Operating Costs per USEIA

Existing Plant Average Fuel and O&M from USEIA Table 8.4 Electric Power Annual 2016

- **COAL**
  - Fuel: $0.026
  - O&M: $0.011
  - Total: $0.037

- **GAS**
  - Fuel: $0.025
  - O&M: $0.005
  - Total: $0.030

- **NUCLEAR**
  - Fuel: $0.007
  - O&M: $0.018
  - Total: $0.025
Existing Plants vs. Xcel Bids

Existing Plant Average Fuel and O&M from USEIA Table 8.4 Electric Power Annual 2016

<table>
<thead>
<tr>
<th>Source</th>
<th>Coal</th>
<th>Gas</th>
<th>Nuclear</th>
<th>Solar</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel (kWh)</td>
<td>$.037</td>
<td>$.030</td>
<td>$.025</td>
<td>$.029</td>
<td>$.018</td>
</tr>
<tr>
<td>O&amp;M (kWh)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xcel Bids</td>
<td></td>
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</tbody>
</table>

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Innovative & Efficient End Uses – Electrification Is Underway

Photo credits: EPA Energy Star / Cassandra Profita/OPB/EarthFix
What Makes Electrification Beneficial?
Is All Electrification Created Equal?

• Brattle: “Utility sales could nearly double by 2050”!

• Is it all about load growth?
What Makes for **Beneficial Electrification (BE)**?

*Three Explicit Criteria: Achieve At Least One Without Adversely Impacting The Others*

1. Saves Customers Money Long-Term; New Services
2. Reduces Environmental Impacts
3. Enables Better Grid Management
An Easy Example: Oil vs. Heat Pump Water Heater

BOCK 58800 32E OIL FIRED WATER HEATER, GALLON / 104000 BTU - TANK ONLY

Our Price Per Unit: $1,054.83

Rheem Prestige Hybrid Electric Water Heater

$1,389.00
Consumer Economics

Photo credit: Flickr 401(k) 2012
## Consumer Economics

<table>
<thead>
<tr>
<th>Oil Water Heater</th>
<th>Heat Pump WH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital:</strong></td>
<td><strong>Capital:</strong></td>
</tr>
<tr>
<td>$1,054</td>
<td>$1,389</td>
</tr>
<tr>
<td><strong>150 gallons oil/year</strong></td>
<td><strong>1,500 kWh/year</strong></td>
</tr>
<tr>
<td><strong>$3.00/gallon</strong></td>
<td><strong>$.12/kWh average</strong></td>
</tr>
<tr>
<td><strong>$450/year</strong></td>
<td><strong>$180/year</strong></td>
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<tr>
<td><strong>10 Years:</strong></td>
<td><strong>10 Years:</strong></td>
</tr>
<tr>
<td>$5,554</td>
<td>$3,189</td>
</tr>
</tbody>
</table>
Environmental Benefits
# Emissions

<table>
<thead>
<tr>
<th>Oil Water Heater</th>
<th>Heat Pump WH</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 gallons oil/year</td>
<td>1,500 kWh/year</td>
</tr>
<tr>
<td>22 lb CO₂/Gallon</td>
<td>50% Gas 50% Coal</td>
</tr>
<tr>
<td>3,300 lb CO₂/year</td>
<td>1,400 lb CO₂/MWh</td>
</tr>
<tr>
<td></td>
<td>2,100 lb CO₂/year</td>
</tr>
</tbody>
</table>
Grid Management
Water Heater Loads Are Easy to Spot
Grid Management: Grid-Integrated Water Heating

- Water heaters only need to run 2-3 hours/day
- Can store an all-day-long supply
- Can be controlled into low-cost, low-emission hours
- No peak demand impact if managed
- It’s a place to send excess wind and solar electricity
Charging Occurs Mid-Day and Mid-Nite on Wind and Solar
No, You Don’t Run Out of Hot Water

State of Charge in Stored kWh

Hours of the day
4 Principles for Operationalizing BE
1. Put Efficiency First
Efficiency Across Fuel Types

2. Recognize the Value of Flexible Load for Grid Operations
Value of Flexibility for Integrating Renewable Energy

Avoid Home Charging during these hours

Source: California ISO
Wind Curtailment Is Already Significant

Note: All curtailment percentages shown in the figure represent both forced and economic curtailment. PJM's 2012 curtailment estimate is for June through December only.

Source: ERCOT, MISO, CAISO, NYISO, PJM, ISO-NE, SPP
3. Understand the Emissions Effects of Changes in Load
The Grid Is Getting Cleaner

Marginal Units by Fuel

- Coal
- Gas
- Oil
- Wind
- Other
- Municipal Waste
- Uranium
- Demand Response
- Interface

Year:
- 2012
- 2013
- 2014
- 2015
- 2016
Importance of Marginal Emissions on a “Dirty” Day

NEISO July 27, 2016

# / MWh of Marginal Generating Units
4. Use *Emissions Efficiency* to Measure the Air Impacts of Beneficial Electrification
More Carbon Intensive

Less Carbon Intensive

More Energy Efficient

Less Energy Efficient

Uncontrolled heat pump Water heater

Controlled heat pump Water heater

Energy Star
Natural Gas Water heater

Standard Natural Gas Water heater

Uncontrolled electric resistance Water heater

Controlled electric resistance Water heater
More Carbon Intensive  Less Carbon Intensive

More Energy Efficient  Less Energy Efficient

Energy Star
Natural Gas Water heater

Uncontrolled electric resistance Water heater

Controlled electric resistance Water heater

Standard Natural Gas Water heater

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More Carbon Intensive  
Less Carbon Intensive

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*Uncontrolled heat pump Water heater*

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More Carbon Intensive

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More Energy Efficient

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Standard Natural Gas Water heater

Uncontrolled electric resistance Water heater

Controlled electric resistance Water heater
- More Carbon Intensive
- More Energy Efficient
- Less Carbon Intensive
- Less Energy Efficient

- **Uncontrolled heat pump Water heater**
- **Controlled heat pump Water heater**
- **Energy Star Natural Gas Water heater**
- **Standard Natural Gas Water heater**
- **Uncontrolled electric resistance Water heater**
- **Controlled electric resistance Water heater**
5. Measure Life Matters

- Lighting
- Water Heater
- Space Heater
- Light-Duty Vehicle
- Heavy-Duty Vehicle
- Industrial Boiler
- Power Plant
- Residential Building

2015  2020  2025  2030  2035  2040  2045  2050
As the Grid Gets Cleaner, Electric Options Become More Beneficial

![Graph showing emissions over time for different types of water heaters: Electric Resistance Water Heater (blue), Heat Pump Water Heater (green), and Gas Water Heater (red). The graph indicates that electric options become more beneficial as the grid gets cleaner.](image-url)
6. Design Rates to Encourage Beneficial Electrification
Rate design should make the choices the customer makes to minimize their own bill consistent with the choices they would make to minimize system costs.
TOU Rates Can Focus on the System Peak Period

5 Beneficial Electrification In Practice: Initial Steps
Develop Your Policy Framework

- Have your regulators or city set goals?
- Have you identified barriers to electrification?
- Will you adopt metrics for electrification?
- Do policies recognize timing?
- Do proceedings include affected participants?
- Develop an inclusive process
Things Can Change Quickly

5th Avenue, NYC, Easter 1900
See any automobiles?

Source: Tony Seba
Things Can Change Quickly

Park Avenue, NYC, Easter 1913
See any horses?

Source: Tony Seba
Summary

• Given the innovations occurring in the electric sector, there are lots of opportunities for electrification.

• **Beneficial Electrification** is a framework – a way of talking about electrification – that seeks to ensure that electrification is beneficial to consumers, the environment, and the grid.
Electrification: Some Resources

- *Beneficial Electrification: Ensuring Electrification in the Public Interest*

- *Taking First Steps: Insights for States Preparing for Electric Transportation*

- *LBNL, California 2025 Demand Response Potential Study.*

- *GTM, How California Can Shape, Shift and Shimmy to Demand Response Nirvana, January 26, 2017.*

- *Beneficial Electrification: Ensuring Electrification in the Public Interest*

- *Beneficial Electrification of Transportation*

- *Getting From Here to There: Regulatory Considerations for Transportation Electrification*

- *BLOG: We All Wish We Were More Flexible: Electrification Load as a Grid Flexibility Resource*
About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org

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