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Beneficial Electrification: Electrification in the Public Interest

Illinois Commerce Commission NextGrid Working Group

David Farnsworth  
Senior Associate  
The Regulatory Assistance Project (RAP)®

50 State Street, Suite 3  
Montpelier, Vermont  
United States

+802 498 0708  
dfarnsworth@raponline.org  
raponline.org
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 Pursuant to inter-agency agreement between Public Counsel Section of the Office of the Attorney General of Washington State and Washington State Energy Office

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

WIND

$.029

$.018
Existing Power Plant Operating Costs per USEIA

- **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 Plant Average Fuel and O&M from USEIA Table 8.4 Electric Power Annual 2016
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>Energy Source</th>
<th>Fuel</th>
<th>O&amp;M</th>
<th>Xcel Bids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>$0.037/kWh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas</td>
<td>$0.030/kWh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nuclear</td>
<td>$0.025/kWh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>$0.029/kWh</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wind</td>
<td>$0.018/kWh</td>
<td></td>
<td></td>
</tr>
</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></th>
<th><strong>Oil Water Heater</strong></th>
<th><strong>Heat Pump WH</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capital:</strong></td>
<td>$1,054</td>
<td>$1,389</td>
</tr>
<tr>
<td><strong>150 gallons oil/yr</strong></td>
<td>$3.00/gallon</td>
<td>1,500 kWh/yr</td>
</tr>
<tr>
<td><strong>$450/yr</strong></td>
<td></td>
<td>$.12/kWh average</td>
</tr>
<tr>
<td><strong>10 Years:</strong></td>
<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 $\text{CO}_2$/Gallon</td>
<td>50% Gas 50% Coal</td>
</tr>
<tr>
<td>3,300 lb $\text{CO}_2$/year</td>
<td>1,400 lb $\text{CO}_2$/MWh</td>
</tr>
<tr>
<td></td>
<td>2,100 lb $\text{CO}_2$/year</td>
</tr>
</tbody>
</table>
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

Workplace Charging

Source: California ISO
Wind Curtailment Is Already Significant

Note: Each year, the total reflects only those ISOs for which we have curtailment data.

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

![Diagram showing pollution levels at different times of day.](Image)
The Grid Is Getting Cleaner
Importance of Marginal Emissions on a “Dirty” Day

NEISO July 27, 2016

# MWh of Marginal Generating Units

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

0 200 400 600 800 1000 1200 1400 1600 1800 2000

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4. Use *Emissions Efficiency* to Measure the Air Impacts of Beneficial Electrification

![Graph showing emissions efficiency](Image)

- **Emissions Associated with a Specific Purchase**
  - High
  - Low

**Electricity System Resource Mix**

- **Now**: Fossil
- **Future**: Renewable

**Accuracy**: The graph illustrates how different types of water heaters (Traditional Electric Water Heater, Gas Water Heater, Heat Pump Water Heater) compare in terms of emissions efficiency. The comparison is shown across a timeline from 'Now' to 'Future', highlighting the transition from fossil fuels to renewable energy sources.
More Carbon Intensive

More 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

Less Carbon Intensive

Less Energy Efficient
More Carbon Intensive

Energy Star
Natural Gas Water heater

Less Carbon Intensive

Uncontrolled heat pump Water heater

Controlled heat pump Water heater

Uncontrolled electric resistance Water heater

Controlled electric resistance Water heater

More Energy Efficient

Standard Natural Gas Water heater

Less Energy Efficient
More Carbon Intensive

Uncontrolled electric resistance Water heater

Uncontrolled heat pump Water heater

Energy Star Natural Gas Water heater

Standard Natural Gas Water heater

Controlled heat pump Water heater

Less Carbon Intensive

Less Energy Efficient

Controlled electric resistance Water heater

More Energy Efficient
5. Measure Life Matters

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

Years: 2015 to 2050
As The Grid Gets Cleaner, Electric Options Become More Beneficial

![Graph showing emissions over time for different water heaters: Electric Resistance Water Heater, Heat Pump Water Heater, and Gas Water Heater. The emissions decrease over time, with the electric options showing the lowest emissions after a certain point.]
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

Price Can Influence When EVs Are Charged

Dallas/Ft Worth (standard rates)

San Diego (time-of-use rates)

Adapted from: M.J. Bradley, 2017
BE Principles

1. Efficiency First
2. Recognize the Value of Flexible Load for Grid Operations
3. Understand the Emissions Effects of Changes in Load
4. Use Emissions Efficiency to Measure the Air Impacts of Beneficial Electrification
5. Measure Life Matters
6. Design Rates to Encourage Beneficial Electrification
Beneficial Electrification In Practice: Initial Steps
Develop Your Policy Framework

- Set Goals
- Identify Barriers
- Adopt Metrics
- Recognize Timing
- Include Affected Participants
- Develop an Inclusive Process
RAP Materials on BE

- *Ensuring Electrification in the Public Interest*: June, 2018
- *Space Heat*: Summer, 2018
- *Water Heat*: Summer, 2018
- *Electric Vehicles*: Fall, 2018
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* sets out a framework and principles to help decision-makers ensure that electrification is beneficial to consumers, the environment and the grid.
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

David Farnsworth
Senior Associate
Resources from RAP

- Beneficial Electrification: Ensuring Electrification in the Public Interest
- Utilities Can Get a “LEG” Up with Beneficial Electrification—But Regulators Also Have to be Ready
- Beneficial Electrification: A Growth Opportunity
- Beneficial Electrification: A Key to Better Grid Management
- Brewing up the Regulation of the Future