



# **Intelligent Efficiency Conference**

## **Track A: Integrating Distributed Resources**

### **1A Enabling the Virtual Power Plant**

**Conrad Eustis, Portland General Electric Co.  
Barriers to Alonetic Appliances**

# Portland General Electric

855,000 customers, 52 cities served

Service territory population 1.9 million,  
43% of state's population

4,000-square-mile service area

2,650 employees

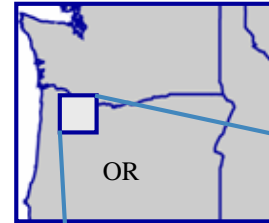
Summer peak 3,950 MW (2009)

Winter peak 4,073 MW (1998)

**Number #1 in US by NREL in Renewable  
energy sales and customers**

First multi-MW Li-Ion battery-inverter system  
placed in operation by a utility

21% of owned-generation nameplate capacity  
is wind generation; 36% is renewable.



# Word for Emerging Concept

- In 2040 we want most loads and distributed generation to be **alonetic**



- Word created in 2014
- Opposite of alonetic is **egonetic** which is the behavior of today's devices

**Alonetic**, adjective  
ăl • ō • nět' • ĩk

- **alo-** from Latin “to **support**”
- “**net**” as in the “electric grid **net**work”;
- **-ic** of, or **pertaining to**

**Definition:** The ability of an electric device to beneficially support operation of the electric grid

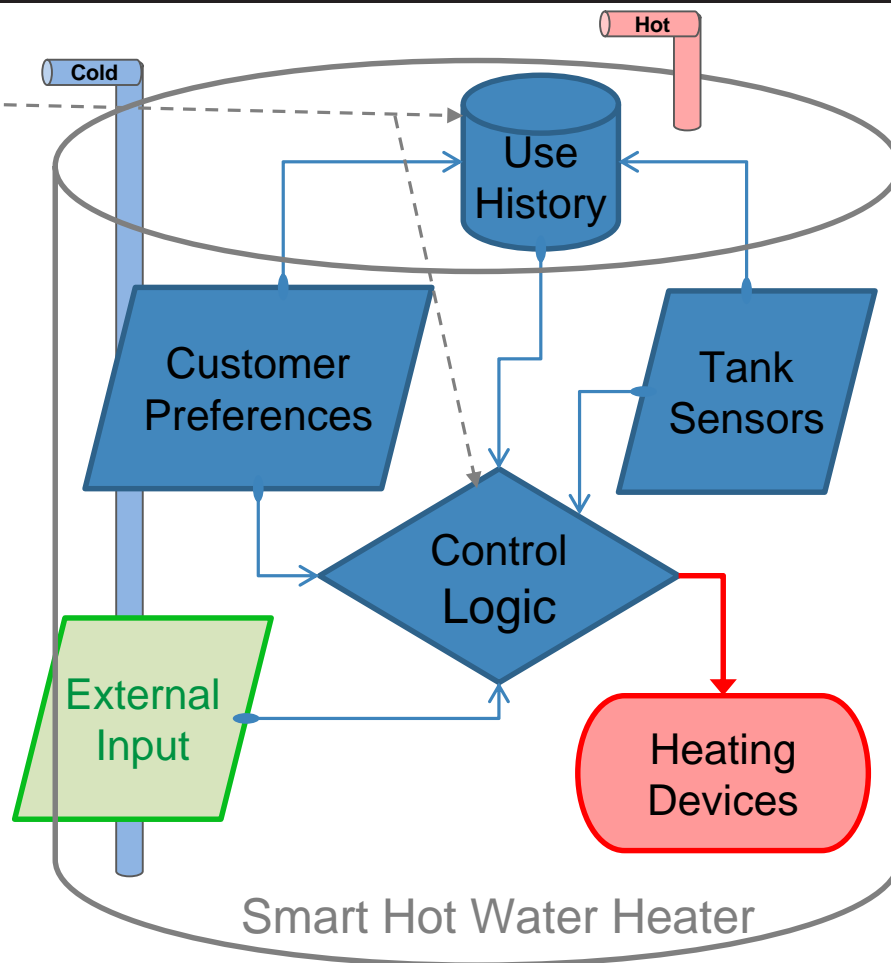
# Definition/details of smart water heater

*Moore's law comes to load behavior here*

1. A water storage tank where **heating devices** are controlled by logic in an electronic circuit. (I.e. not bimetallic switches)

2. A water heater designed to accept **external signals** as an input to the control logic

E.g. Hourly Price Forecast  
OR  
Direct control for load shifting



# Current PGE Pilot: Customer installs communication



ANSI/CTA-2045 “plug”  
on communication  
device



Early communication device from e-Radio

- This E-Radio device hears control commands **broadcast on FM** radio and returns water heater status via Wi-Fi **if enabled by Customer**.
- This option can work in **99+% of US**, (including rural areas) today

**GOAL:**

**ANSI/CTA-2045 socket on tank.**  
(This one proprietary)

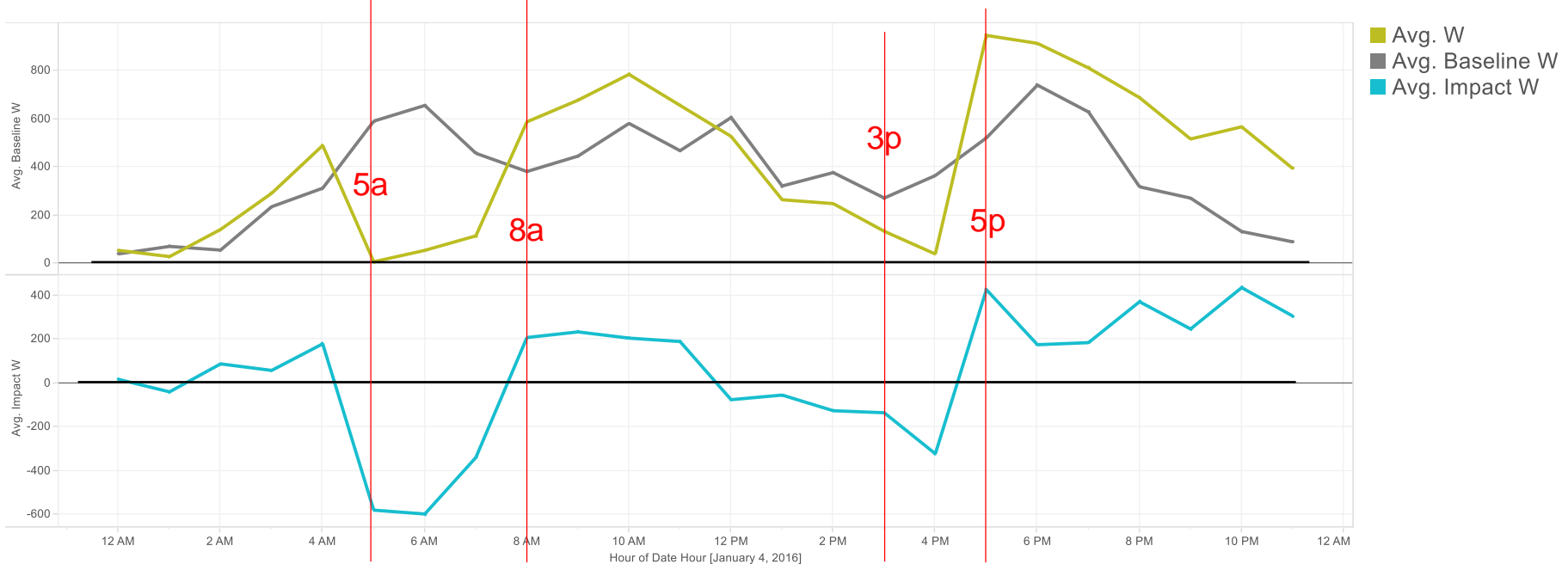
# Advantages of a standard socket

- Enables any WAN, or LAN, or wired communication method
- Compared to embedded communication, doesn't use energy or hardware cost until customer enrolls
- Security issues solved in communication device not in appliance
- Standard creates high volume consequently lower cost for communication device
- Communication device can have a “library” of device-specific “drivers”
  - Command protocols can come and go, without ever affecting the functionality of an appliance with a 20-year life

# Peak Shaving Benefit

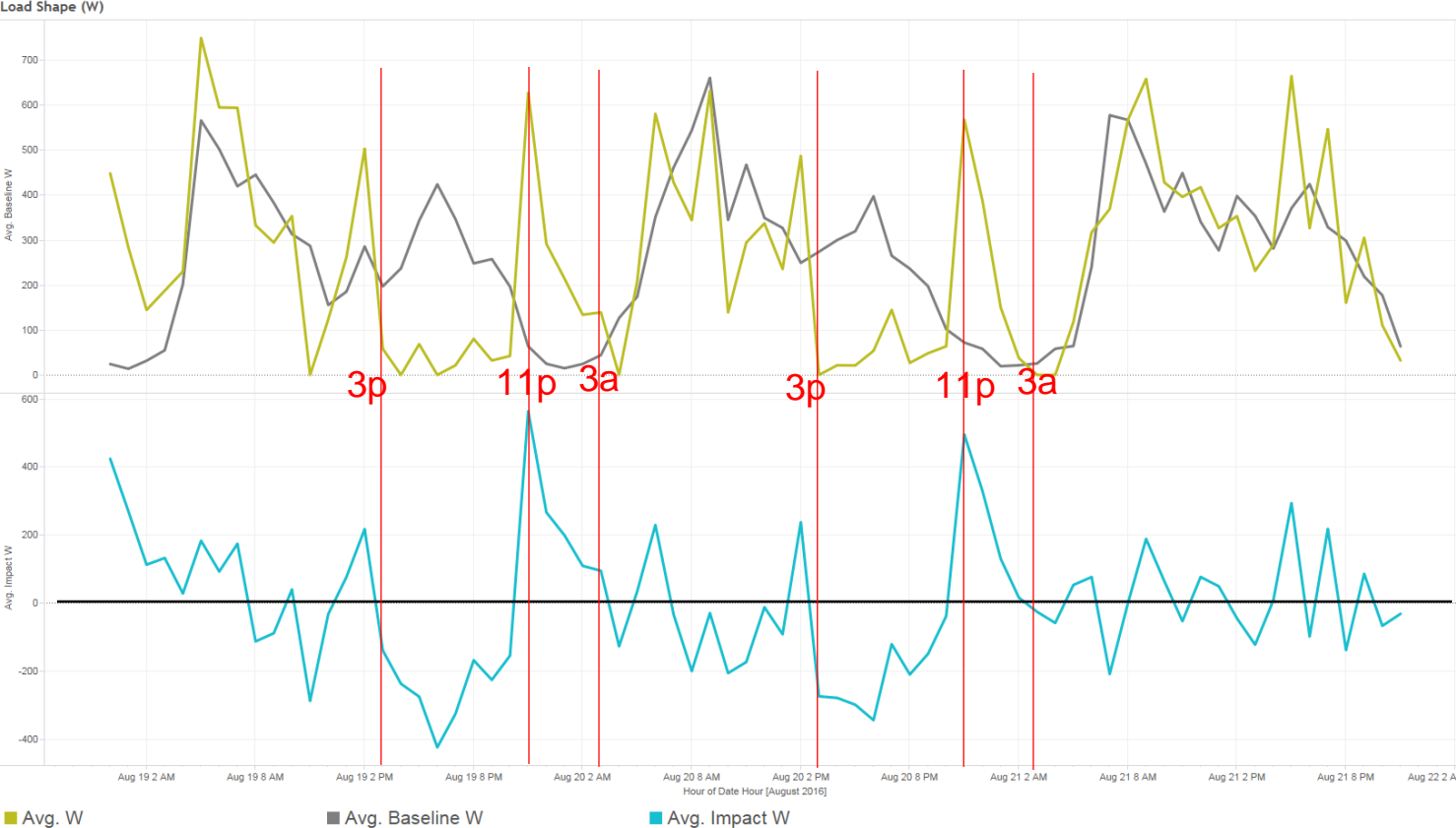
- Traditional demand response tested in winter and summer
- Peak demand impacts around  $\sim 0.3$  kW in both seasons

Summer			
Duration	Time	Peak Days	Avg W Impact
4 hour	3pm-7pm	1	-291
6 hour	2pm-8pm	2	-266
8 hour	3pm-11pm	1	-244
Winter			
Duration	Time	Peak Days	Avg W Impact
6 hour	5am-9am, 3pm-5pm	1	-297
6 hour	5am-8am, 3pm-6pm	1	-391
4 hour	3pm-7pm	1	-297



# Energy Shifting Benefit

- Example Days: 8/19-8/21
  - Control strategy: load up for 15 minutes, then shed from 3pm to 11pm, then duty cycle for 4 hours

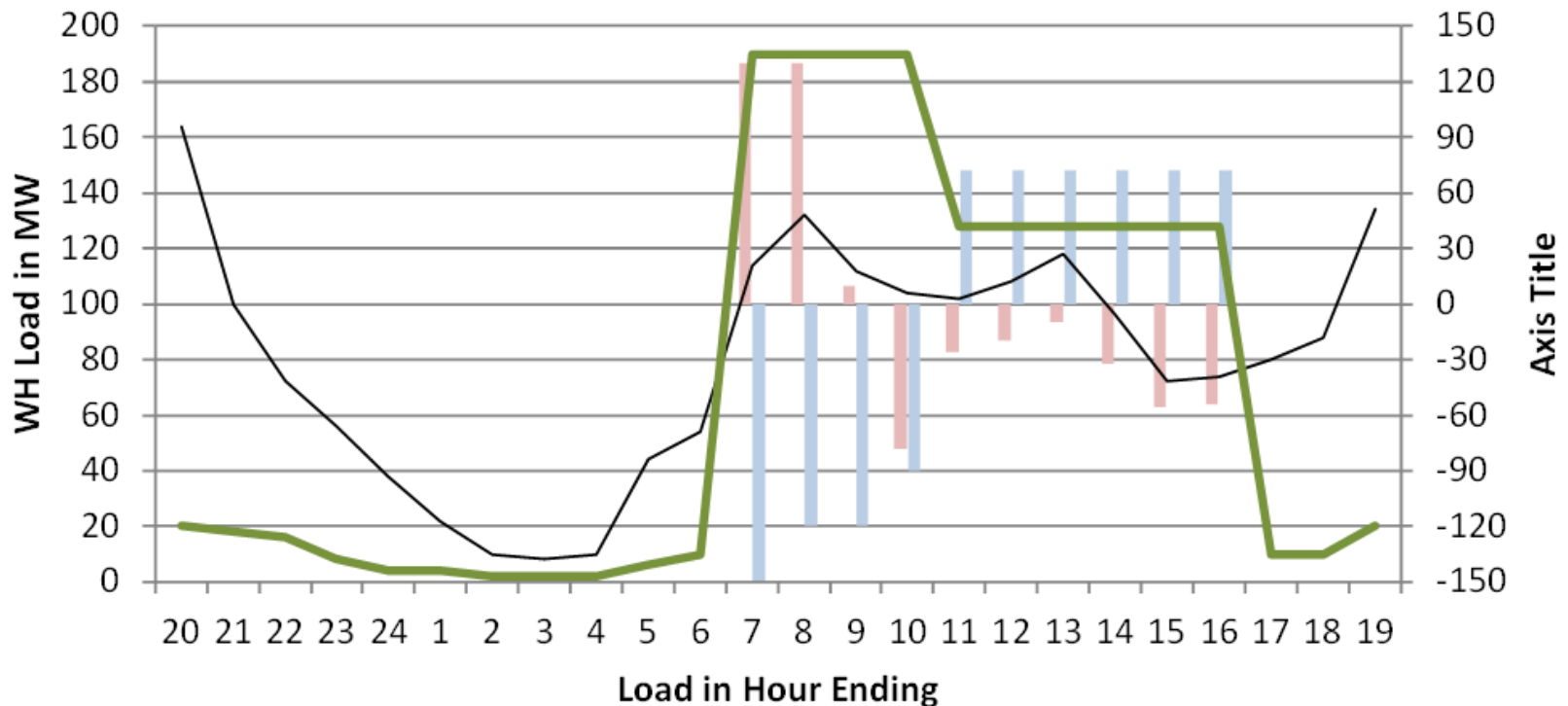


Hour	W Impact
0	340
1	200
2	80
3	68
4	-52
5	91
6	133
7	-22
8	-104
9	24
10	-34
11	-171
12	11
13	12
14	137
15	-179
16	-169
17	-93
18	-289
19	-76
20	-172
21	-96
22	-86
23	343
Average	-4
<b>Total Charge</b>	<b>1167</b>
<b>Total Discharge</b>	<b>-1160</b>



# One Use Case: Real-time "Inc" & "Dec"

## Load Control to Provide Incs or Decs 7 to 10a



Max "Dec" Plan    Max Inc Plan    Nominal WH Load    Shaped WH Load

# Standardization Creates Major Benefits

- Less cost and simple means **more customers** will try it
- With market transformation all 50 million existing electric water heaters (including heat pump water heaters) could be economically controlled; potential means:
  - **25,000 MW of demand response capacity**
    - (i.e. ability to avoid 100 large peaking plants = \$20 billion)
    - Daily ability to provide 25 GW in Incs and Decs
    - 120 million MWh of discretionary load to absorb excess renewables
  - Annually displace 25 million tons CO<sub>2</sub> (= elimination 7 million cars)
  - Annual reduction in revenue requirement of \$5 billion

# Barriers to Alonetic Devices

- “Smart” appliances today all have proprietary interfaces
  - **Irony:** IoT is about everyThing interoperating; but we have more than a dozen mega-companies pushing their proprietary approach to ensure upside for their business
- Communication interface must be designed and implemented at factory.
- Customers (that buy appliances) not seeking grid responsive capability; thus in commodity appliance market, manufacturers incur cost and have no way to recovery cost; since benefits are in electricity industry
- No major player to create market standard: 30+ major “appliance” manufacturers; 100+ major utilities
- Without every water heater equipped with socket, incremental cost to connect existing smart water heaters is \$250, not \$20

# Approaches to market transformation

1. Seek legislative mandate  
(insufficient consensus)
2. Ask DOE to identify consensus standard  
(Wyden/Cantwell letter; DOE didn't try hard enough)
3. Now trying, legislation for large, national demonstration
4. Market transformation led by Pacific NW (In progress now, strategy: "I'll have what she's having")
5. PGE will lead by example

Public Law 110-140  
110th Congress

An Act

To move the United States toward greater energy efficiency, to increase the production of clean renewable fuels, to increase the efficiency of products, buildings, and vehicles, to deploy greenhouse gas capture and storage, to improve the performance of the Federal Government, and for other purposes.

Dec. 19, 2007  
[H.R. 6]



# Thanks

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**Conrad Eustis**

**503-464-7016**

**[Conrad.eustis@pgn.com](mailto:Conrad.eustis@pgn.com)**