

Business Models to Advance Smart Water Heaters

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Portland General Electric

852,000 customers, 52 cities served

Service territory population 1.7 million,
43% of state's population

4,000-square-mile service area

2,600 employees

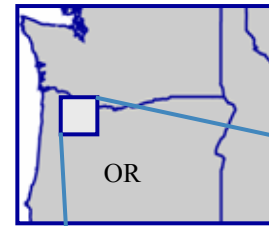
Summer peak load of 3,950 MW (2009)

Winter peak load of 4,073 MW (1998)

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

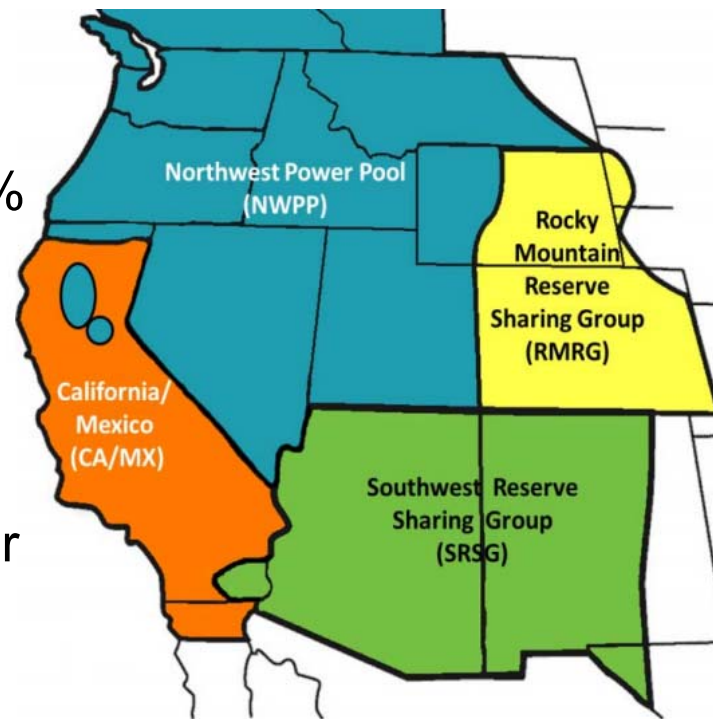
First multi-MW Li-Ion battery-inverter system
placed in operation by a utility

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



WECC future state: a 2040 scenario

- Steadily increasing pressure to reduce greenhouse gases
- Eleven WECC states generate 40% of electricity from non-hydro renewables (65% with hydro)
- Over-generation causes 5-hour periods of negative wholesale prices on 1 in 4 days
- Carbon footprint of heat pump water heater only 40% of 0.7 EF gas water heater
- IoT sufficiently developed so most appliances easily added to home network



WECC = Western Electricity Coordinating Council is one of 8 US control regions regulated by FERC and NERC; it includes most of the 11 adjacent western states.

Why grid interactive water heaters?

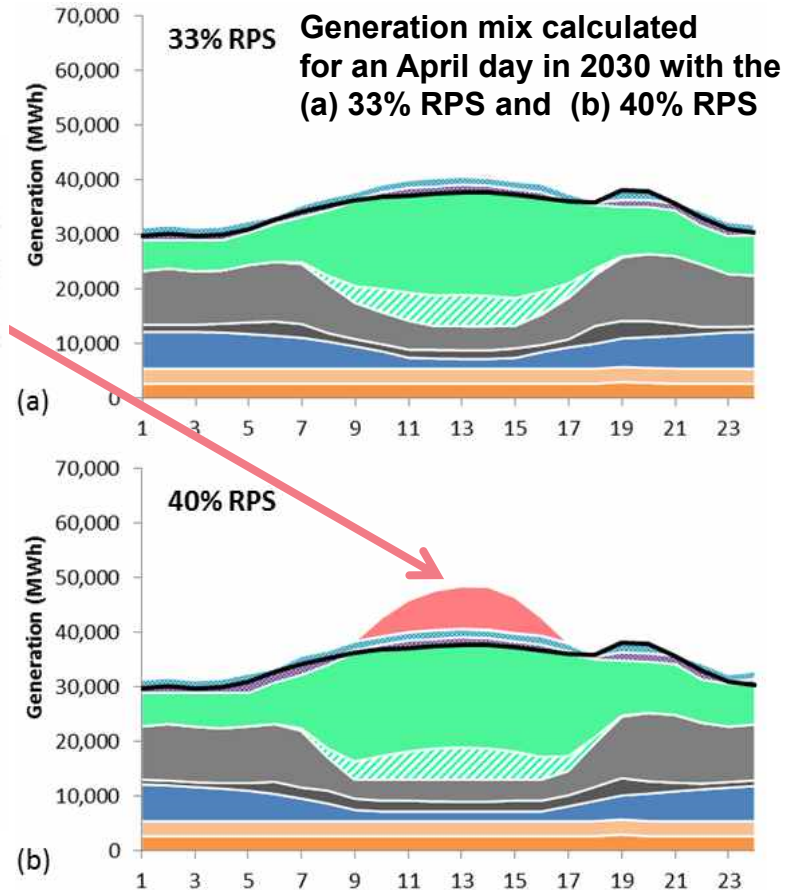
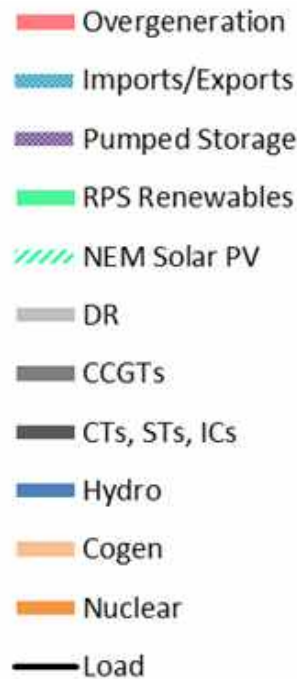
Daily over-generation

Three solutions:

1. Turn off wind PV (*wasteful*)
2. Battery storage (*expensive, but part of solution*)

3. “Smart” devices with flexibility to use renewable electricity when surplus

E.g.: **Hot water heaters**, HVAC, refrigerators, electric vehicles, water pumping, dishwashers, pool pumps, dryers



Reference: *Investigating a Higher Renewables Portfolio Standard in California*, Energy and Environmental Economics, Inc., 101 Montgomery Street San Francisco, CA 94104. Jan 2014

Word for an 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' • ĭk

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

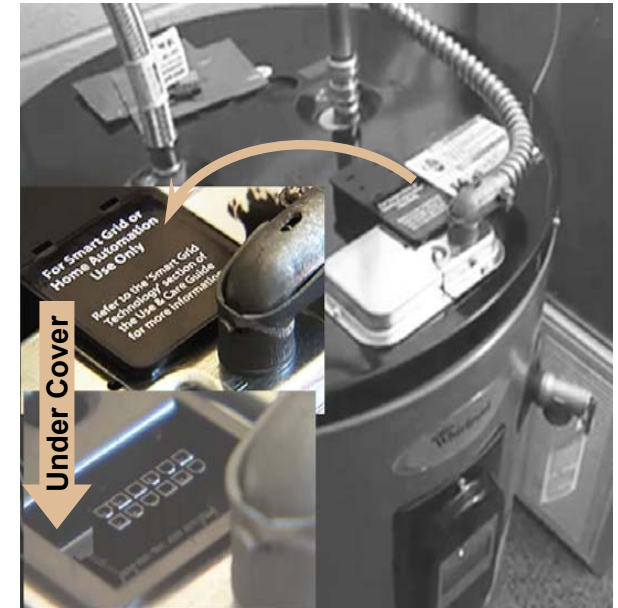
Definition: The ability of an electric device to beneficially support operation of the electric grid

End-state retail pricing

- Many utilities already have means to collect hourly usage info
- Few utilities have ability to bill residential customers under dynamic, hourly pricing – but this is the end state
 - “Simplicity” rate alternative: Pay premium for flat rate pricing
- Chicken or egg problem
 - Many customer advocates don’t want dynamic pricing until “smart” devices can respond automatically
 - Manufacturers can’t afford to build “smart” without a customer value proposition

Solution

- Start with smart water heaters
 - All, with same modular interface
- Why
 - Low involvement device (compared to t-stat)
 - High demand response value to utilities
 - Storage valuable for load shifting
 - Year-round value
 - Socket needed to allow **customer** installation & low cost communication devices
- Need market transformation plan
- After smart water heaters, go for more...



Definition of smart water heater

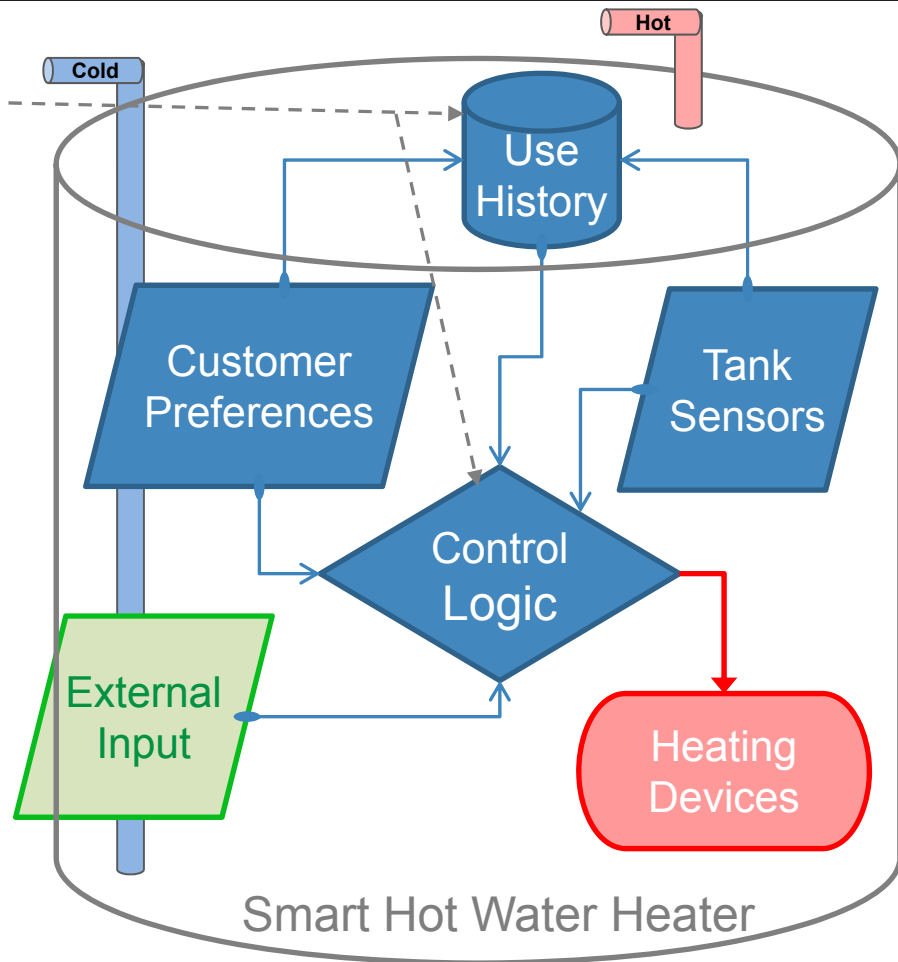
Moore's law comes to load behavior here

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

Hourly Price Forecast

E.g. OR

Direct control for load shifting



Business models to market transformation

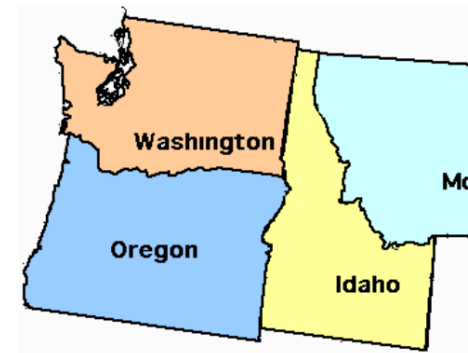
1. Seek legislative mandate
2. Ask DOE to identify consensus standard
3. Market transformation led by Pacific NW
4. Lead by example

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]



In order of least cost (and least influence)



Legislative Approach

- Lowest cost approach
- Benefit/cost exceeds 10X
- Support from some legislators and environmentalists

BUT

- Tried this: Congress doesn't like to pick standards

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Ask DOE to find a consensus standard

- Cantwell/Wyden asked Secretary Moniz to lead this effort
- Office of Energy Efficiency and Renewable Energy leaning on ASRAC and SGIP; stay tuned
- For more information about this approach attend Session 6a tomorrow at 1:30

- then maybe legislation for DOE action?



Market transformation led by Pacific NW

- Pacific NW offers a unique environment
 - Low rates
 - Traditional ability to meet peak demand via hydro – gone
 - Strong regional leadership NEEA, NWPCC
- BPA and PGE sought funds from BPA's Technical Innovation Fund [R&D] to conduct a 600-point demand response, regional demo with CTA-2045 approach.
 - In planning stages
 - Off-the-shelf water heaters; customer-installed comm devices
 - Will test 24 x 7 control strategies
 - Deliverables: Market transformation plan, and biz case to support



Lead by example

- In planning stages for 2017 or 2018 pilot demo
- To meet IRP goal
 - Start simple with peak demand, while perfecting 24x7 offer
- Looking at
 - Emerson SmartSwitch (w CTA-2045) for retrofit
 - Smart water heater rental
 - Offer to large multi-family building owners
 - Combo EE/DR incentive for heat pump water heaters
- Will be 2x more expensive than if CTA-2045 native on tank
 - Won't expand to other loads until CTA-2045 succeeds



Thanks

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