BONNEVILLE POWER ADMINISTRATION

# Developing 'Grid-Friendly' Electric Water Heating – Efficient & Controllable

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ACEEE Hot Water Forum

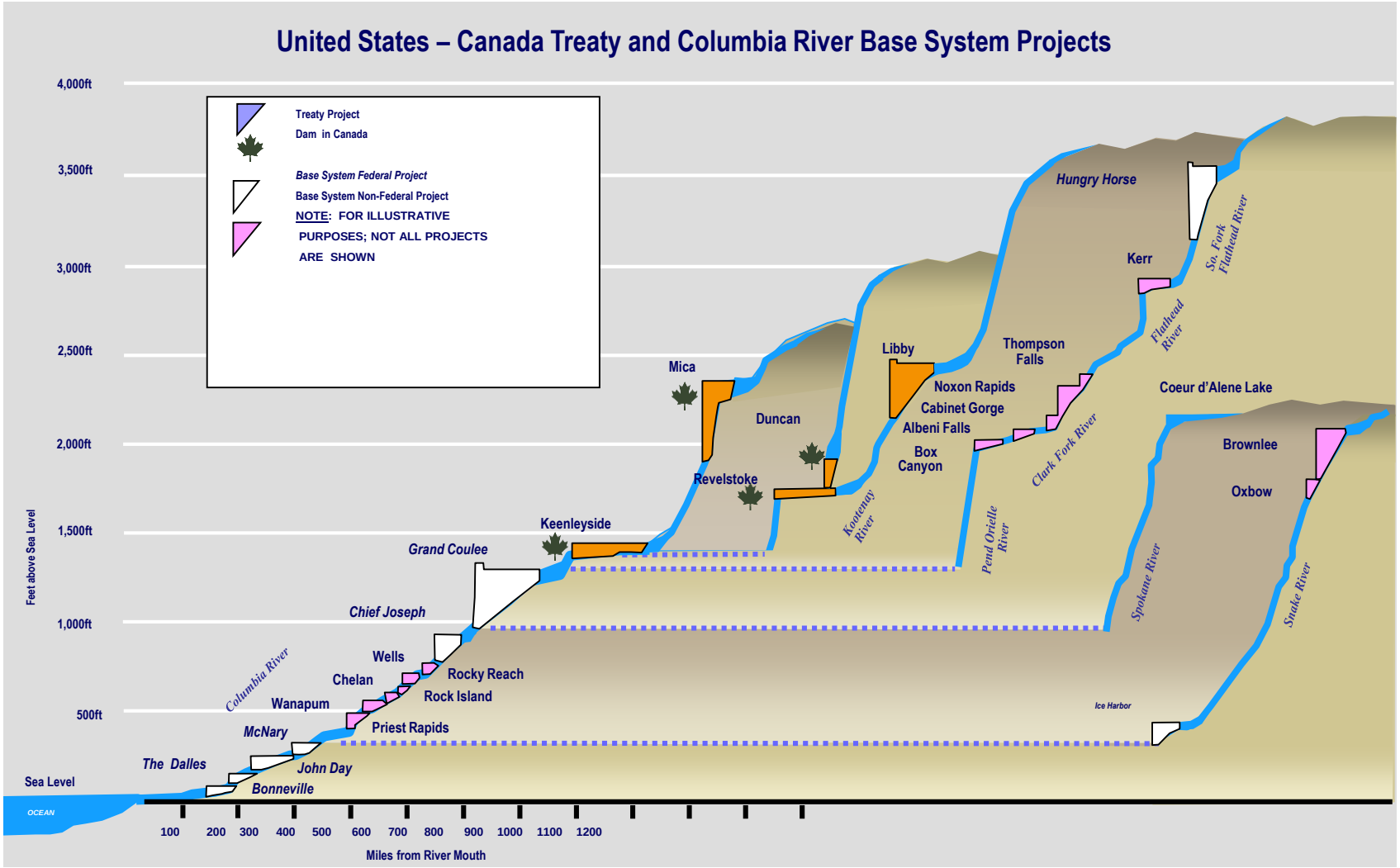
2/27/17

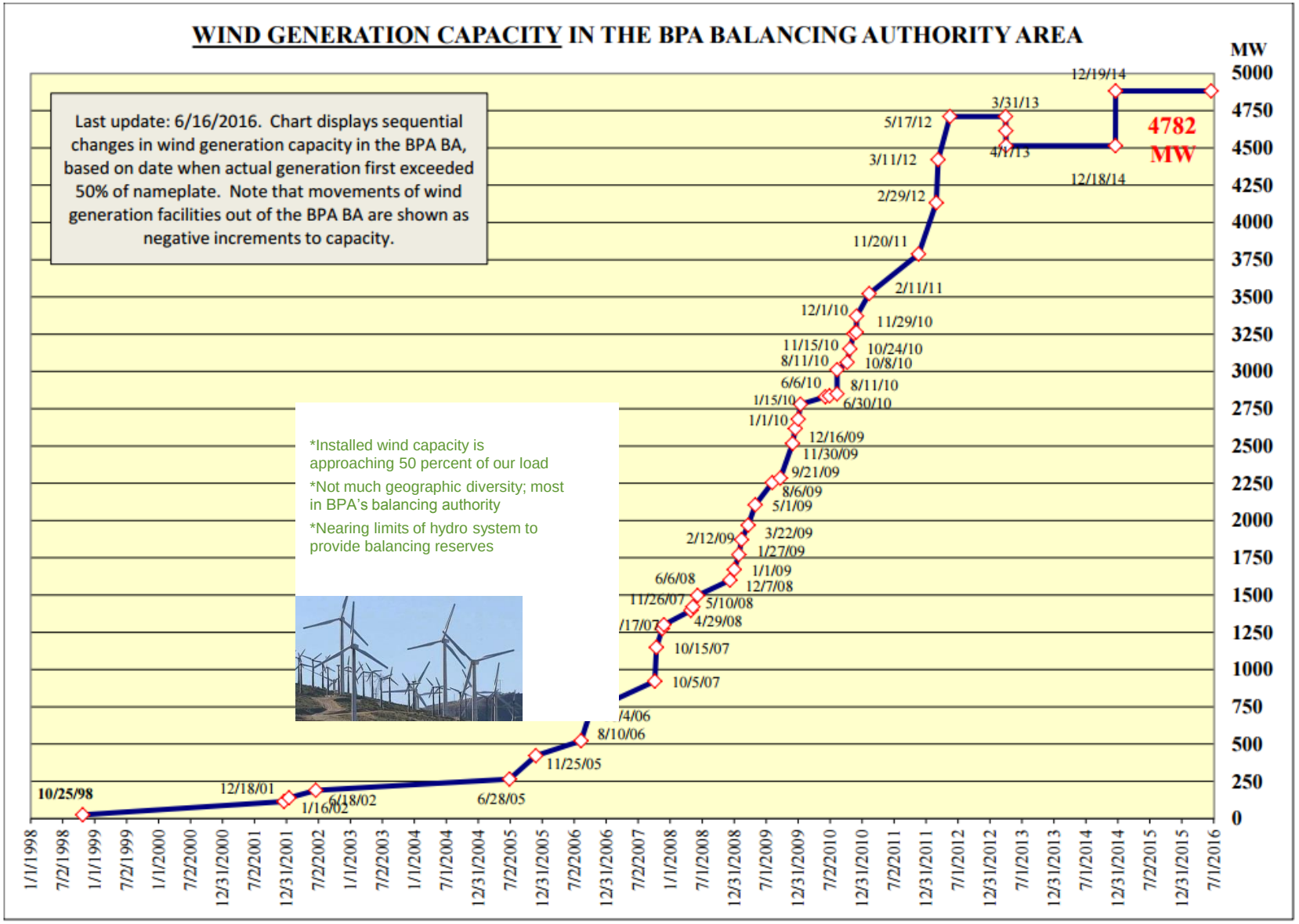
Portland Oregon

1. PNW Landscape
2. Understanding load shapes
3. Research

# BPA Supplies 42% of Power, 75% of Transmission

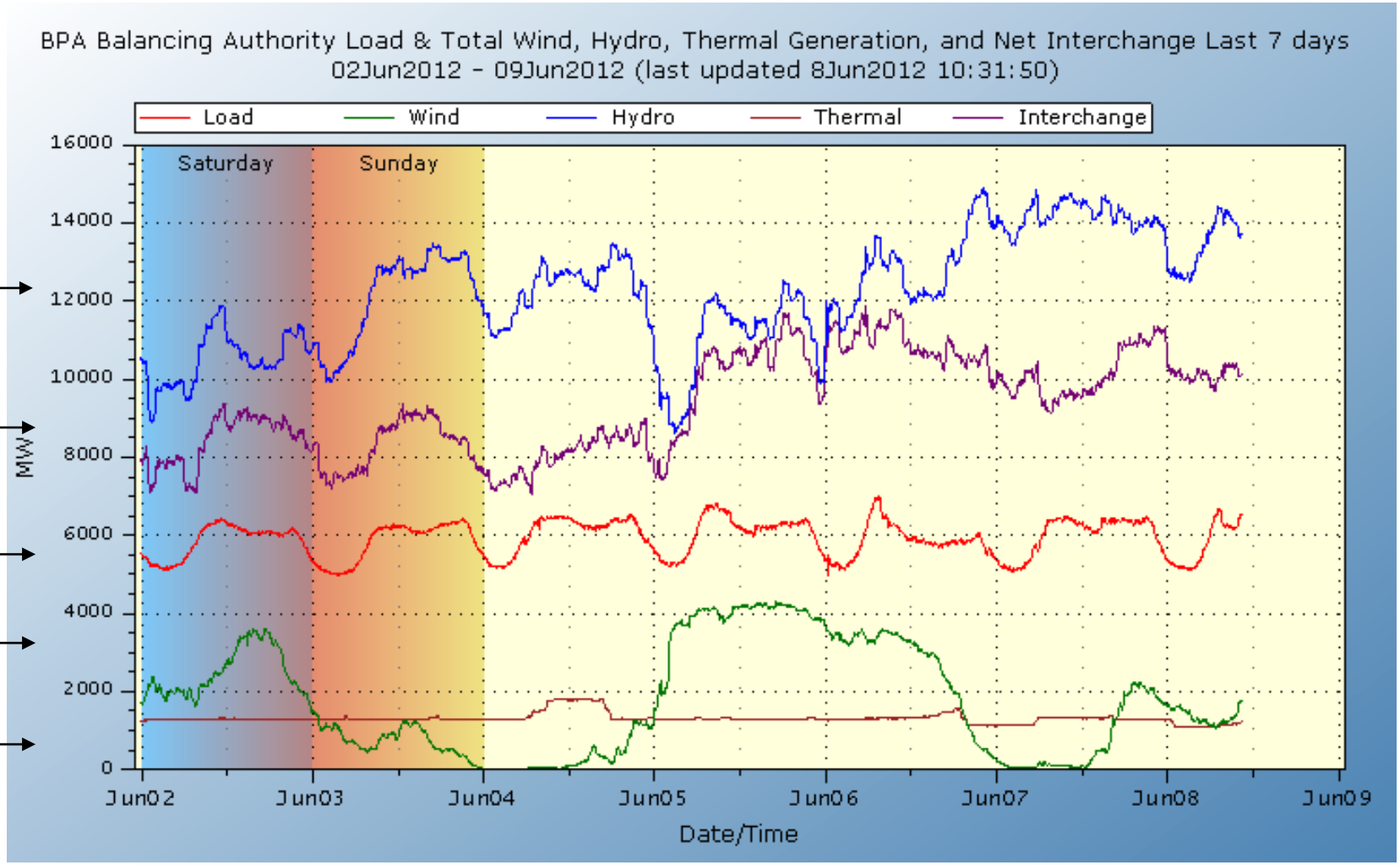
# Pacific Northwest Hydro Characteristics






BPA Transmission Technical Operations/TOT 12/19/2014

# Balancing Loads and Resources




hydro

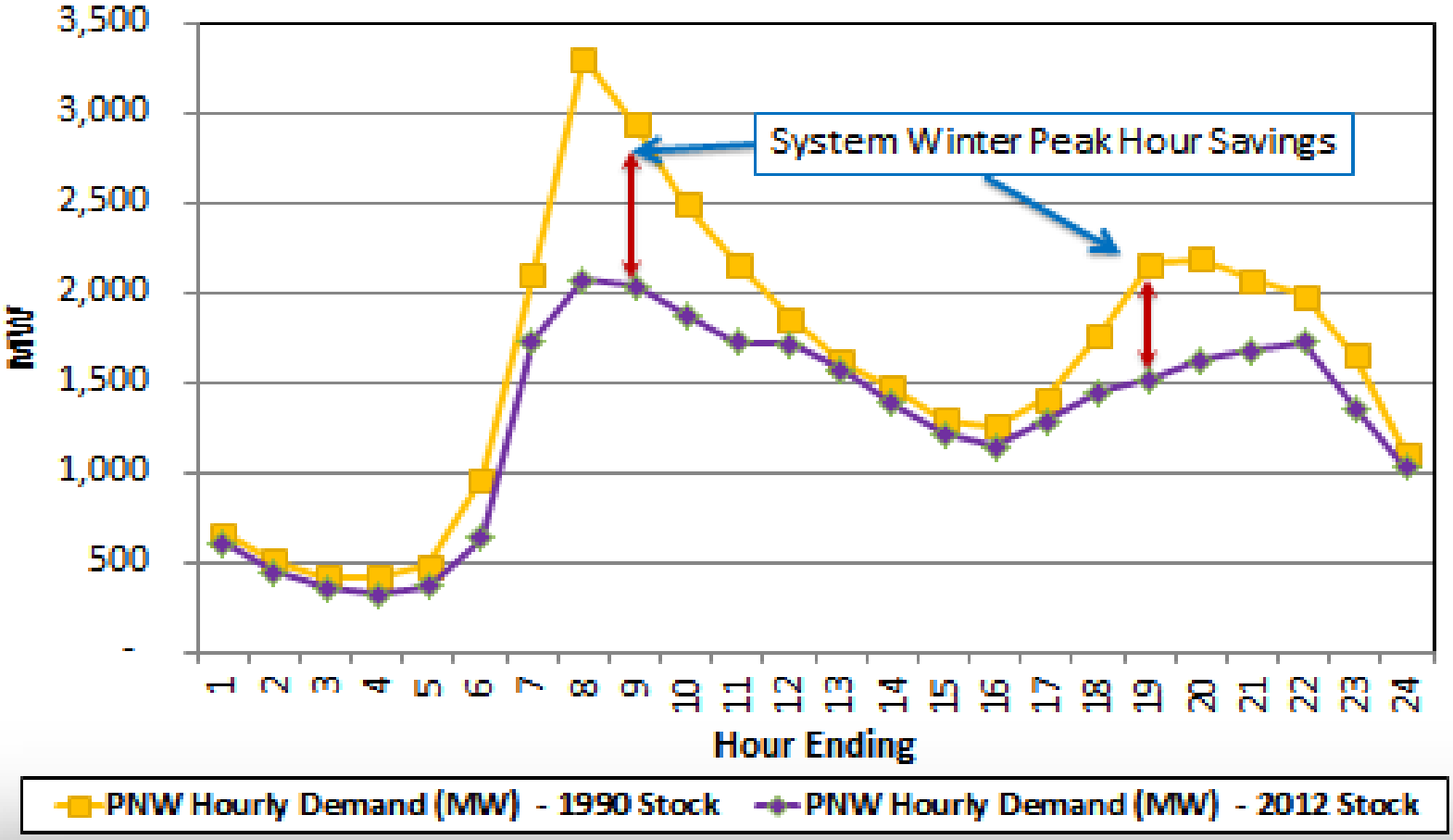
inter-change

load

wind

thermal

# Residential Water Heating PNW Hourly Demand Then (1990) and Now (2012)

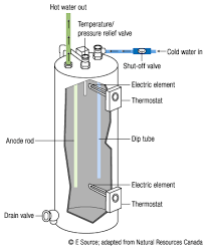


# What's the Load We're Addressing?

ELCAP, Demand response tests, and Residential Building Stock Assessment metering study have shown what the load is for electric resistance water heating (4kW element)

| | Peak hour average kW |
|---|---|
| 1984 | 1.75 |
| 1992 | 1.1 |
| 2004 | 0.8 |
| 2014 winter/Summer | 0.9/0.6 |
| 2016 winter/Summer | 0.7/0.5 |

# What Happens in the Peak Hour at one house?

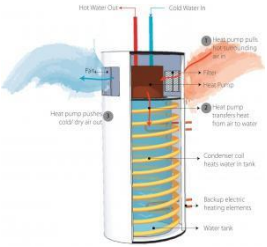



Electric Resistance

4500 W

10 min

Recovery Hour
4,500 W x 10 min = .8 kWh
.8 kwh/hr =
avg .8 kW in peak hour




Integral HPWH

500 W

60 min

Recovery Hour
500 W x 60 min = .5 kWh
.5 kwh/hr =
avg .5 kW in peak hour

- Other questions:
  - Diversity factors
  - Average vs peak
  - Multiple hour peak period
  - Water draw
  - Control strategies
  - Different refrigerants and storage tanks
  - Cost
  - Other benefits
  - Regulations

# Efficiency and Grid-Benefits Research

BPA | Utility | Consumer | Equipment

1. Signals from BPA, to Utility, to Equipment

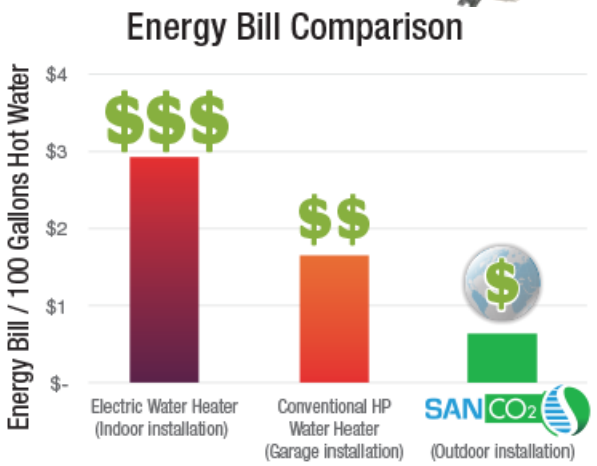
2. Equipment efficiency and response to signals:
   - Mixing valves
   - Control strategies
   - Thermal storage capacity (load up or load down)
   - Refrigerants
   - Combined space and water heat
   - Specs
   - Load shape for various types of equipment
   - Impact of Draw schedule

3. Communication technology:
   - signal type (long haul to house)
   - signal type (short haul, within house)
   - communication port in equipment
   - communication module

4. Market Transformation

# Co2 Refrigerant

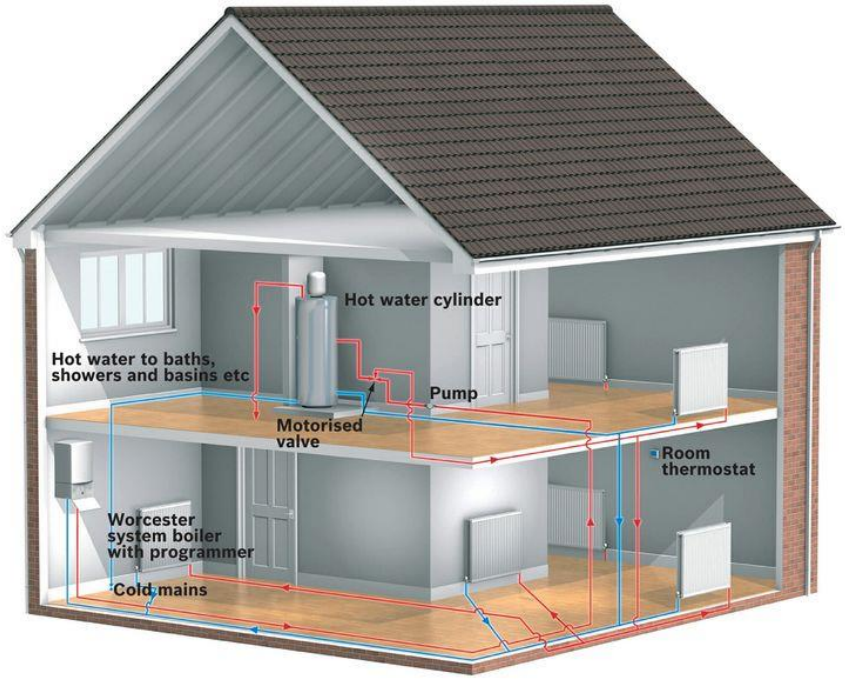
- COP of 2-6
- Performed down to -15F
- Low GWP
- 140-170F water enables
  - Storage to get thru peaks without needing compressor or R
  - Space and water


- Field testing data in cold climate (Northwest)
- Reference: Washington State University presentation by Ken Eklund available at www.sandenwaterheater.com
- Electricity price: 12.73 cents per kwh (EIA Residential October 2015)

# Combined Space and Water

- Good fit for highly energy efficient, low load homes



# CTA 2045

## EPRI Research
## Any Service Provider, Any Device, Any DR Program

Any Service Provider

End-use Device

*Consensus Responses*

Energy Service Provider or Application

Communication Module

Any Network

CEA-2045 Port

- Moderately Shed Demand
- Aggressively Shed Demand
- Shutdown (Emergency)
- Increase Demand Now (Load Up)
- Autonomously Duty Cycle
- Go to a Percentage of Rated Demand
- Use Temperature Offset to Change Set Point
- Price of Energy
- Feedback (Event Override Status, Operational State. Energy Usage, Energy Storage Capacity and Present Level, etc)





EPRI ELECTRIC POWER RESEARCH INSTITUTE

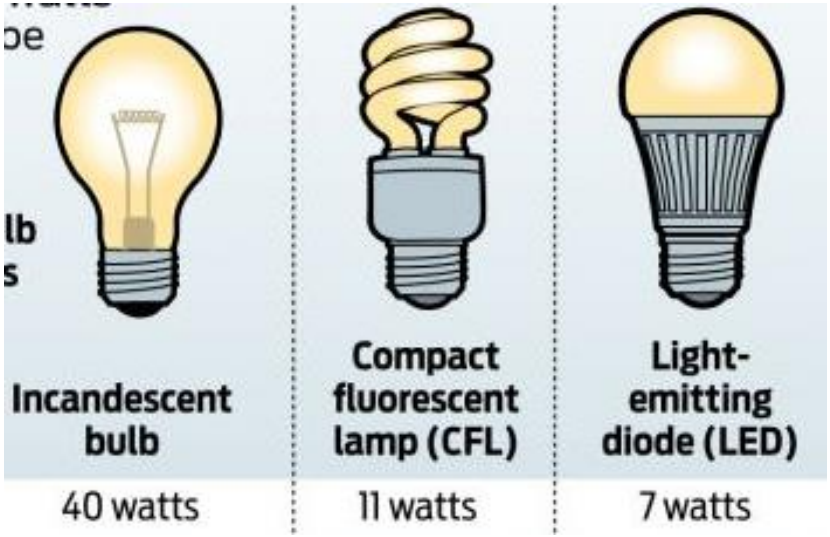
# Long Term Aim – Efficient Loads That Can Respond To Grid Needs

***Efficiency:***
***Lower Use – when ON***

PERMANENT

DISPATCHABLE

***DR or DER:***
***Reduce Peak – by sending command to turn OFF or ON***

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