



Grid-aware Water Heaters and the ENERGY STAR Specification

**Would optional criteria be helpful?
What would they be?**

Abigail Daken
March 20, 2018
Portland, OR



Desired Outcomes

- How useful are heat pumps for load flexibility?
- Market prospects for heat pumps in the next few years?
- Is now the time for optional connected criteria in the ENERGY STAR residential WH specification?
Why/why not?
- Introduce EPA's approach to connected criteria.
- Technical requirements for grid responsive water heaters – agreements and disagreements.
- Additional capabilities of connected water heaters?



Agenda

- Welcome, introductions
- Market prospects for heat pumps
- How useful are heat pumps for load flexibility?
- Current approaches for WH grid communications
- Findings from EPRI study
- Connected in existing WH and ENERGY STAR specifications
- Focused Discussion
- Next Steps and Wrap-up

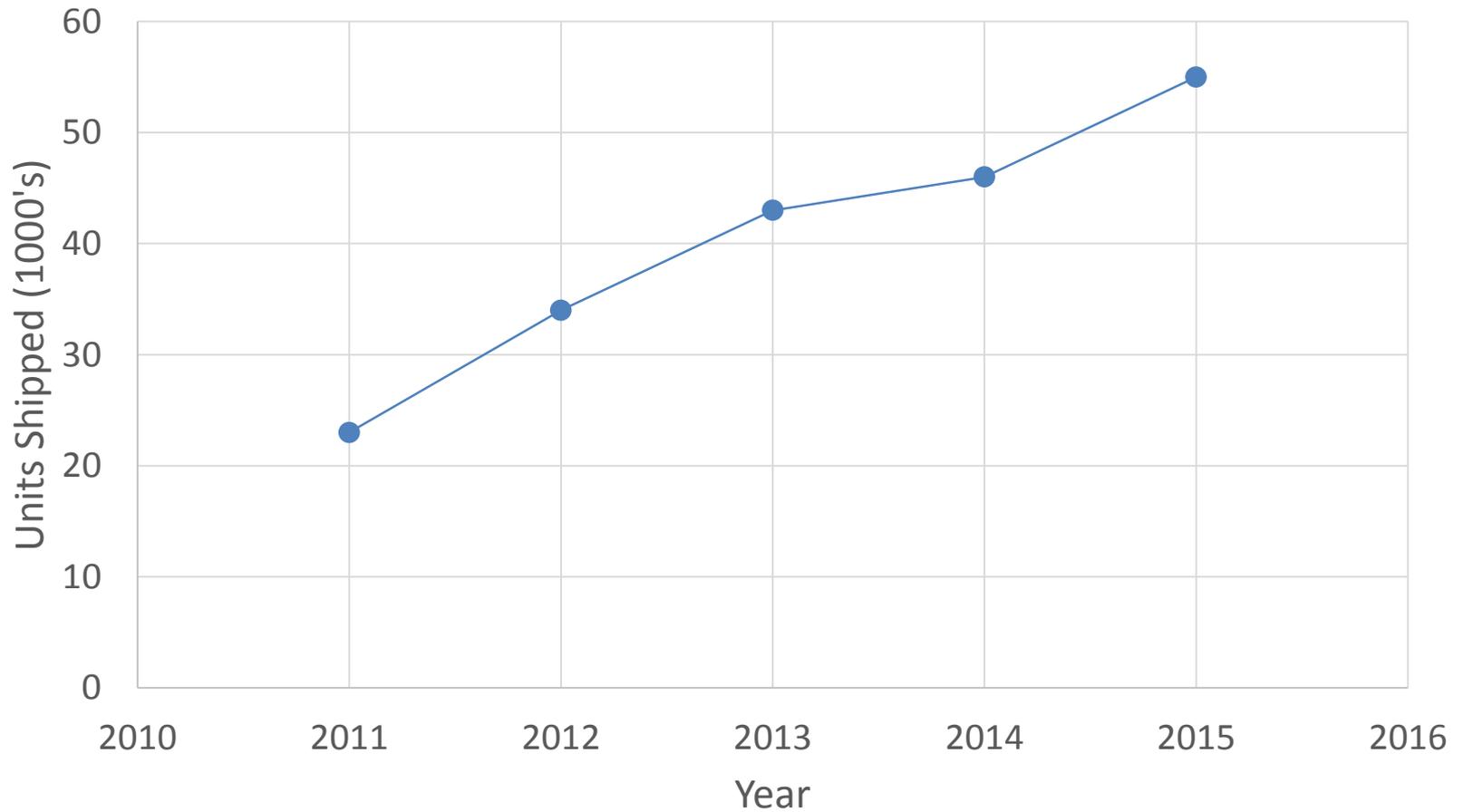


Market prospects for heat pumps

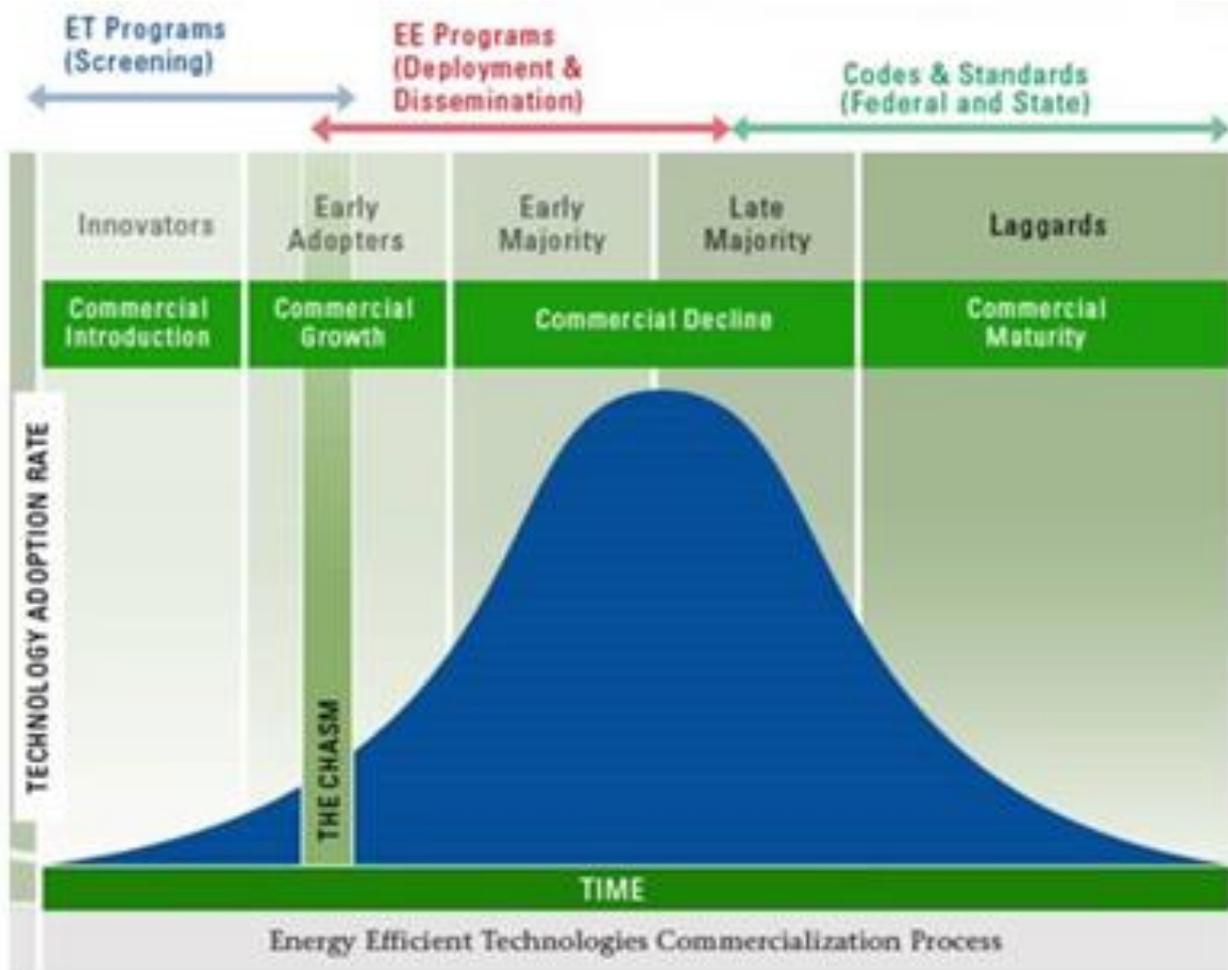
- ENERGY STAR Historical Data (Abi Daken, EPA)
- California regulations
- Geoff Wickes, NEEA
- Discussion



History of ENERGY STAR WH Sales



Technology Adoption





Are we at the tipping point for HPWH?

- Several reasons to believe HPWH sales may take off shortly
 - California housing regulations remove bias against electric water heating (effective 2020)
 - CAPUC incentive program regulations are changing – would allow incentives in CA (expect to hit in 2019 or 2020)
 - In the Northwest (NW), looking to DR to mutually reinforce
- Any other reasons?



Discussion notes, HPWH sales prospects

- PG&E: electrification pilots starting 2019; hard to predict timescale, partly because driven by local government
- Snohomish PUD: to drive numbers up we have to get past mail-in rebate as the initial purchase cost is a serious barrier
- In the NW: doubled sales every year, and expect to mostly keep that pace – the levers are there, just push them!
- Rural co-ops provide big rebates for HPWHs, but don't feel its effective – no feeling that the levers are there.
- Edison Electric Institute: significant space needed for proper operation, it's a potential barrier in retrofit applications, particularly in multifamily.
- Many expressed an opinion that it might take a few years for the market to take off. Doesn't seem that everyone is willing to bet that it will even happen.



Load Flexibility and Heat Pump Water Heaters

- Pierre Delforge, Natural Resources Defense Council
- Discussion

HPWH Demand Flexibility Study

Preliminary Results



Pierre Delforge, NRDC, pdelforge@nrdc.org

Ben Larson, Ecotope, ben@ecotope.com

Sponsored by:



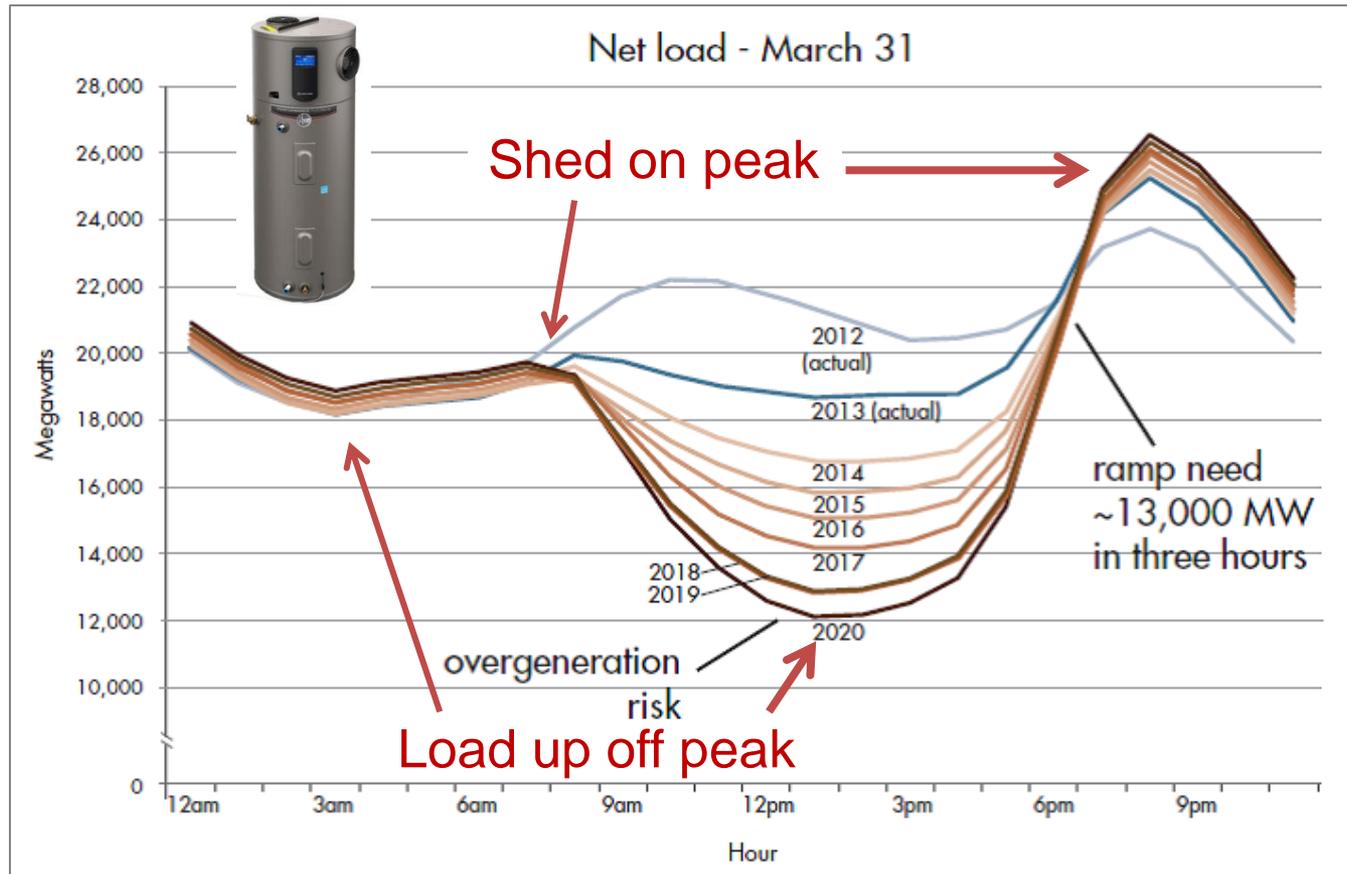
Agenda

1. Objective and Scope

2. Methodology

3. Preliminary Findings

Study objective: Assess heat pump water heater demand flexibility potential in California



- How much can HPWH thermal storage reduce customer and grid costs?

Study approach

2 parts:

1. Simulation

- Ecotope HPWHsim simulation model

2. Lab testing

- 4 HPWH models:
 - Rheem, 50 gallons
 - AO Smith, 66 gallons
 - Bradford White, 80 gallons
 - Sanden, 83 gallons
- Calibrate Ecotope's model
- Validate simulation results

Agenda

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Hourly Marginal Costs (PG&E 2024) – Annual Average

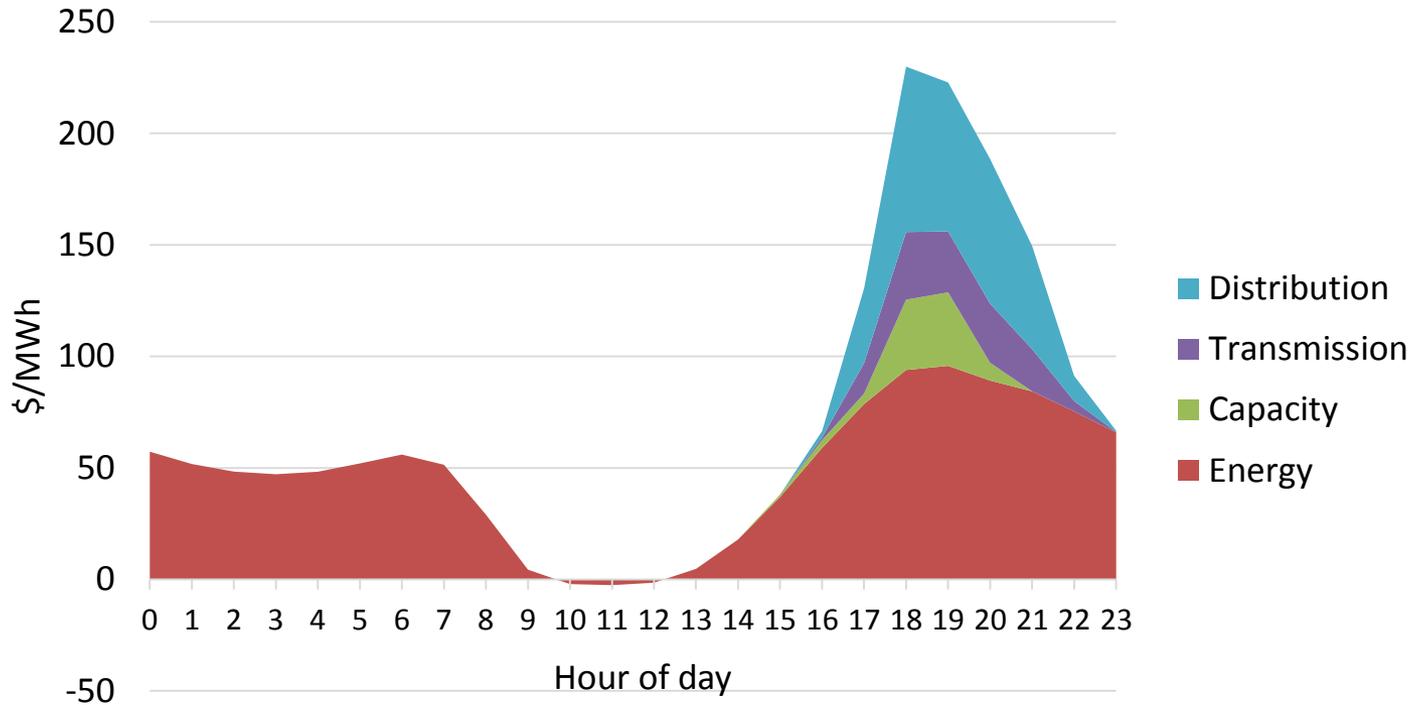
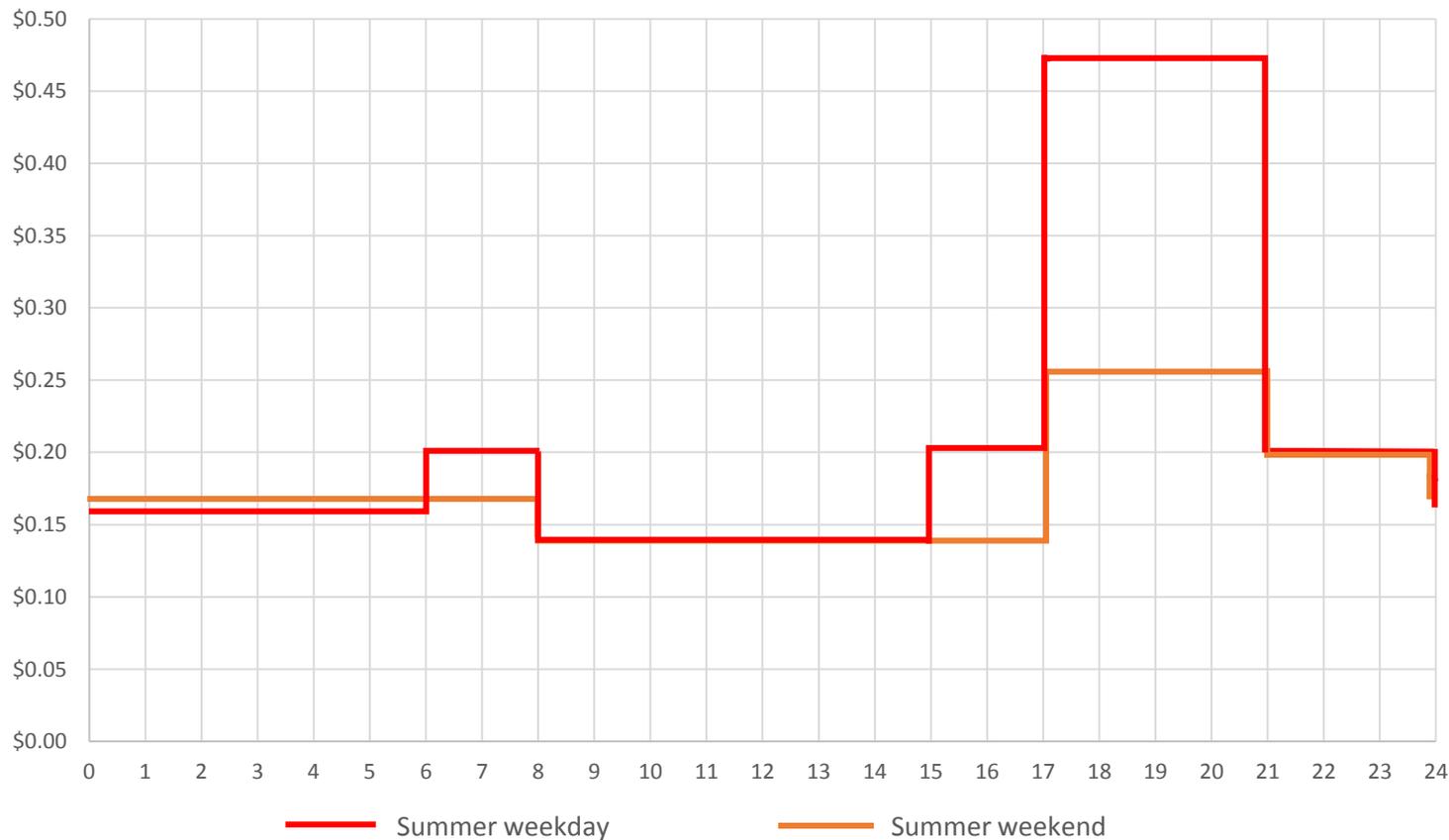


Chart shows annual average of hourly values for simplicity.
Price schedule has 8760 hourly values for entire year.

Residential Time of Use: Hypothetical NRDC “Flexible Water Heating” Rate

Reflective of PG&E 2024 marginal costs. 3x peak/off-peak price differential. Morning partial-peak to reflect morning energy marginal cost mini-peak.



Control Strategies: How to optimize HPWH operation for price schedules

3 levels of “smartness”, to evaluate their relative effectiveness:

1) **Simplest: On/off timer**

- Can be installed by user/electrician/plumber, available with current technology.
- Response only to a known, fixed price TOU price schedule

2) **Smarter: Load-up / shed**

- Load up to 135F/145F/155F during price trough, shed on peak, 125F rest of the time
- Site or cloud controls
- Fixed price TOU price schedule

3) **Smartest: Advanced price optimization, grid-connected**

Hourly optimization based on look-ahead price signal received via outside communication.

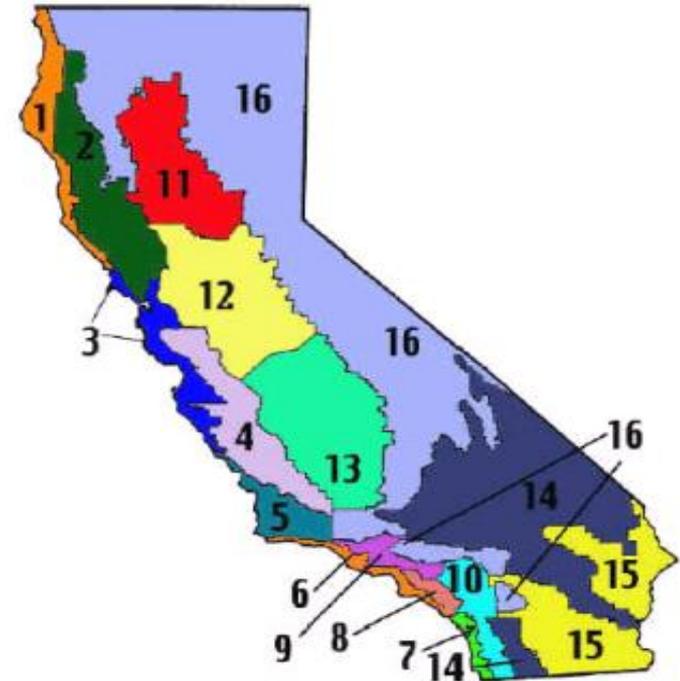
- Grid connectivity and new control functions needed
- Responds to any price schedule: dynamic or TOU

Simulation Runs

Optimization parameters:

Input values	# of values
Price signals: Utility marginal costs, TOU, TDV-NEM2	3
Units: Hybrid HPWH (50, 65, 80-gal), HP-only (50, 80-gal, Sanden Gen3-80), ERWH (50, 65, 80-gal)	11
Max water temp: 125, 135, 145, 155	4
Climate zones: all 16 CA climate zones	16
Draw patterns: 1-5 bedrooms (from CEC compliance tool CBECC-Res)	5
Control strategies: On/Off Timer, Load-up/Shed, Advanced	3
Total Scenarios	31,680

California climate zones:



How to assess if a simulation scenario is successful?

Simulation scenario successful if:

1. Controls do not compromise customer hot water delivery

- (# gallons delivered < 105F) < 0.3% *

AND

2. Costs no higher than uncontrolled case

- Price arbitrage gains > cost of increased energy use

* Hiller C., ASHRAE 1998, DHW sizing guideline: 12 runouts / year. Corresponds to 0.3% missed gallons

Agenda

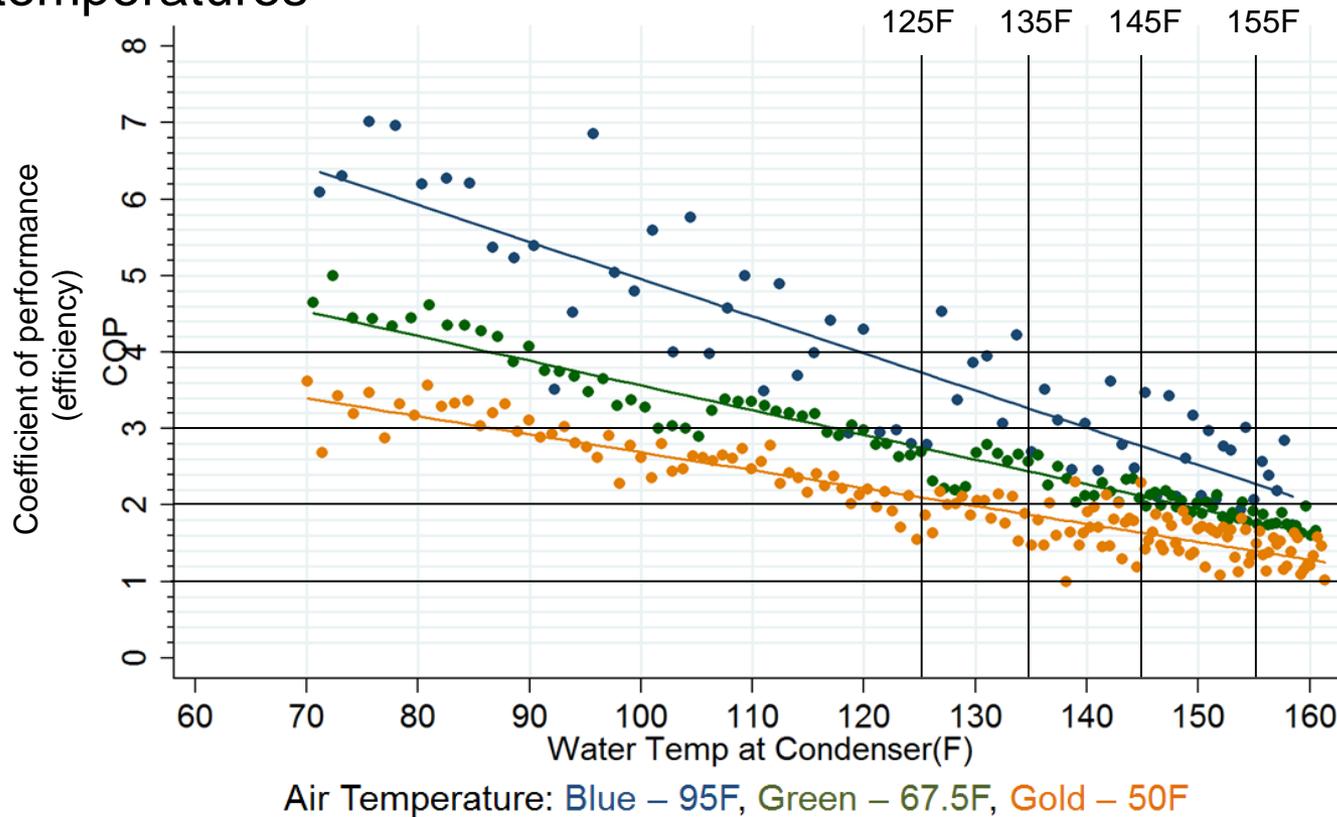
1. Objective and Scope

2. Methodology

3. Preliminary Findings

Compressor efficiency decreases and thermal losses increase at higher set points

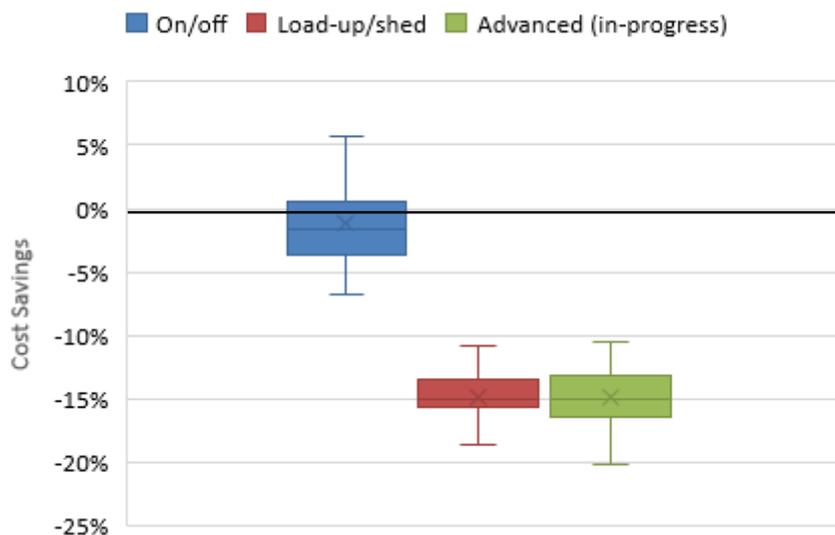
- Lab testing measured compressor efficiency at higher water temperatures



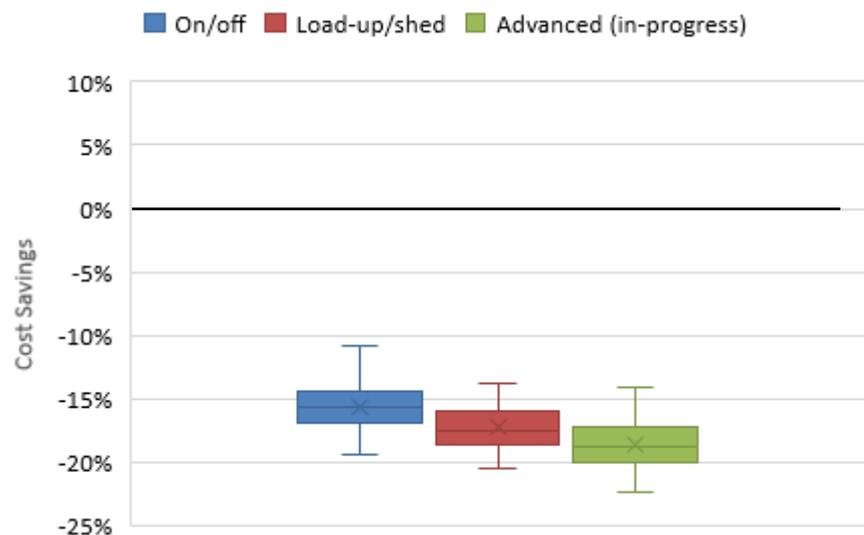
- Trade-off between thermal storage and energy efficiency

Findings: Cost Savings by Control Strategies

R134a Hybrid



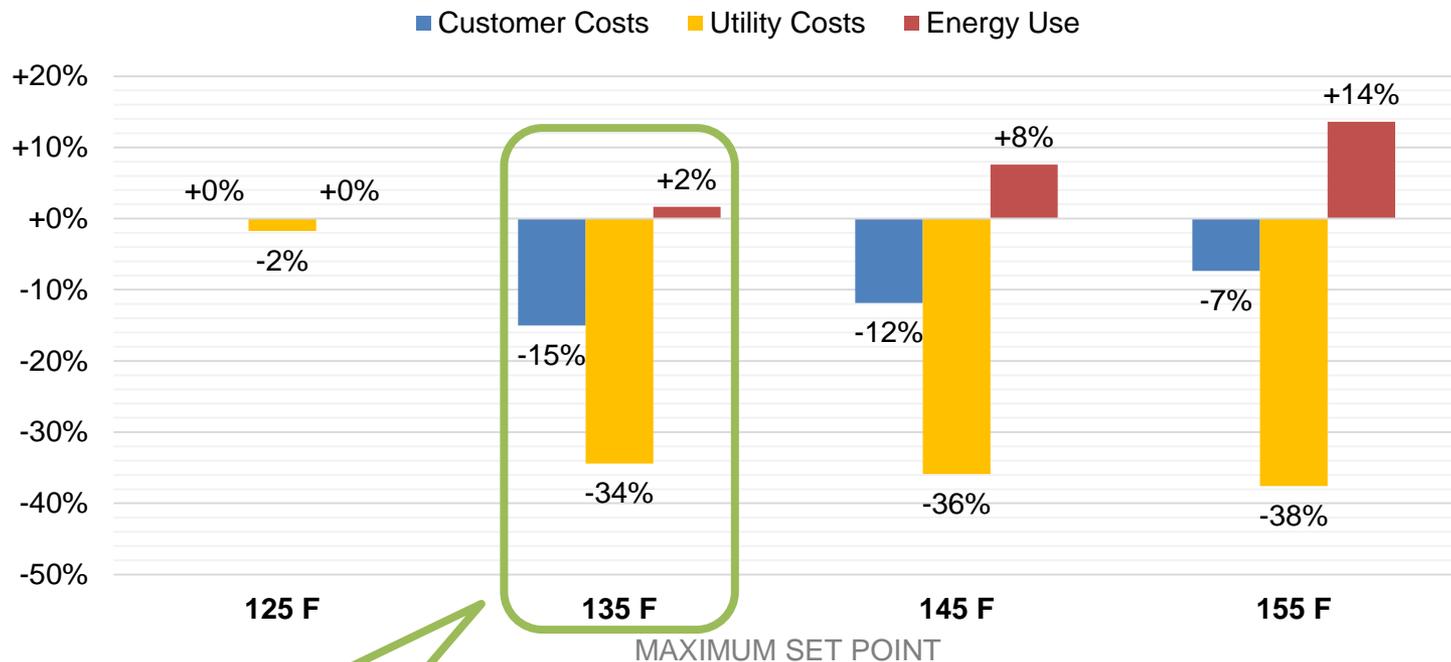
CO2 Heat Pump



- On/off strategy yields limited savings with R134a hybrid technology, and causes significant runouts
- Advanced strategy is work-in-progress

Findings: Optimal Control Temperature

Cost and Energy Savings By Set Point
(Load-up/Shed Control Strategy)



Optimal temperature
for cost / efficiency

Outcomes scorecard

	ERWH Unmanaged	ERWH Managed	HPWH Unmanaged	HPWH Managed
Peak coincidence (5pm-9pm)	20%	0%	15%	1%
Solar coincidence (8am-5pm)	50%	80%	55%	65%
Effective storage capacity / evening	-	1-2 kWh	-	0.3-0.6 kWh
Energy use (kWh/y)	2,570	2,640 (+3%)	1,030 (-60%)	1,040 (-60%/+1%)
Resistive kWh	100%	100%	16%	14%
Consumer bills	\$500	\$380 (-25%)	\$180 (-65%)	\$150 (-70%/-16%)
Utility marginal costs	\$180	\$80 (-55%)	\$57 (-70%)	\$37 (-80%/-35%)

3-bedroom house, CZ12, ERWH 50-gallon + 30F thermal storage
/ HPWH 65-gallon +10F

* Pending further
control optimizations



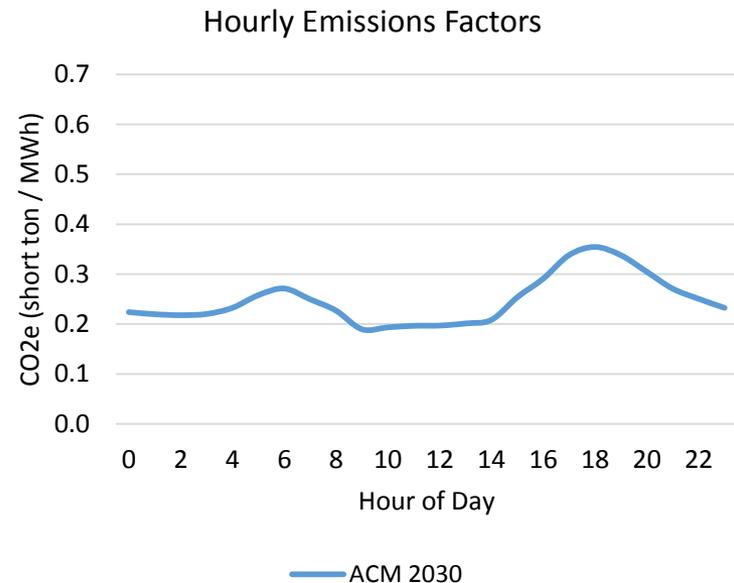
How about GHG reductions?

	ERWH Unmanaged	ERWH Managed	HPWH Unmanaged	HPWH Managed
CO ₂ e (kg)	700	650 (-7%)	270 (-60%)	265 (-61%/-2%)

Wait, why such low GHG reductions from load management?

➤ GHG bean counting issue:

- CPUC ACM emissions factors have low peak/off-peak differentiation
- Uses RPS as both floor and ceiling
- Not appropriate to value load shifting



* Avoided Cost Model: <http://www.cpuc.ca.gov/General.aspx?id=5267>

* RPS: Renewable Portfolio Standard



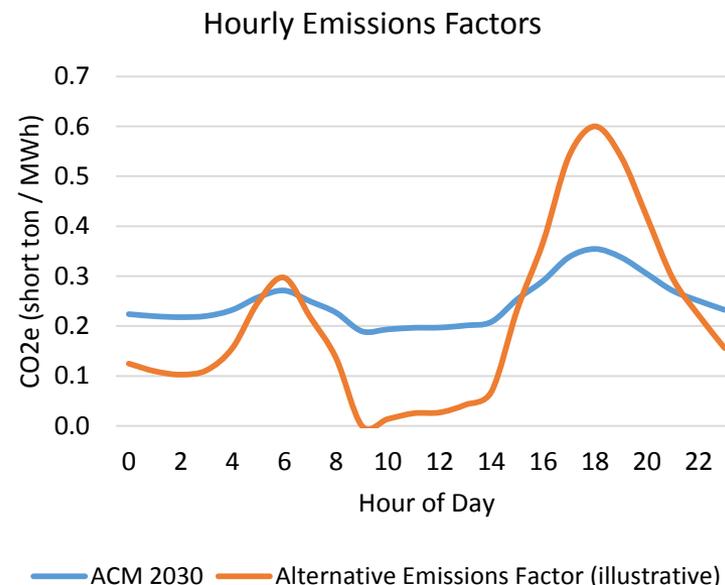
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➤ GHG bean counting issue:

- CPUC ACM emissions factors have low peak/off-peak differentiation
- Uses RPS as both floor and ceiling
- Not appropriate to value load shifting
- Highly differentiated emissions factors would yield > 50% GHG reductions!



* Avoided Cost Model: <http://www.cpuc.ca.gov/General.aspx?id=5267>

* RPS: Renewable Portfolio Standard



Key Takeaways

1. Significant potential for cost-effective HPWH load shifting
 - 130-140F sweet spot (“sweet range”)
 - 15-20% customer savings potential
 - 30-60% utility savings potential

2. Requires:
 1. Smart control technology
 2. Load flexibility programs
 3. TOU rates: cost-reflective and sufficiently differentiated OR alternative customer compensation mechanism
 4. Incentive programs and supportive regulatory environment (e.g. building code)
 5. Appropriate GHG accounting methodology for load shifting

Thanks!

Questions?



Pierre Delforge, pdelforge@nrdc.org

Ben Larson, ben@ecotope.com

Steering Committee: David Rivers (SCE), Owen Howlett (SMUD), Beckie Menten (MCE), Rachel Kuykendall (SCP), Geoff Wickes (NEEA), Christine Tam (Palo Alto), Bruce Wilcox, Jim Lutz, Ram Narayanamurthy (EPRI)



Discussion notes, Load flexibility and HPWH

- Discussion of the valuation (both cost and GHG emissions) of load flexibility. Conclusion – except in certain specific cases (e.g. co-ops), true value doesn't return to customer, generally.
- EEI: doesn't take into account buyer purchases of green power, and note that ALL electric uses are low GHG if the electricity is low emissions
- PG&E: doing study with almost all 50 gal tanks – how sensitive are the results to tank size? Ability to load up is limited, b/c manufacturers won't go above customer set point. Would a mixing valve mitigate the problem?
- AO Smith: 120 F when shipped. UL won't let controls remotely go above customer set point, for good reasons. Mixing valve might help, but there's some work to do.
- Set point could be adjusted upon installation



Discussion notes, Load flexibility and HPWH

- Need to use diversified demand studies (not averages) to capture true runouts depending on outdoor temp.
- Another plug to address scalding – any scalding risk is too much. Some do not trust mixing valves.
 - Note: mixing valves fail safe, if installed properly – less risk if installed at the factory. Mixing valves in HPWHs are not installed at the factory now, but non-certified valves are part of tankless.
- Sanden HPWH must be installed with a mixing valve, but doesn't ship with one.
- Mixing valves are not in themselves expensive, but there are issues about shipping, and the fact that it is currently not something that's provided by the manufacturer



Existing Approaches for Water Heater Load Flexibility

- Aquanta, Inc.
- Keith Dennis, NRECA
- Angela Chuang, EPRI



A few notes about ERWH in the ENERGY STAR specification

- The specification requirements are such the electric resistance water heaters will not meet the requirements, and can't be ENERGY STAR certified
- That is not likely to change
- However, any criteria and test method development can keep electric resistance in mind
 - Ideally, a test method developed for ENERGY STAR would also be useful for electric resistance

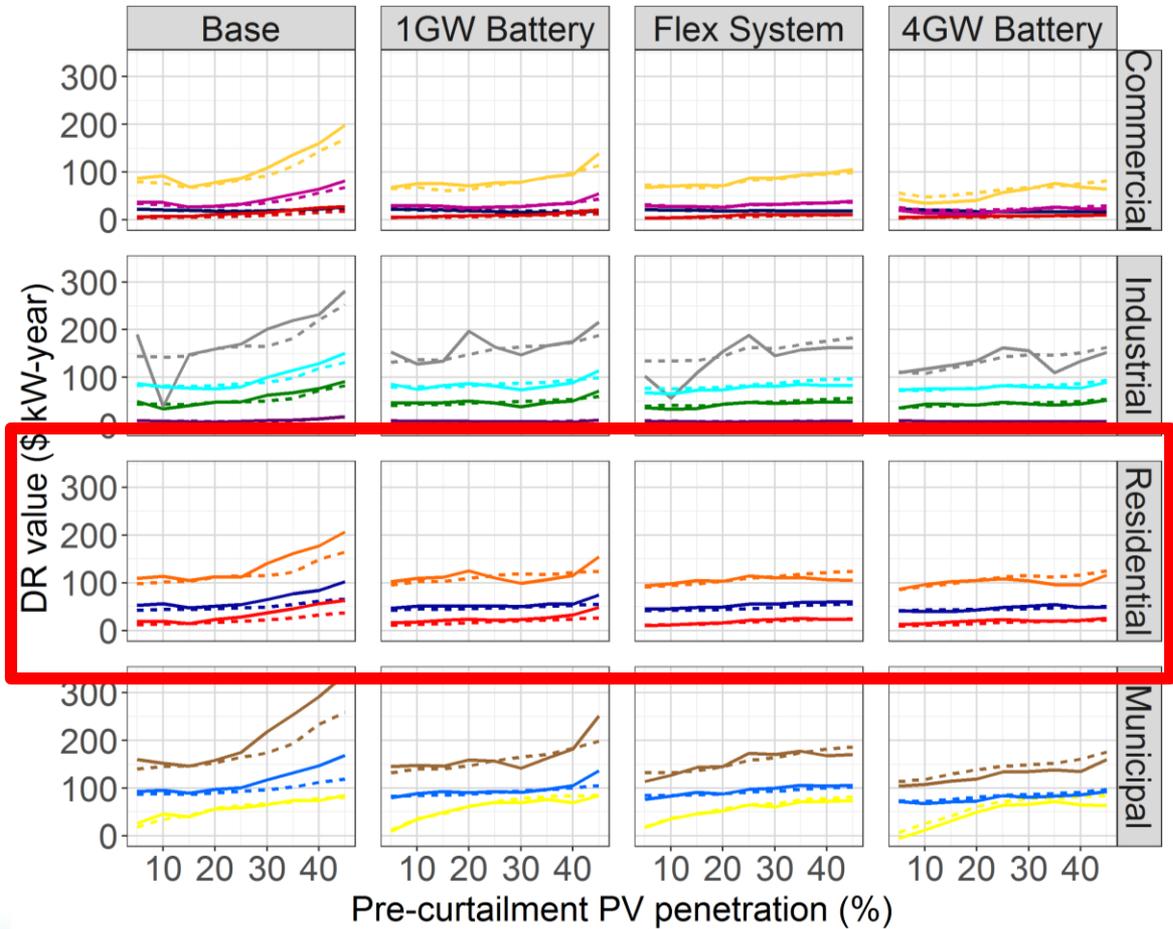


Grid-Integrated Water Heater Control for the 21st Century

Aquanta Inc.
1775 Tysons Blvd, 5th Fl
Tysons, VA 22102
www.aquanta.io

Grid-Interactive Water Heating: Leading Enabler of Renewables

NREL 2017: “Demand Response Potential from the Bulk Grid Perspective”



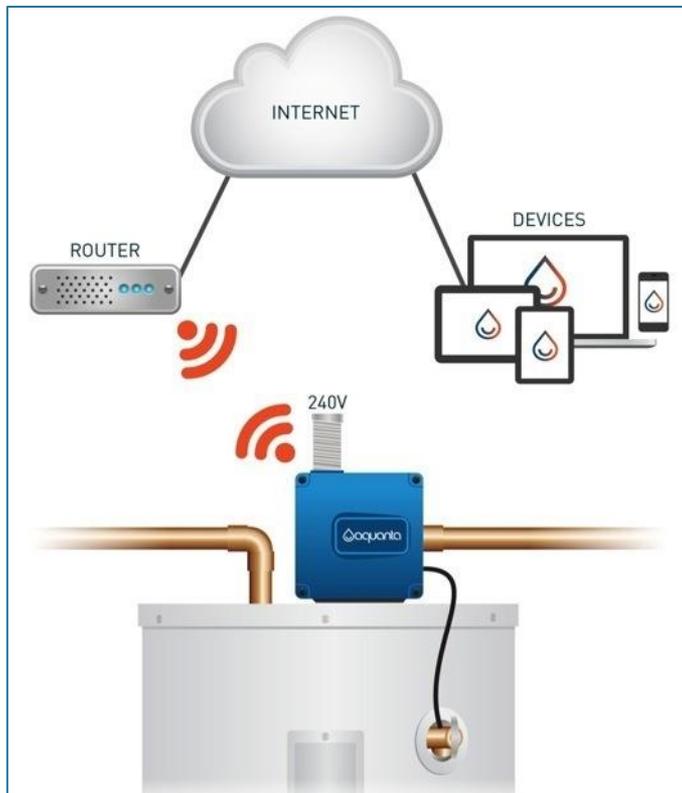
DR Scenarios
 — Low DR
 - - High DR

- DR End Use**
- Commercial cooling
 - Commercial heating
 - Commercial lighting
 - Commercial ventilation
 - Industrial agriculture
 - Industrial datacenters
 - Industrial manufacturing
 - Industrial refrigerated warehouses
 - Municipal outdoor lighting
 - Municipal wastewater pumping
 - Municipal water pumping
 - Residential cooling
 - Residential heating
 - Residential hotwater

Aquanta Water Heater Controller



Aquanta Water Heater Controller



- ▶ **Networked, Smart Home Enabled**
 - Cloud-cloud integration w/ other platforms
- ▶ **Enthalpy Sensor Analytic Capabilities**
 - “Learning” algorithm
 - Enable and enhance Smart Grid
- ▶ **Easy, (Near-)Universal Retrofit**
 - < 60 min install; DIY-friendly
- ▶ **Electric and Gas WH Versions**
 - Compatible w/ 65-80% of US WH installed base

Grid-Connected WHs = Connected T-Stats

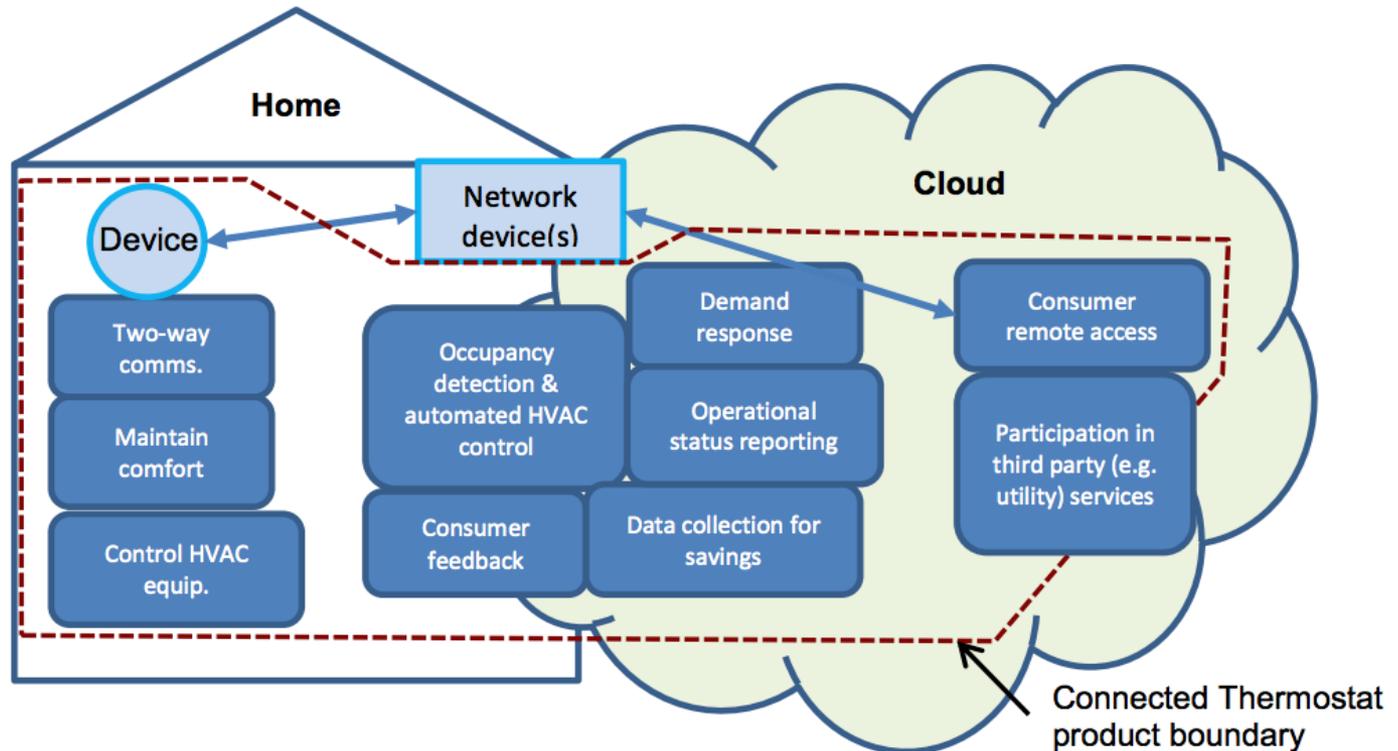


Figure 1: Connected Thermostat Product

Please Broaden The Perspective on Smart Electric Water Heating

Keith Dennis, Sr. Director
National Rural Electric Cooperative
Association

Broad Stakeholder Calls for Smart Water Heating Beyond Heat Pump



April 24, 2017

Ms. Abigail Daken
U.S. Environmental Protection Agency
WaterHeaters@energystar.gov

Re: ENERGY STAR® Residential Water Heaters;

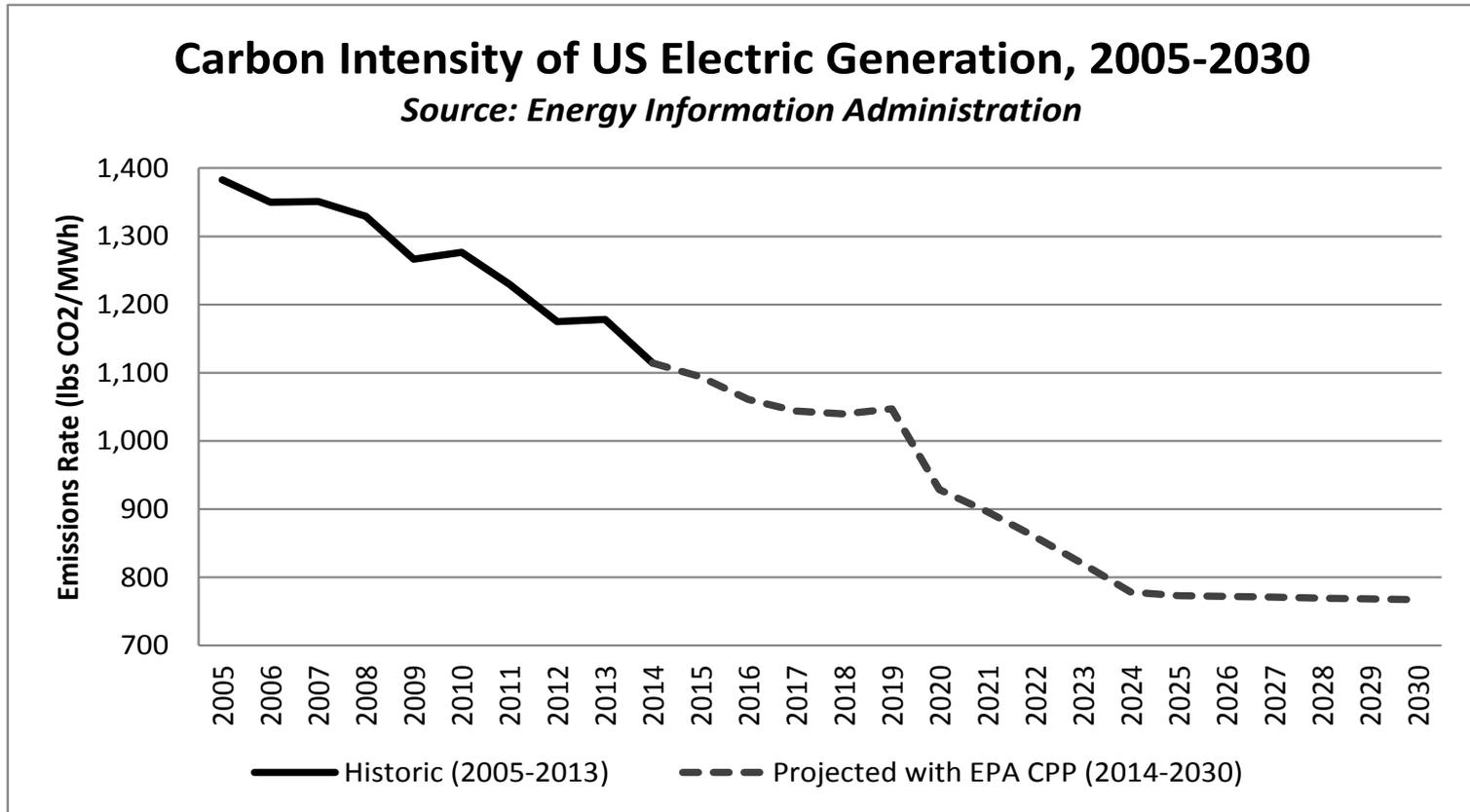
Dear Abigail,

- Growing importance of load flexibility and system-level efficiency.
- Grid-connected water heaters are particularly amenable to providing flexible operation, energy storage, and grid ancillary services.
- Grid-connected ERWH and HPWH both appear to offer consumer and environmental merit under different grid and consumer conditions.
- Achieving market transformation in advanced, controlled electric water heating will facilitate environmentally beneficial electrification.

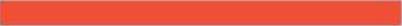
Introduction: What is “Environmentally Beneficial Electrification?”

The use of electricity in end-uses that would otherwise be powered by fossil fuels (natural gas, propane, fuel oil, or gasoline) to reduce greenhouse gas (GHG) emissions.

Carbon Intensity of US Electric Generation 2005-2030



- While the energy efficiency of devices will not change once installed, the ***emissions efficiency***



The Hidden Battery

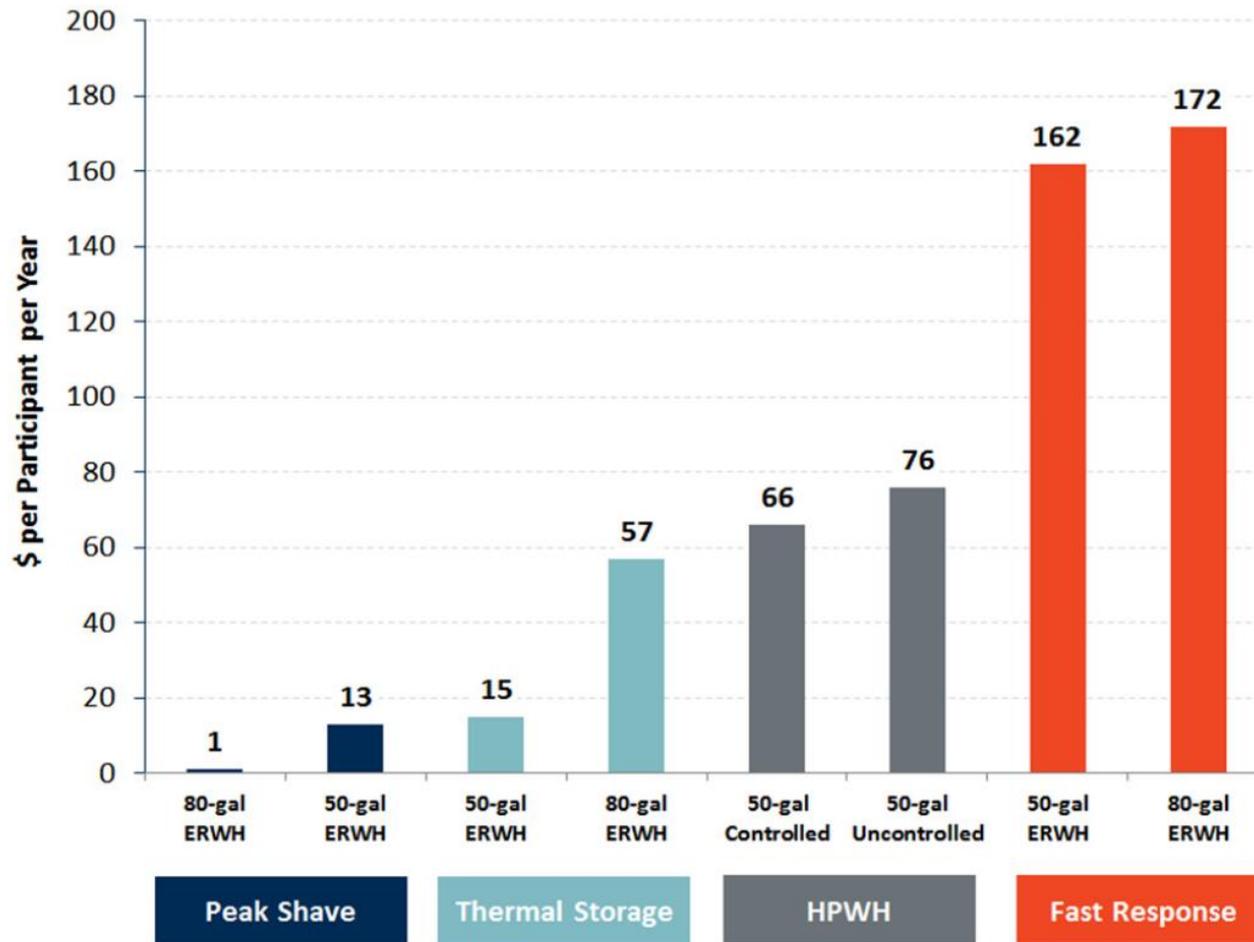
Opportunities in Electric Water Heating

PREPARED FOR



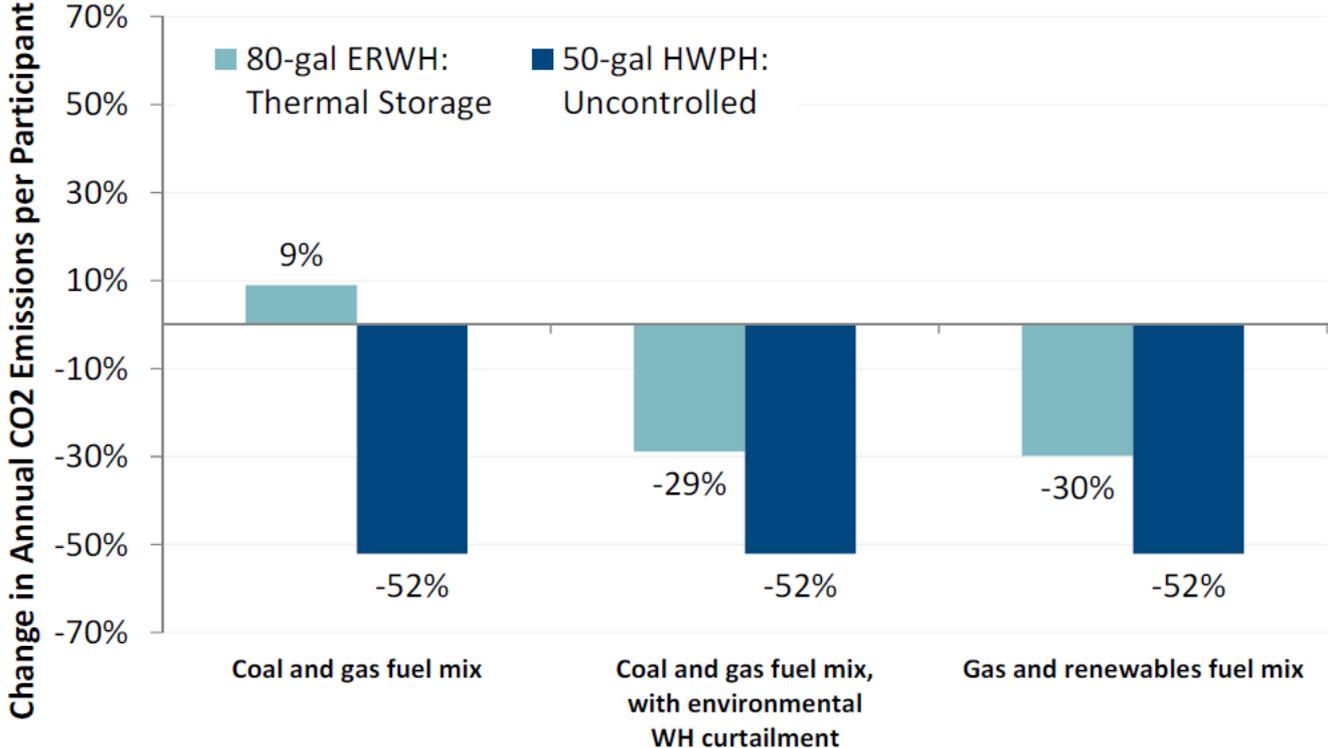
Conclusion— Lots of Options to Save \$

Figure ES-1: Annualized Net Benefits of Water Heating Strategies (PJM 2014)



Potential for CO2 Reductions Load Control

Figure ES-2: Change in Water Heater CO₂ Emissions
(Relative to Baseline Uncontrolled 50-gallon ERWH)



Congress Requests and Actions – Can Voluntary Programs Help?

LISA MURKOWSKI, Alaska, Chairman
JOHN BARRASSO, Wyoming
JAMES E. RISH, Idaho
MIKE LEE, Utah
JEFF FLAKE, Arizona
STEVE DAINES, Montana
BILL GASSIDY, Louisiana
CORY GARDNER, Colorado
ROB PORTMAN, Ohio
JOHN HOEVEN, North Dakota
LAMAR ALEXANDER, Tennessee
SHELLEY MOORE CAPITO, West Virginia
MARIA CANTWELL, Washington
RON WYDEN, Oregon
BERNARD SANDERS, Vermont
DEBBIE STABENOW, Michigan
AL FRANKEN, Minnesota
JOE MANCHIN III, West Virginia
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SAM E. FOWLER, DEMOCRATIC CHIEF COUNSEL

United States Senate

COMMITTEE ON
ENERGY AND NATURAL RESOURCES

WASHINGTON, DC 20510-6150

WWW.ENERGY.SENATE.GOV

September 14, 2015

The Honorable Ernest Moniz
Secretary of Energy
1000 Independence Ave., SW
Washington, D.C. 20585

Dear Secretary Moniz:

We are writing to request that the Office of Electricity Delivery and Energy Reliability establish a working group to establish and promote the widespread adoption of a standard communication “port” for selected appliances, particularly electric water heaters.

Sincerely,



Maria Cantwell
Ranking Member
Senate Committee on Energy and Natural Resources



Ron Wyden
Member
Senate Committee on Energy and Natural Resources

Time to Implement! – The “Community Storage Initiative”



Five blue water droplets are positioned above the text.

Your electric storage water heater is a thermal battery that can help integrate renewable energy into the grid.



America's Electric Cooperatives



Community Storage Initiative Founding Supporters – Where are the Federal and Efficiency stakeholders?



Why Is Support Lacking?

- 97-99 out of 100 electric water heaters sold are electric resistance – why not put some effort to making them smart? ***Past Due***
- National effort needed, not just NW or California
- If emissions are reducing (CA goal for example) will energy efficiency be as important emissions efficiency and teaching the duck to fly? Can EE programs evolve to accommodate?
- We need market transformation to improve system-wide EE and help reduce GHG – Isn't there a program that has been set up for that? (Nudge, nudge ENERGY STAR?)

A HP Only Solution Leaves Many, Many Out of the Smart Heating Opportunity

Considerations – Heat Pump Water Heaters (HPWHs)

Basic Considerations

HPWHs are unique compared to other water heaters in that their performance and efficiency are dependent on the conditions in which they are operated. HPWHs transfer heat from the surrounding air to the water and will produce exhaust air that is cool and dry. In addition, HPWHs generate noise similar to a dehumidifier when running and require periodic air filter cleaning. HPWHs have unique requirements in terms of placement and available space compared to a conventional electric resistance unit.

Consequently, before considering a HPWH, you should be able to answer “Yes” to all these questions about HPWH install location.

HPWH Install Location Questions	Check Yes or No	
Is location in an unoccupied space where cooling and noise will not be an issue?	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Does location offer more than 1,000 cubic feet of surrounding air (i.e., approximately the space of a 12 foot by 12 foot room)? (Efficiency will suffer in a closet – even one with louvred doors - and you need adequate clearance around air entry and discharge.)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Does location offer sufficient height to install? (HPWH are usually taller than traditional storage tank water heaters to accommodate the heat pump.)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Can location accommodate or does it already have a condensate drain or pump? (HPWHs produce condensate.)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Is ambient air temperature not consistently in freezing range (32 degrees F) or below? (HPWHs do not operate in freezing temperature like outdoors or in garages during northern climate winters.)	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Does ambient air temperature remain between 40° - 90° F year-round? (An ideal spot would be near a furnace in a basement that is very warm all winter or a garage in very warm climates.)	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Additional Cold Climate Considerations

- From EPA Web Site:
- Must answer “yes” to all of this – and this is before grid-connected tech....

Flexible Demand Response with Water Heaters

Grid Services and Functions

Angela Chuang
Senior Technical Leader

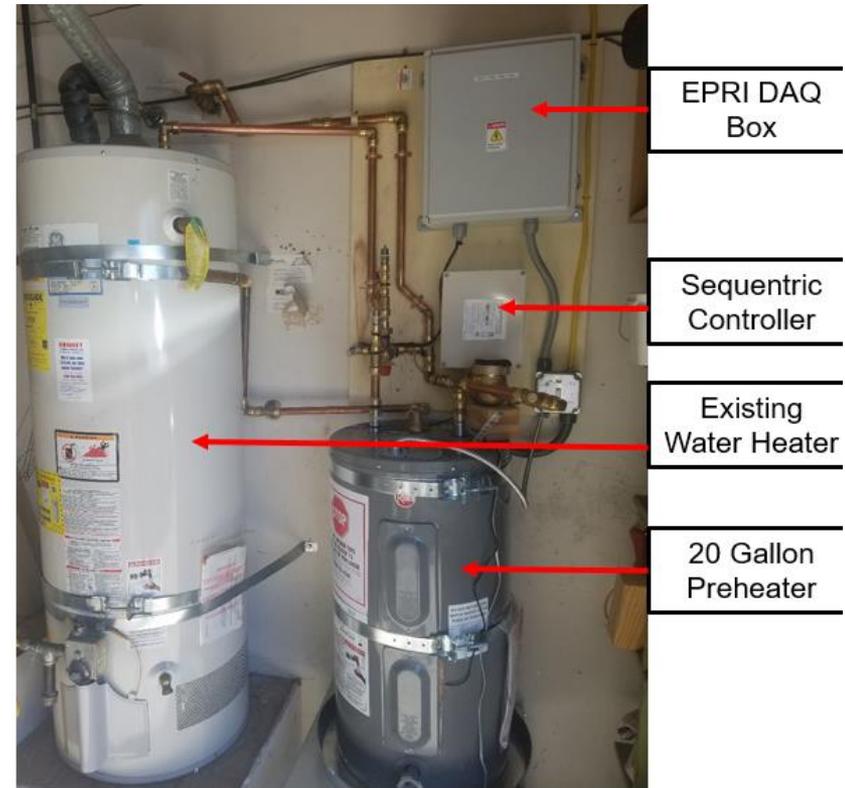
**ENERGYSTAR and Connected Water Heaters:
Stakeholder Discussion, Portland, OR**
March 20, 2018



SMUD-Hosted Flexible DR Demo

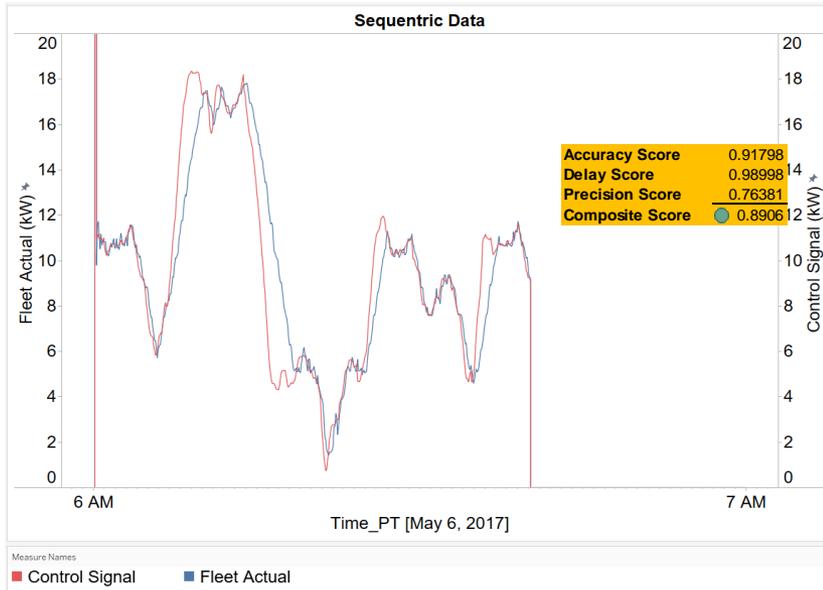
Field Test Overview

- Six 20-gallon electric resistance preheaters were installed in the field with Sequentric controllers
- EPRI monitored the water draw and power usage of most preheaters
- Testing occurred for approximately 2.5 months
- Several events were run:
 - 40-min PJM RegD test signal
 - 8-hour PJM RegD test signal
 - 1-hour ramp up/down
 - 3-hour ramp up/down
 - LMP Dispatch



SMUD Host Adviser: Josh Rasin; EPRI PM: Angela Chuang; EPRI Lab Lead: Doug Lindsey; Sequentric Lead: Dan Flohr

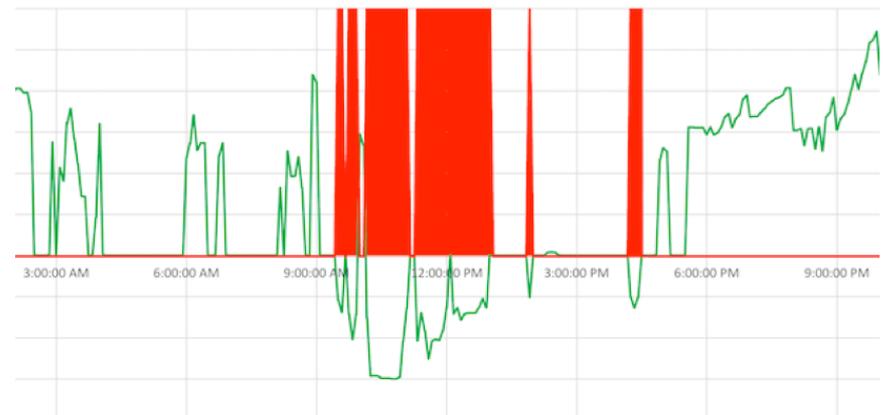
40-Minute PJM Signal



- The fleet closely followed the test signal. Deviations primarily occurred during large ramps up or down. Overall, PJM scoresheet score of 89%.

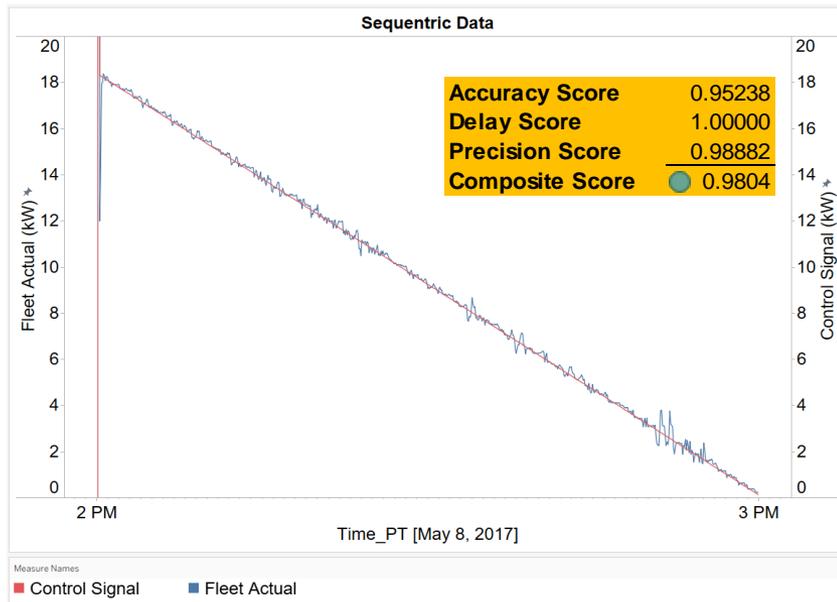
SMUD WATER HEATER OPERATION DRIVEN BY LMP

May 27, 2017 LMP WAS NEGATIVE FOR 220 Minutes

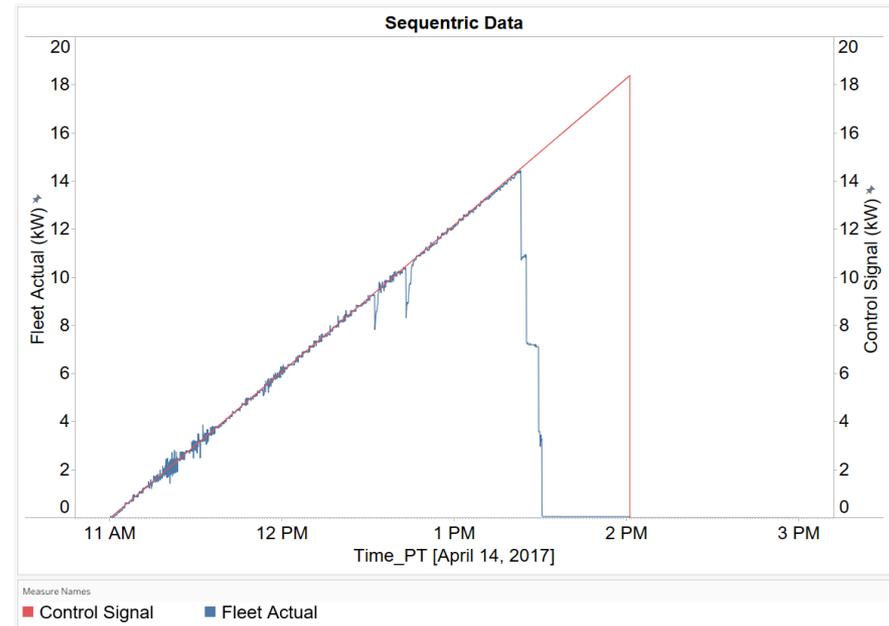


- The WHs were asked to turn on during periods of negative LMP using real-time data. The 4 WHs that EPRI monitored responded at full on when they had available capacity.

1-Hour Ramp Down vs. 3-Hour Ramp Up



- The 1-Hour ramp down event was completed successfully. There was a little variability towards the end but the line would be smoother with more WHs in a fleet. The PJM scoring sheet rated the event at 98%.



- This 3-hour ramp up event did not finish. It lasted 2 hours and 23 minutes before too many WHs ran out of capacity. WH4 ran out first after 1.5 hours, then WH2 dropped out 12 minutes later. The remaining four ran almost at full output before one-by-one they dropped offline.

Takeaways

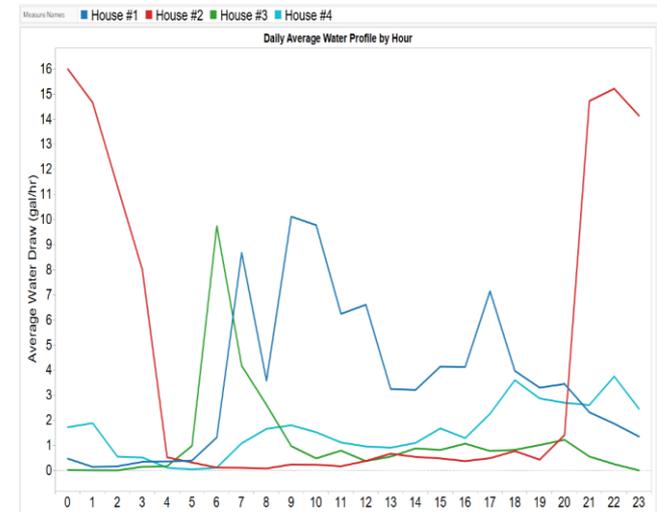
- The water heater fleet varied consumption as desired
 - Capable of providing Flexible DR (targeted increase too)
- LMP test successfully turned on the WHs during negative pricing intervals
 - potential value to energy traders
- Desirable Connected device functionality or capability
 - Flexible DR functions
 - ramping, regulation, LMP-based charging
 - Tank capacity or temperature
 - to inform estimate of DR availability
 - Operational status reporting
 - power/energy usage, fuel type, operating mode, consumer override...
 - Others
 - Integrate mixing valve
 - Local sensing and/or reporting of line voltage

Flexible Demand Response

Evaluation of Water Preheaters to Support Grid Services at Sacramento Municipal Utility District

3002011775

Final Report, October 2017





Findings from EPRI study

- Chuck Thomas, EPRI

Communication Interfaces and the Connected Device

Chuck Thomas
EPRI

ENERGY STAR Connected Water Heater Discussion

ACEEE Hot Water Forum 2018, Portland Oregon
March 20th , 2018

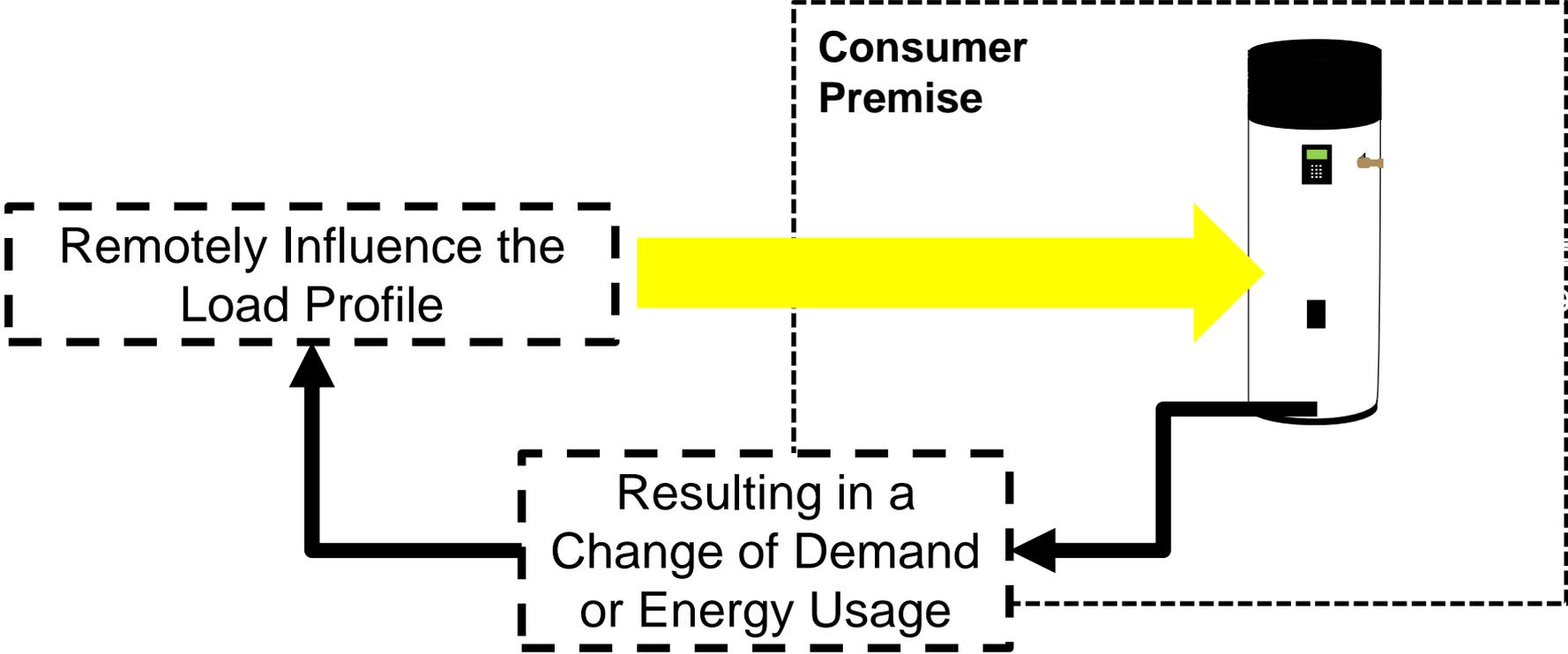


Purpose

This presentation was compiled to share knowledge gained over 10-years of research that focused on developing, testing and deploying new communication technologies and implementation guidelines to enable OEMs to mass produce end-use devices with embedded load management capabilities that can interoperate with ANY network, ANY third-party energy management application to provide consumers with the option of using “off-the-shelf” purchased products to provide energy services (grid services) for monetary or environmental purposes.

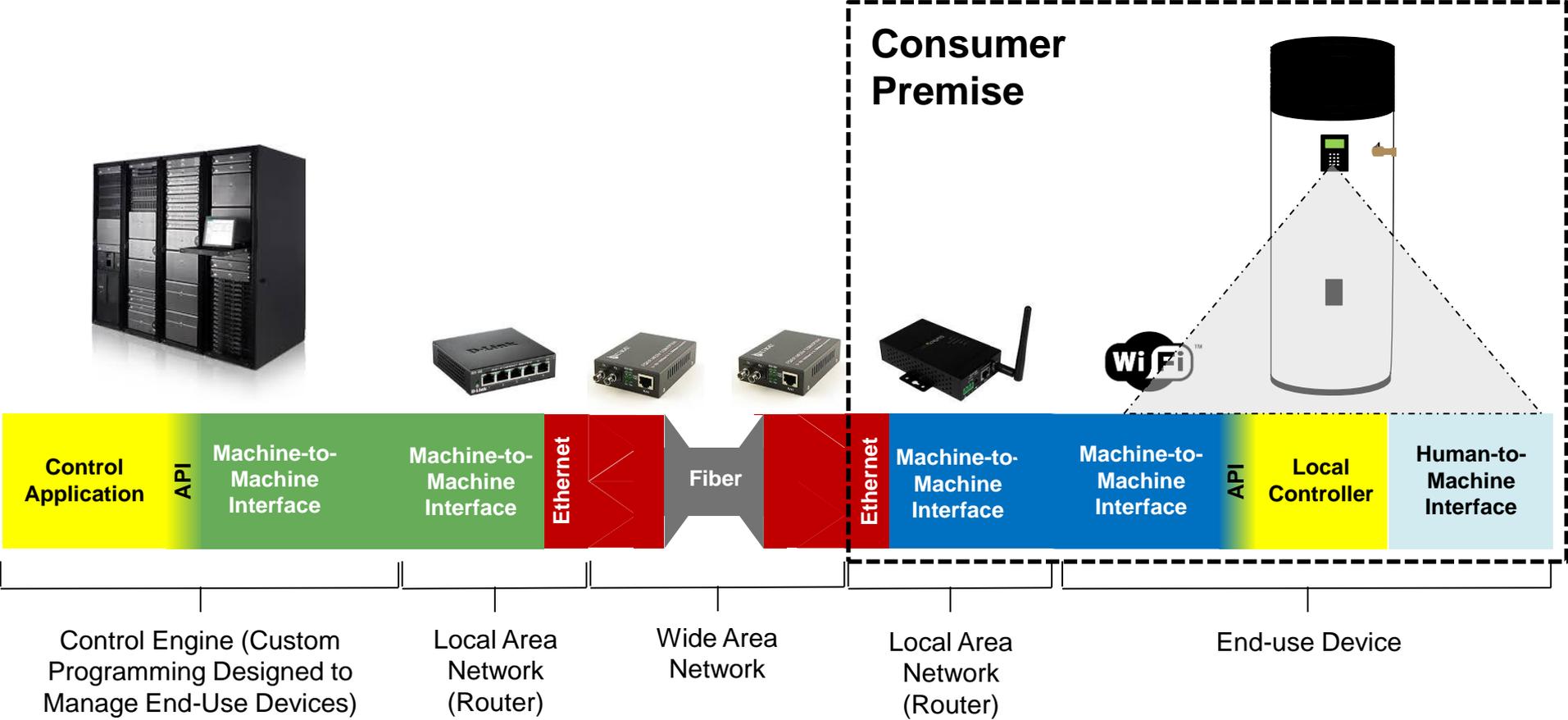
Connected Device Architecture Overview

The Challenge , to Remotely Influence End-use Device



Connected Device Architecture Overview

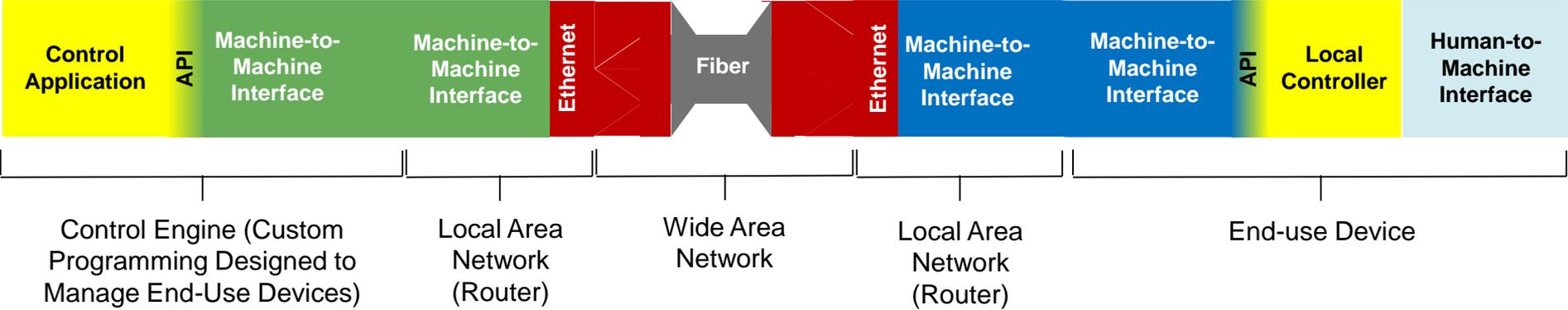
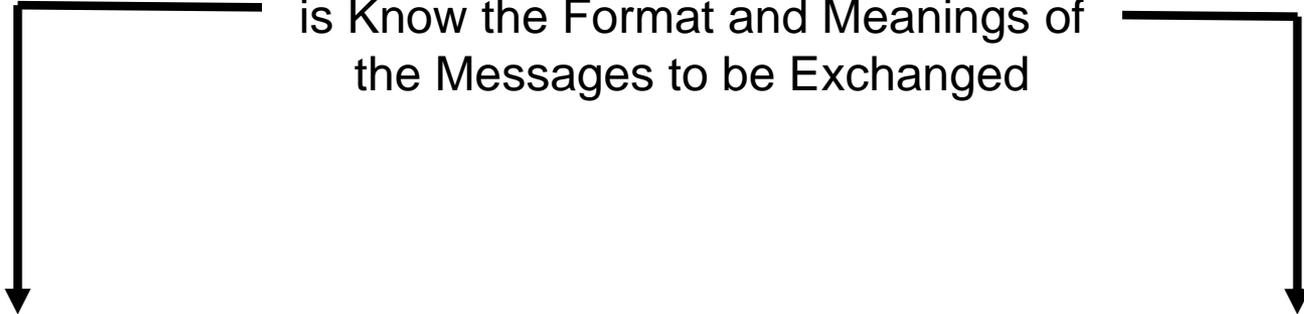
Example Deployment



Connected Device Architecture Overview

Remote Application and End-use Device **MUST** Understand Each Other

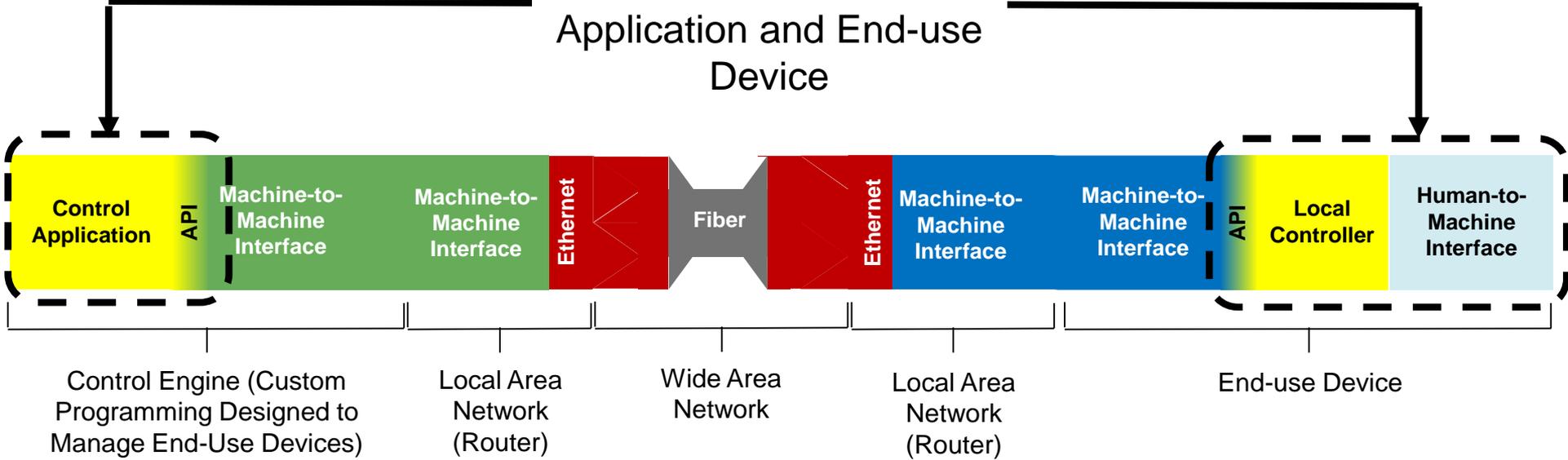
The Only Way These Two Applications “Understand” Each Other is Know the Format and Meanings of the Messages to be Exchanged



Connected Device Architecture Overview

Example1 – Vertical Integration

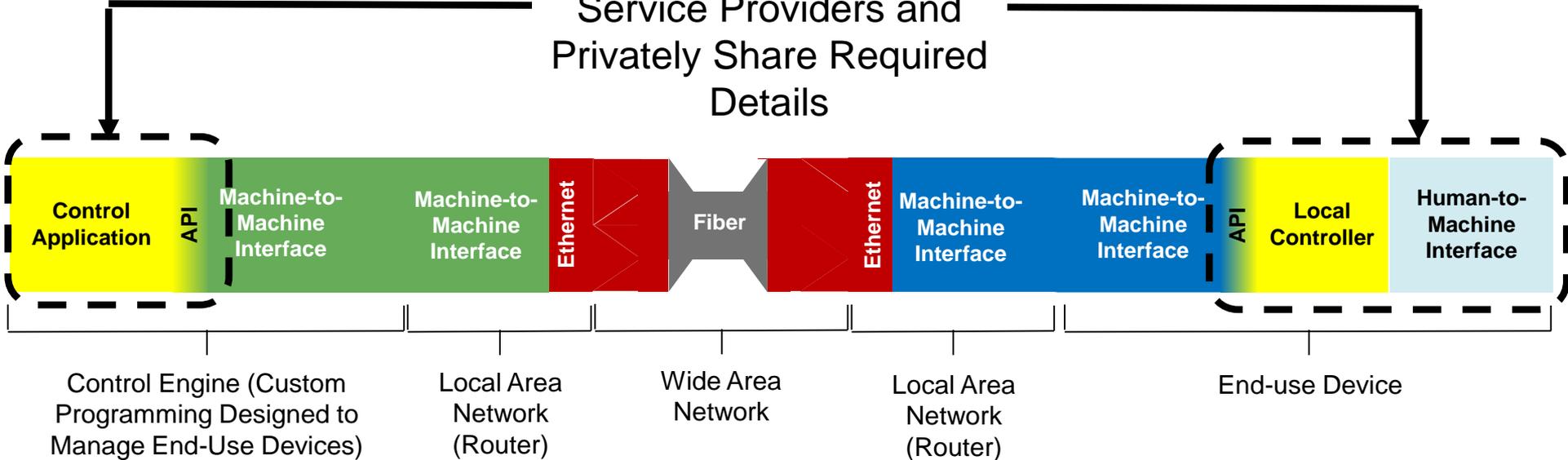
Same Manufacturer Provides Both Application and End-use Device



Connected Device Architecture Overview

Example2 – Vertical Integration

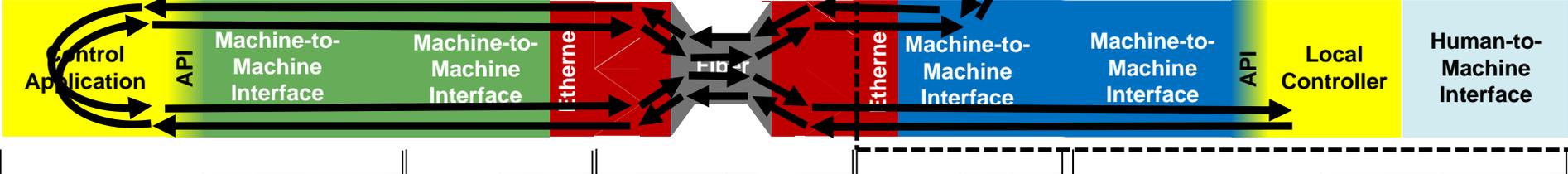
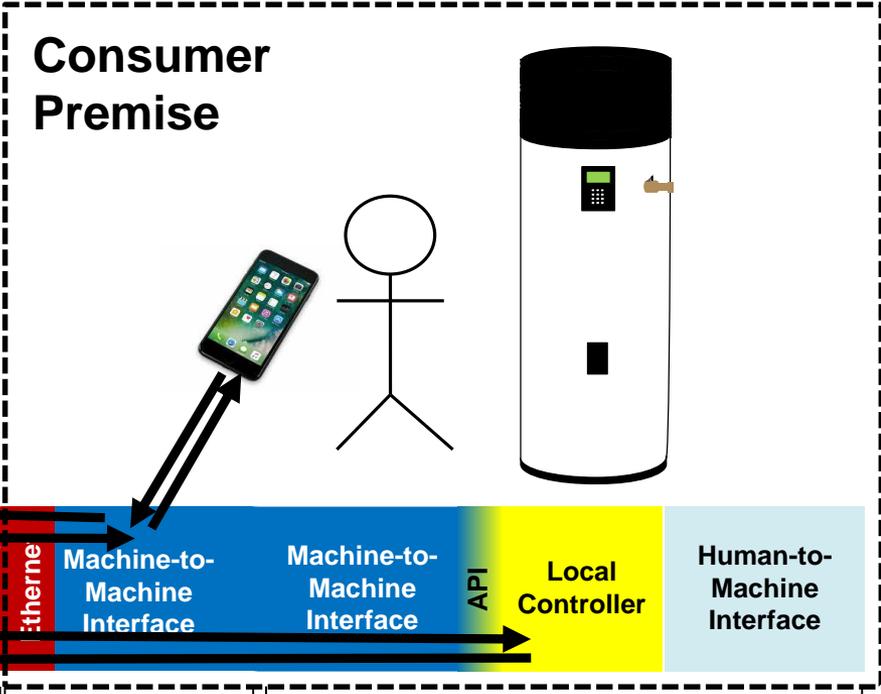
Or Manufacturers Partner with other Service Providers and Privately Share Required Details



Connected Device Architecture Overview

The Data Path (Consumer to End-use Device)

Consumer must go through the LAN, WAN and Remote Application to Manage End-use Devices Within Their Own Premise



Control Engine (Custom Programming Designed to Manage End-Use Devices)

Local Area Network (Router)

Wide Area Network

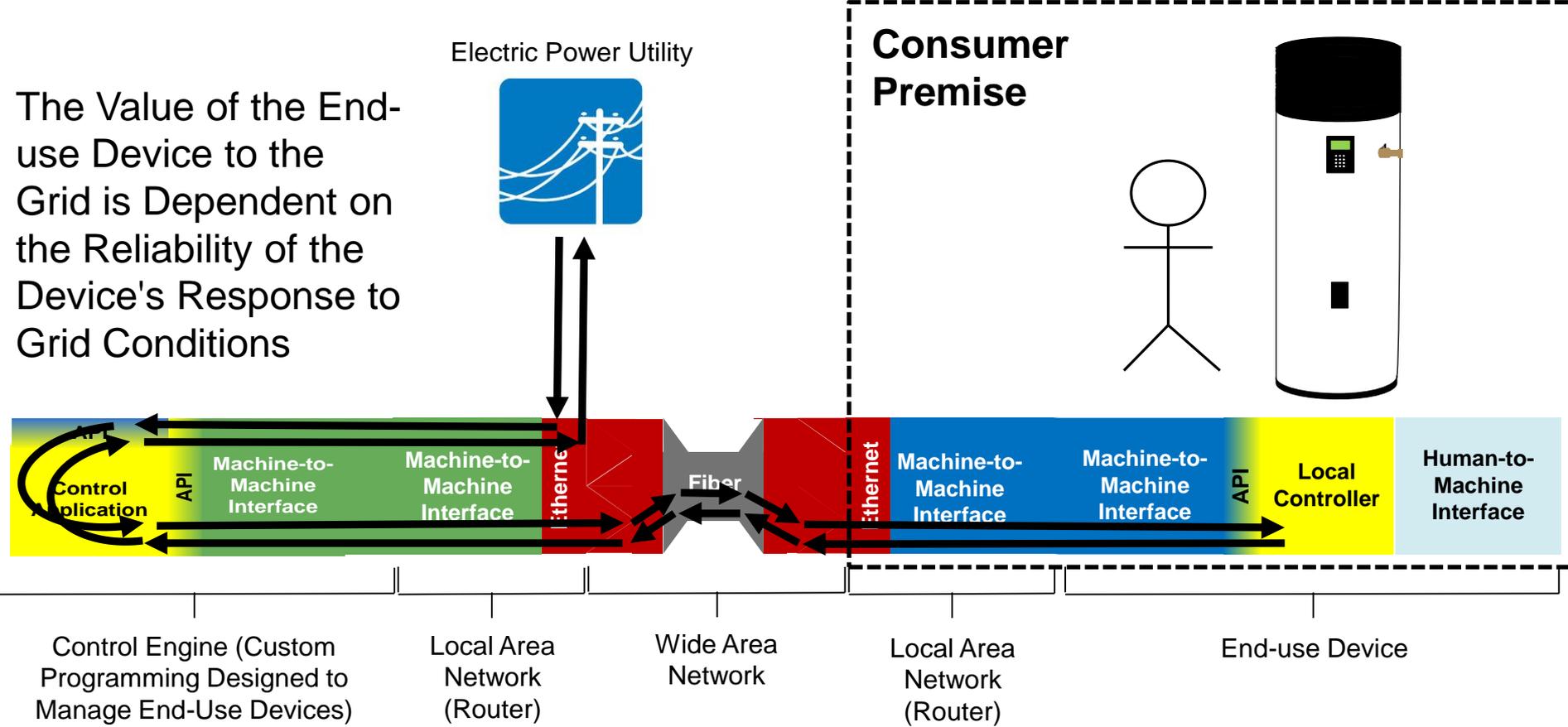
Local Area Network (Router)

End-use Device

Connected Device Architecture Overview

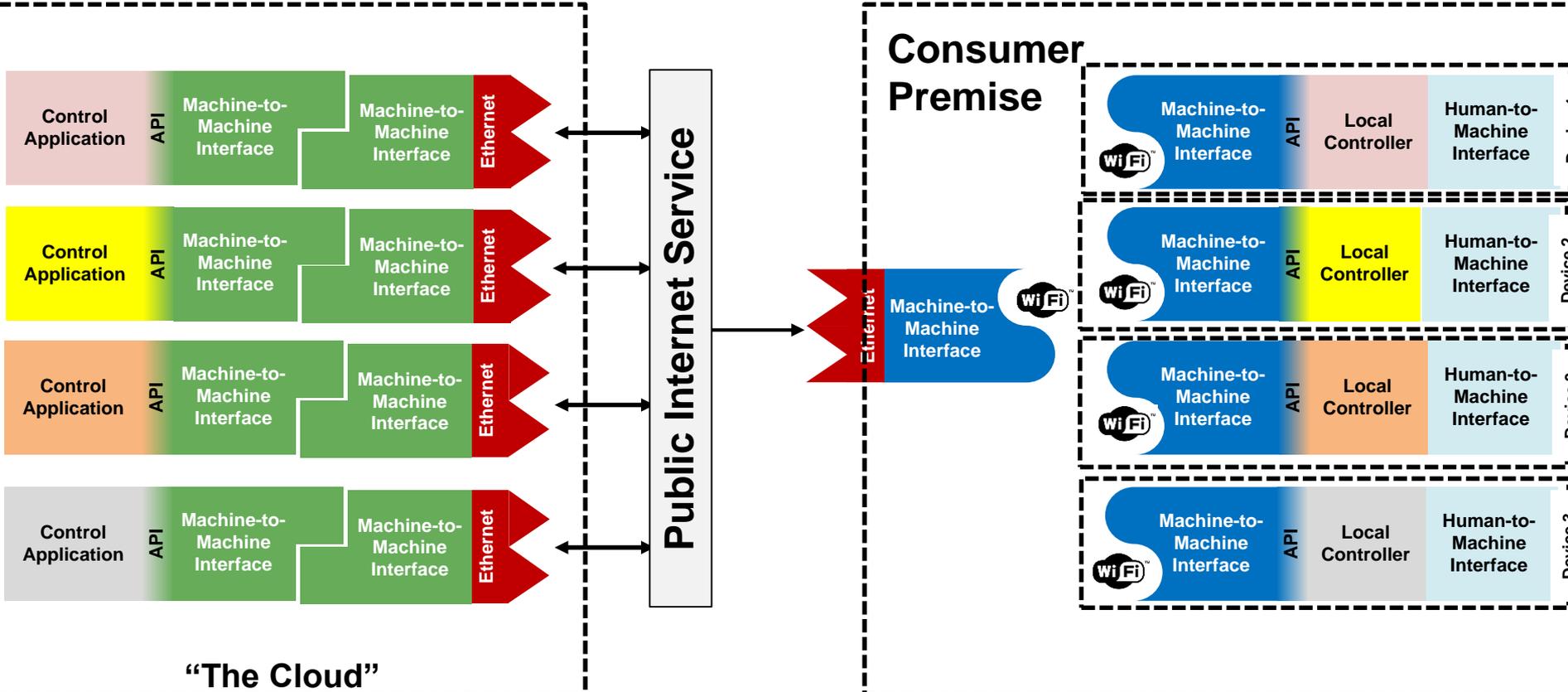
The Data Path (Utility to End-use Device)

The Value of the End-use Device to the Grid is Dependent on the Reliability of the Device's Response to Grid Conditions



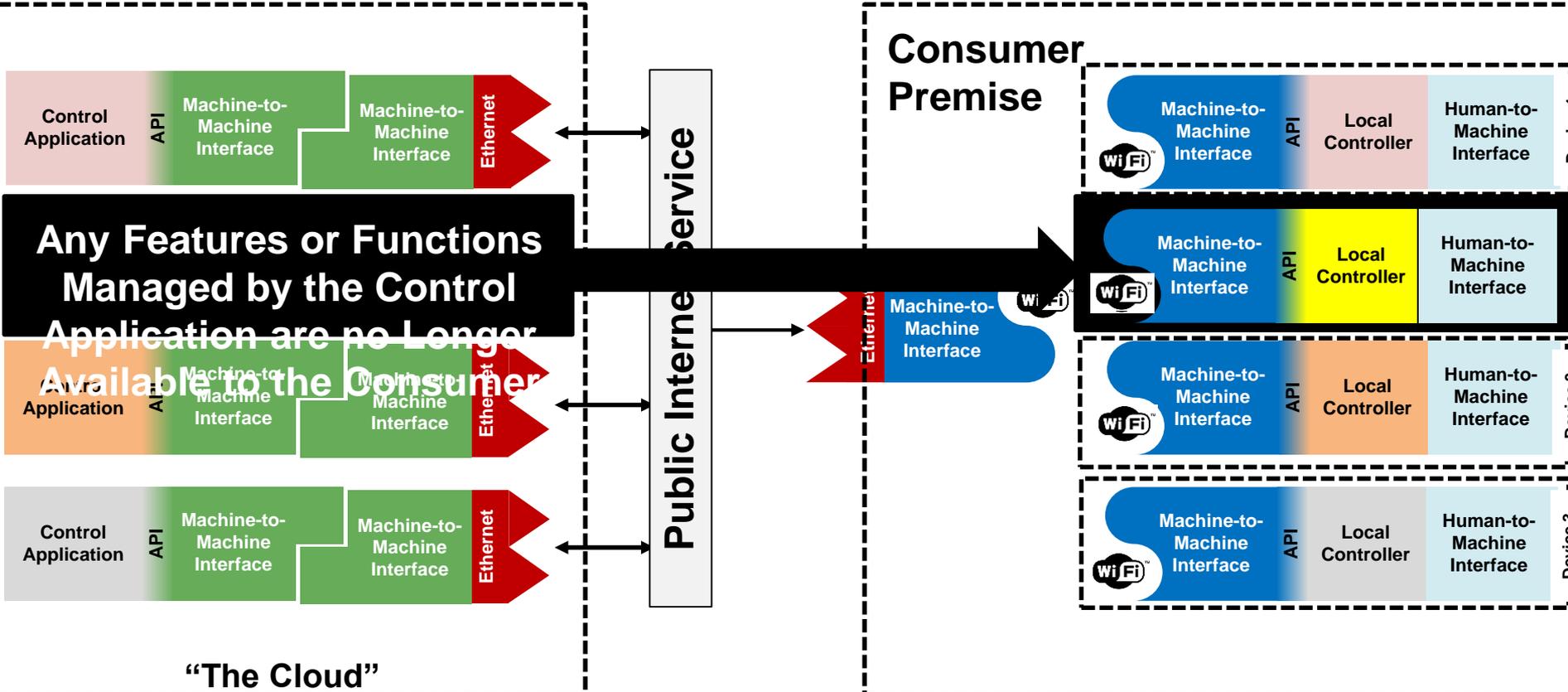
Connected Device Architecture Overview

Stranded Assets Scenario



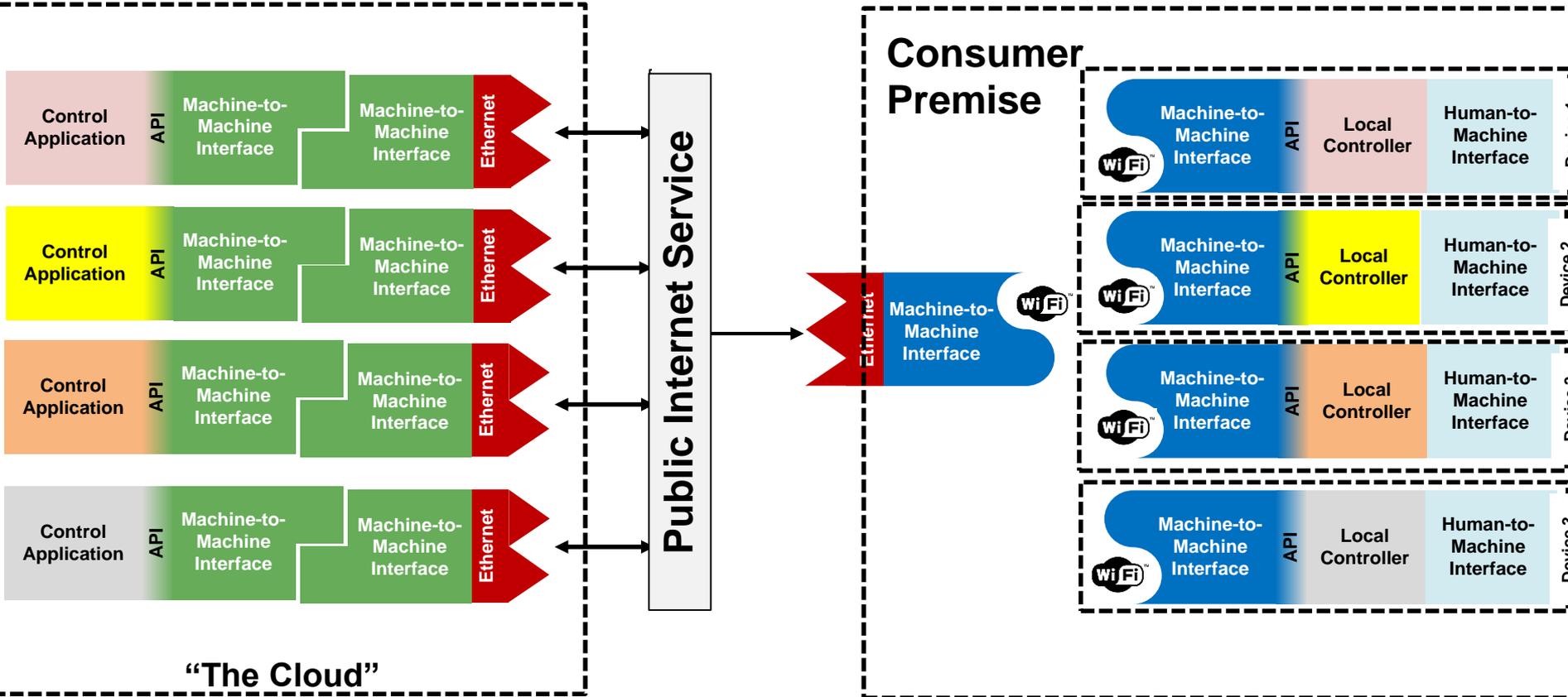
Connected Device Architecture Overview

Stranded Assets (Loss of OEM or Third-party Service Provider Application)



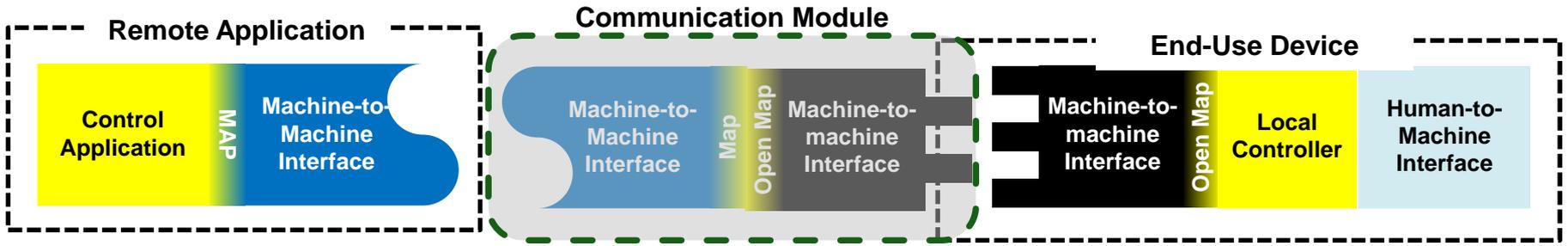
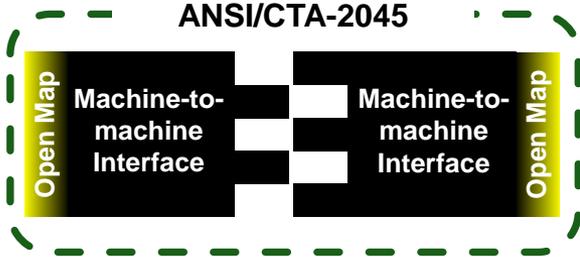
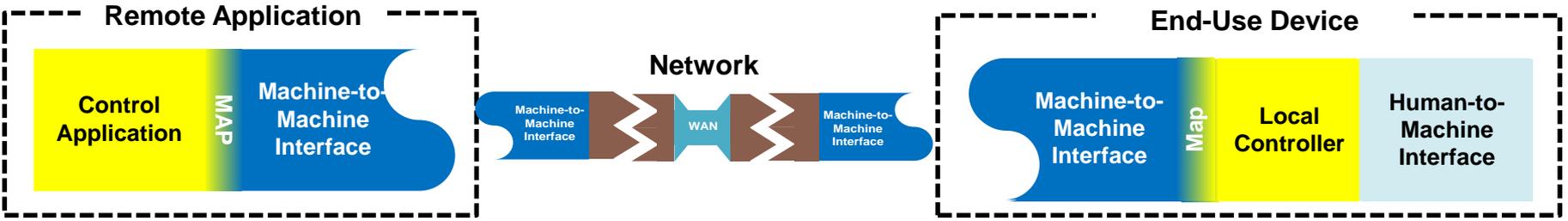
Connected Device Architecture Overview

Stranded Assets (Local Area Network Update)



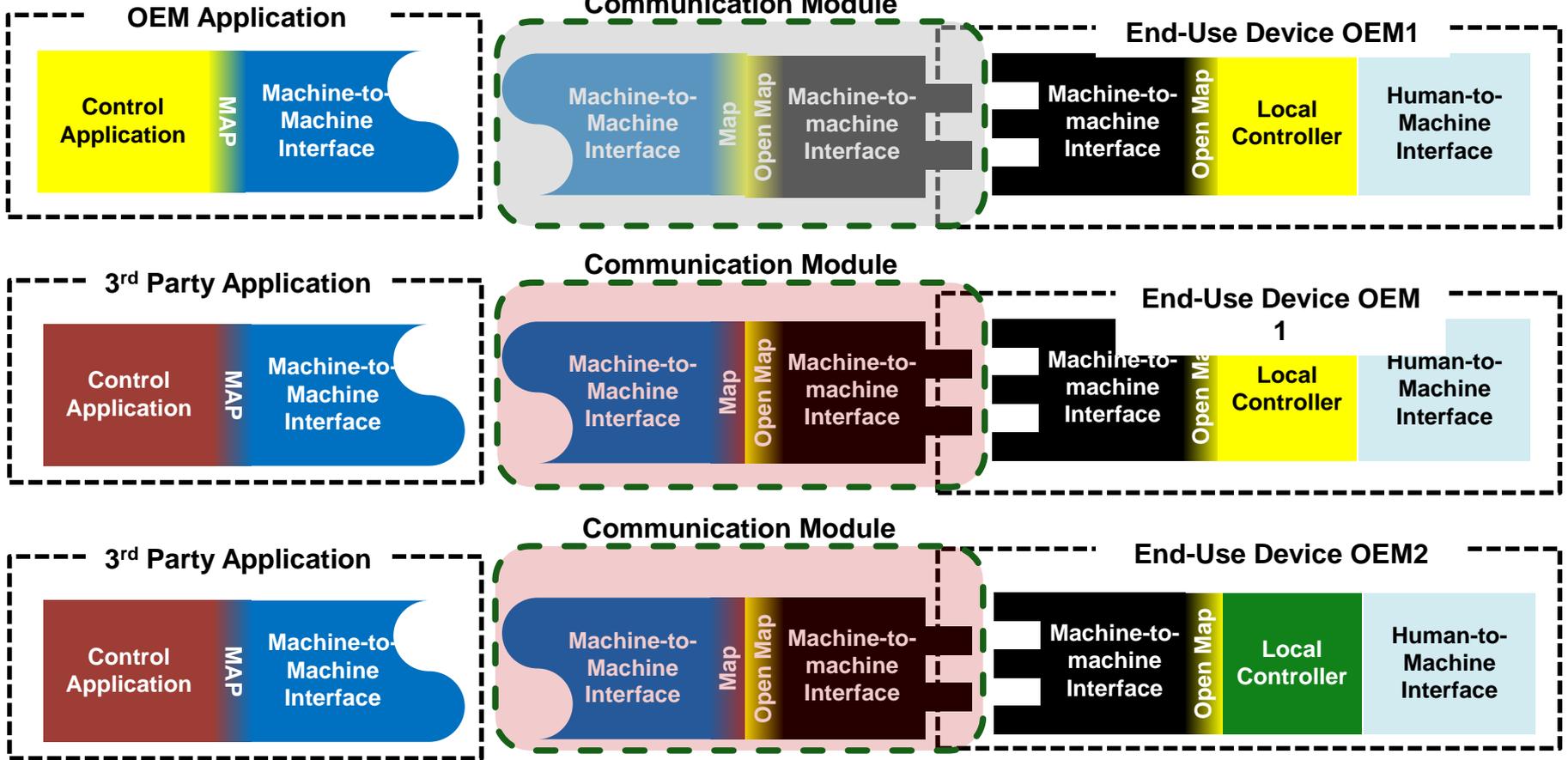
Connected Device Architecture Overview

Open Communication Port



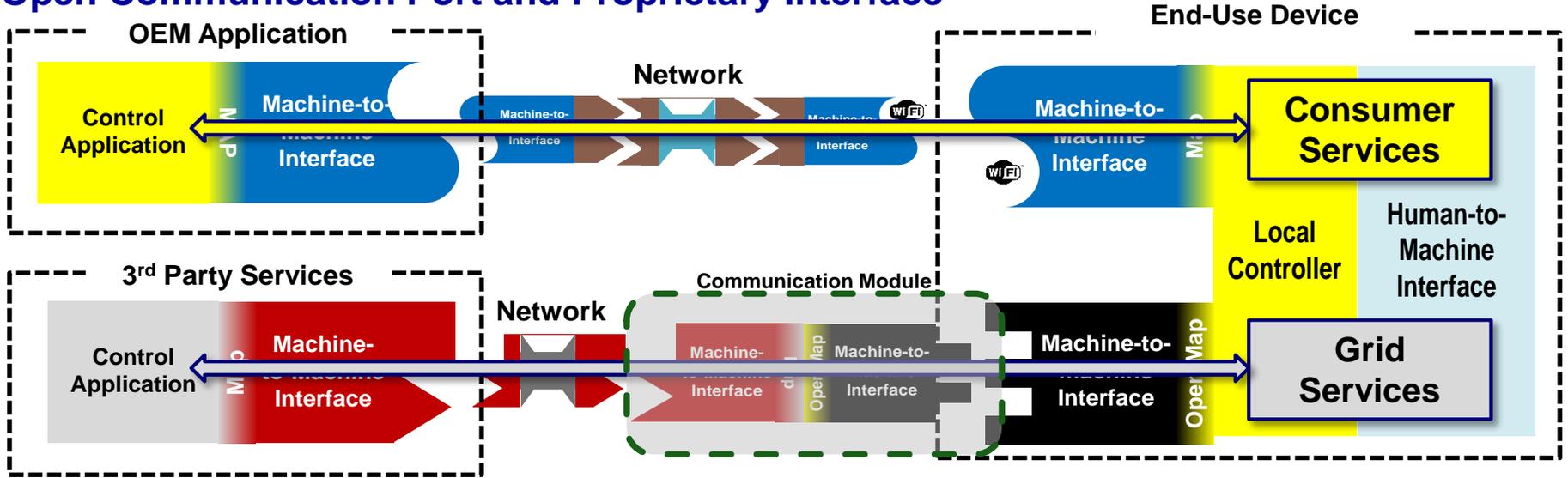
Connected Device Architecture Overview

Open Communication Port



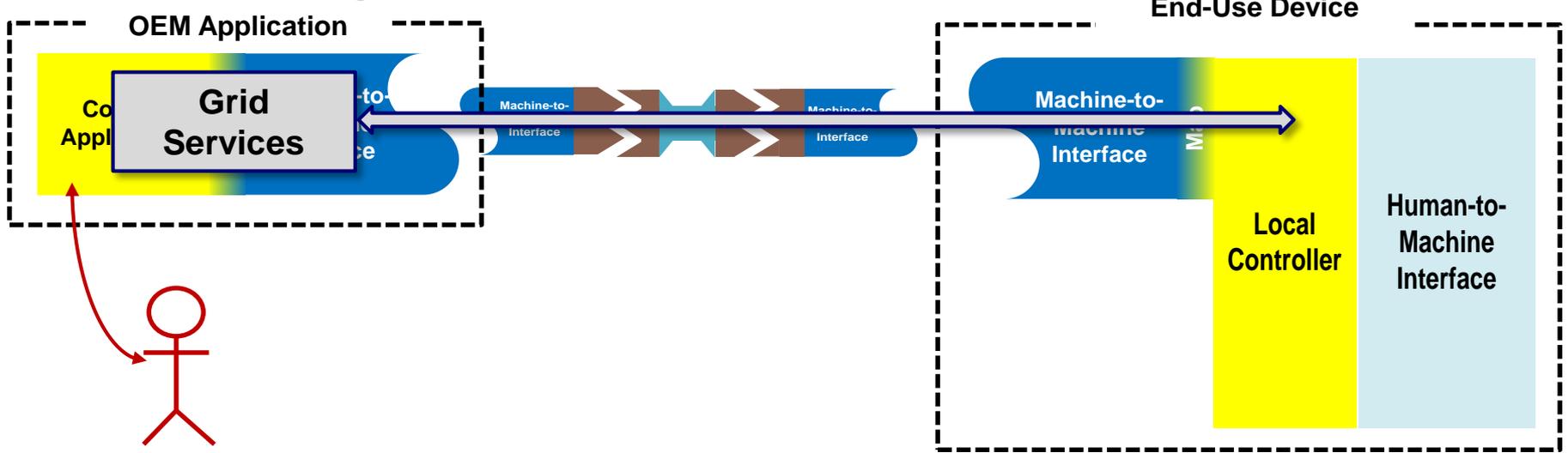
Connected Device Architecture Overview

Open Communication Port and Proprietary Interface



Connected Device Architecture Overview

Independent Testing

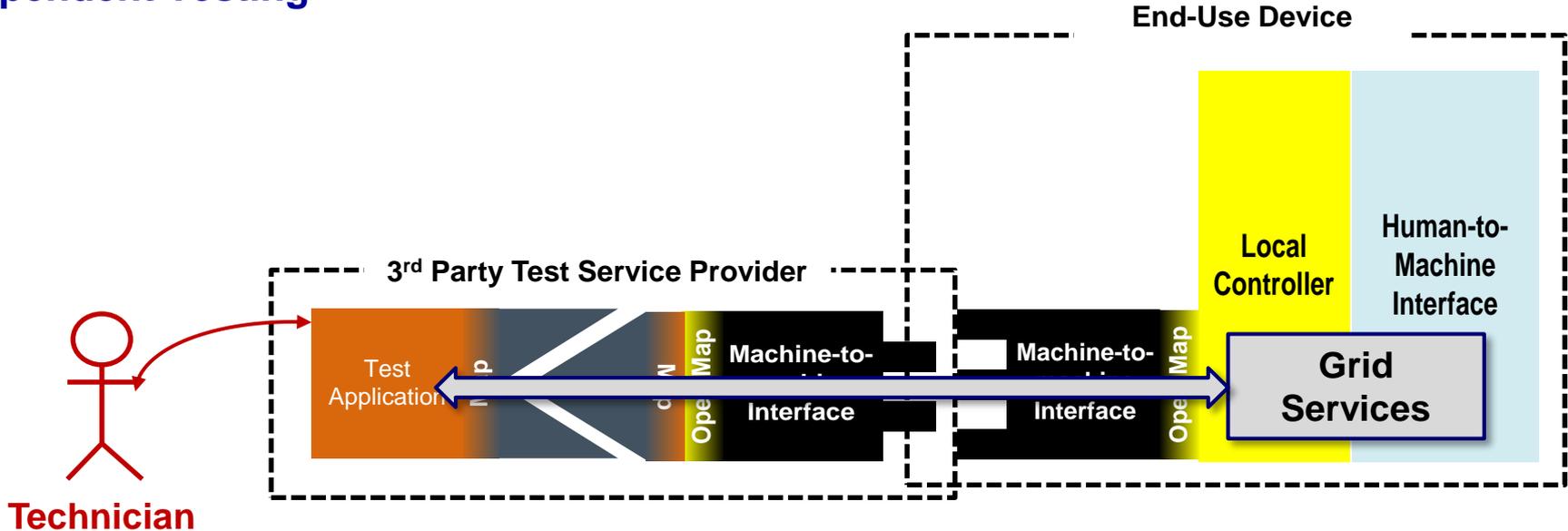


Technician

- In Order to Test Grid Services, the Technician must have access to the OEM Application
- Certification or Compliance of Grid Services Applies only to the OEM Application Version Number Tested
- Variation between OEM Applications Decreases the Confidence Level of the Test Results

Connected Device Architecture Overview

Independent Testing



- A Standardized Test Harness Can be Used by ANY Technician
- Since Grid Services are Embedded into the End-use Device, the Technician can Independently Test the End-use Device
- Test Applications and Procedures can be Customized then Standardized to Support different Connected Specifications



Together...Shaping the Future of Electricity

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Specializing in Automated Controls, Communication Protocols, Lab and Field Test of Emerging Technologies



Current Connected Requirements

- In ENERGY STAR specifications
- In the NEEA Advanced Water Heater Specification
- In the CEE Water Heater Initiative
- In AHRI 1380
- In the CEC proposals
- Discussion



ENERGY STAR Current Role in Connected Products

- **ENERGY STAR Specifications with Connected Criteria**
 - Connected Thermostats V1.0
 - Products with optional connected criteria: Refrigerators, Room Air Conditioners, Lighting, Laundry, Pool Pumps, Dishwashers, Commercial Ice Machines, Electric Vehicle Chargers
- **ENERGY STAR Optional Connected criteria**
 - Open standards and/or interoperability (cloud connection is fine)
 - Energy use reporting capabilities and Standby power limits
 - Consumer amenity (as appropriate)
 - Demand Response
- **Natively networked ENERGY STAR product categories without specific connected criteria include most IT and consumer electronics products**



ENERGY STAR Connected Criteria

	Smart T'stats	Fridges & Freezers	Laundry	Room A/C	Dish-washers	EVSE	Lighting	Pool Pumps	Ice Makers
Energy Consumption Reporting		✓	✓	✓	✓		✓	✓	✓*
Operational Status Reporting		✓	✓	✓	✓		✓	✓	✓*
Remote Management		✓	✓	✓	✓		✓	✓	✓*
Demand Response	✓	✓	✓	✓	✓	✓		✓	✓
Open Access	✓	✓	✓	✓	✓	✓	✓	✓	✓
DR override by Consumers	✓	✓	✓	✓	✓	✓		✓	✓
Capabilities or DR Summary	✓					✓			✓



NEEA Advanced WH Specification

- Applies specifically to heat pumps
- Very general DR requirements, relying on CTA-2045
- Uptake?
- Status of test method(s)?
- Future plans?

March 20th, 2018

Transforming NW Water Heating Markets for Flexible Demand Management.

Geoff Wickes NEEA



Outline

- Advanced Water Heater Specification 6.0
- Levels of performance
- Moving to 7.0 next steps
 - Inclusion of more specifics
 - Gas water heaters

AWHS 6.0

May 10th, 2016

- Shifted from EF to UEF
- Added additional Tier levels
- Clarified Testing Methods
- Included Demand Response
- Included Split systems
- Clarified default modes

<http://neea.org/advancedwaterheaterspec>



[About NEEA](#)

[Initiatives](#)

[Resources](#)

[Home](#) >> [Advanced Water Heater Specification](#)

Advanced Water Heater Specification

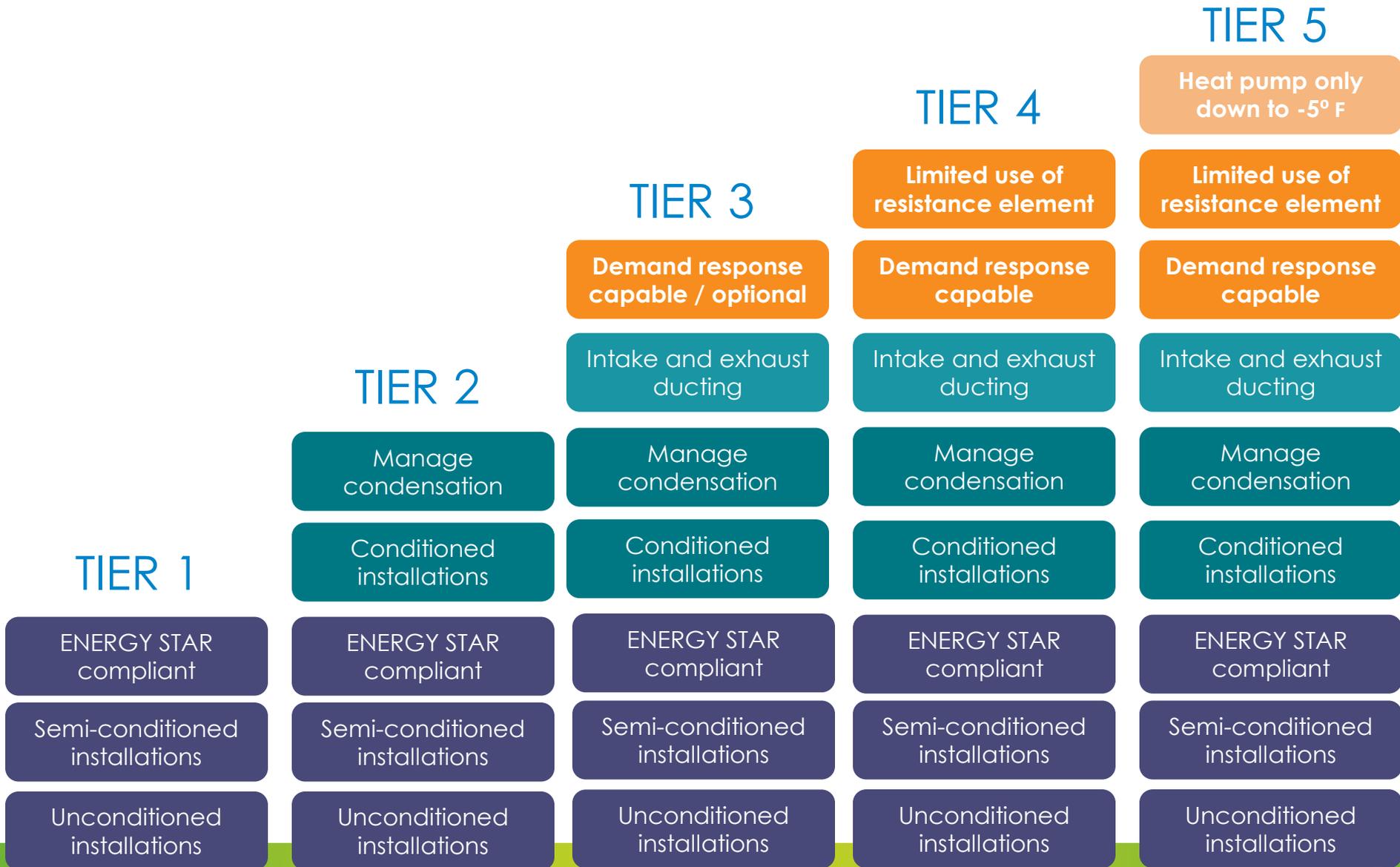
Utilities, energy efficiency organizations and market partners developed the Northern Climate advance higher performing heat pump water heaters. An updated version of the specification the Advanced Water Heater Specification.

While this specification is rooted in ensuring performance in cooler northern climates, its applicability extends beyond the Northwest. The updated specification also enhances the end goal of NEEA's HPV of a 2025 federal standard requiring HPWHs for all electric storage tanks greater than 45 gallons.

-  [Qualified Products List](#)
A list of products that have been tested and found to be compliant to the Advanced Water Heater Specification. The list will be updated as additional products are qualified, based on the specification. PDF, 837.85 KB
-  [Advanced Water Heater Specification](#)
The current version of the specification. PDF, 424.33 KB

Home

Product Tier Overview



Tier	Minimum Northern Climate UEF	Minimum Features	Minimum supported installation locations	Sound levels	Demand Response Enabled
Tier 1.0	2.0	<ul style="list-style-type: none"> ENERGY STAR compliance Freeze protection 	<ul style="list-style-type: none"> Semi-conditioned Unconditioned 	dBA < 65	Optional
Tier 2.0	2.3	<u>Tier 1 plus:</u> <ul style="list-style-type: none"> Minimal use of resistance heating elements Compressor shut-down/notification 10 year warranty Condensate mgmt. 	<ul style="list-style-type: none"> Conditioned Semi-conditioned Unconditioned 	dBA < 60	Optional
Tier 3.0	2.6	<u>Tier 2 plus:</u> <ul style="list-style-type: none"> Simultaneous intake and exhaust ducting capable Air filter management Unit to be tested in factory-default mode Override and default mode behavior 	<ul style="list-style-type: none"> Conditioned Semi-conditioned Unconditioned 	dBA < 55	Optional but preferred
Tier 4.0	3	<u>Tier 3 plus:</u> <ul style="list-style-type: none"> Physical design or default controls which limits resistance element heating to less than upper 50% of tank 	<ul style="list-style-type: none"> Tier 3 	dBA < 50	Yes
Tier 5.0	3.5	<u>Tier 4 plus:</u> <ul style="list-style-type: none"> No resistance element usage in default mode unless outside ambient air temperature below -5° F 	<ul style="list-style-type: none"> Tier 4 	dBA < 50	Yes

AWHS 7.0 Starting 2019

- Soliciting feedback and comments
 - Starting Q2 2018 – Targeting complete Q2 2019
- Increasing testing information
 - Split system testing methodology
- Inclusion of DR required at Tier 3 and above
 - CTA 2045 ready
 - Inclusion of DR testing with key commands
- Inclusion of Gas with UEF greater than 1.0
- Continued harmonizing with NRCAN, California and other regional entities



Thank You!
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TOGETHER *We Are Transforming the Northwest*





CEE HPWH Connected Criteria

- John Taylor, Consortium for Energy Efficiency

CEE HPWH Connected Criteria

▼ Definition and Key Aspects

- Must meet CEE HPWH requirements first
- Optional; can apply to any CEE tier



▼ Connectivity

- On-Premise, Open Standards Connectivity
- Open Access

▼ Load Management Capabilities

- Application ACK (acknowledgement)
- Application NAK (negative acknowledgement)
- Outside communication connection status
- End shed/run normal
- Shed
- Critical peak event
- Grid emergency
- Present relative price
- Autonomous cycling and terminating cycling
- Load up
- Get/set user preference level
- Customer override
- Query and response operational state
- Query and response: device information request
- Get/set commodity read request and reply
- Get present water temperature

▼ Consumer Override



AHRI 1380

- For highly efficient central AC, Heat pumps, and ductless
- Has a specific table of known responses to signals such as those in CTA-2045
- Requires either CTA-2045 or OpenADR, with protocol translation present in the device and/or module
- Status: Not yet approved by Board, a few issues from product sections being worked through
- Status of test method(s): included
- Future plans?



Focused Discussion (part 1)

- Could including optional connected criteria in the water heater specification serve a useful purpose at this time?
 - Could the publication of an associated test method be helpful?
 - What's needed to make it helpful?



Focused Discussion (part 2)

- What would the criteria look like
- Known issues to resolve
 - Protocol translation in the device/module required? EPA is open to this debate for WH; would not apply to all products.
 - Consumer over ride without limit? What about grid emergencies?
 - How specific to be about product responses.
- Other issues to talk through?



Scalding, mixing valves and set temperatures

- With resistive elements, there are some strategies you can use (e.g. provide capacity by heating only part of the tank) that are not available when heating with a compressor
- For heat pumps, the overheating is very important to be able to provide load up capacity, and also for ensuring that customers have enough hot water.



Sticky issue 1: Protocol translation in the product/module

- Can you update the modules the way you can update a smart thermostat?
- Why are smart thermostats using cloud-based services popular if the CTA module based architecture is better?
 - Different drivers for provision of connected functions?
 - Enables different functions?
- Why pre-judge what the local architecture is? Why not focus on the end goals and stay tech agnostic?
- 20% of homes do not have Wi-Fi connectivity, and even some that do, it's been found not to be used for DR



Sticky issue 2: Over-rides

- If a customer really needs an over ride, they should get it – it's not that easy to get anyway. The question is whether it returns to normal operation
- For opting into low efficiency/high capacity modes for HPWHs, NEEA ended up requiring that it returns within 72 hours
- For guests, who stay for up to a week, it can be a real problem to opt out for every event – maybe a set period of time? 72 hours? Would work better.
- NRDC proposed to CEC a 72 hour override capability
- Manufacturers could accept a grid emergency over ride of an over ride for up to an hour
- Consensus that any over ride should be temporary



Sticky issue 3: How specific to be about responses

- To get the value of load shifting, we have to be specific about load up or shed, look at the max temperature, soft and hard shed, per NRDC study. Set of commands need to be available.
 - Does this depend on the assumptions of the study?
 - Granular responses that can be built into very sophisticated services might be best
 - Some granular responses (e.g. load up) can be really tricky, because of things like the scalding



Sticky issue 3: How specific to be about responses

- Delicate balance between what the customer needs and what will help the grid
- Manufacturers lead degree of specificity, are in the best position to know how to balance customer needs with grid needs
- Specific responses (at a less granular level) will provide a shorter path to provide some services now



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