

Smart Thermostats: Learning about Connected Customers

Ram Narayanamurthy, Jen Robinson

Behavior Energy and Climate Change
Conference

October 19, 2015



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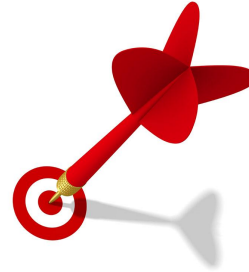
A new world of technology options for consumers



EPRI smart thermostat collaborative

- Evaluate the impact of smart thermostats in real-world circumstances

➡ Effects of thermostats
as used by people –
technology *and* behavior



Do smart thermostats
save people energy
& money?

Uses for thermostat
data to benefit people
and programs?

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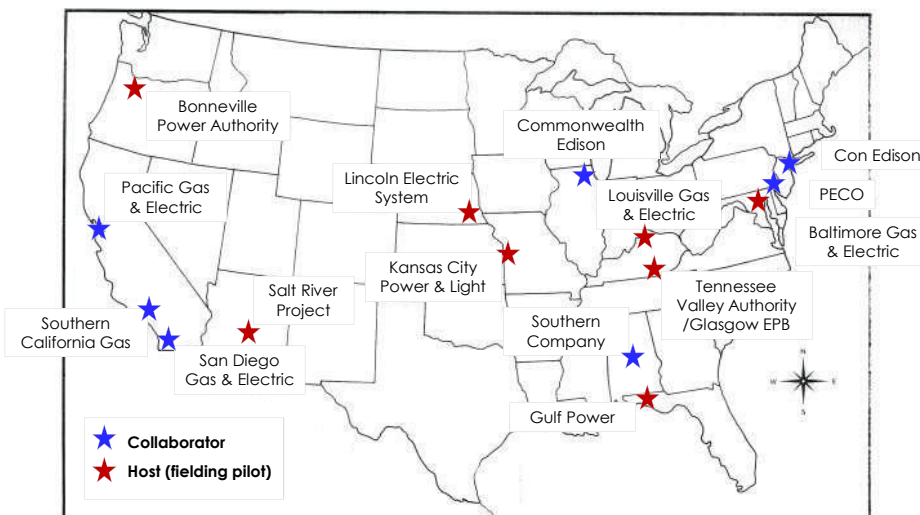
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Participants

International:

★ EDF (France, UK, Italy)



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Research activity



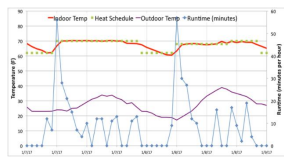
Pilots



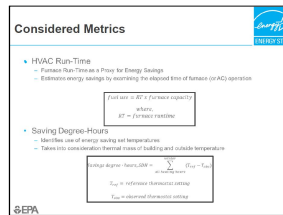
Measurement & Verification



Technology Scouting



Thermostat Data Analytics



EPA Collaboration



Stakeholder Meetings & Workshops

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Pilots at a glance



	2014		2015												2016											
Pilot	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
TVA/Glasgow																										
SRP																										
BGE																										
KCP&L																										
LES																										
LG&E-KU																										
Southern/Gulf Power																										

Recruit & Install
Winter Test Season
Summer Test Season

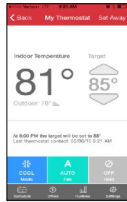
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Some pilot projects

Salt River Project



- Radio Thermostat/EnergyHub platform
- Offered to EZ-3 customers (Time of Day rate)
- Focus on load shifting + customer bill reduction
- Leveraging smart thermostat data for:
 - Connectivity analysis
 - Customer segmentation

Baltimore Gas and Electric



- Cooling impacts (4 events in 2015)
- ~2,000 thermostats total (Honeywell and ecobee)
- 2 DRMS systems

Kansas City Power and Light



- Honeywell and EcoFactor thermostats
- ~1100 treatment + 700 control thermostats total
- Summer events completed
- Thermostat data transfer completed

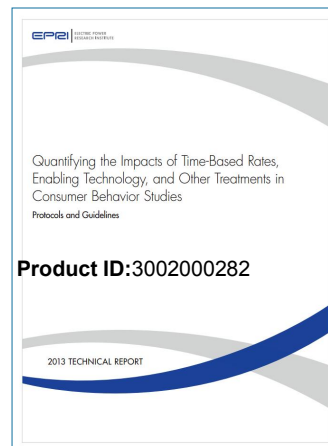
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Pilot design approach

- Started with experimental
 - Randomized Controlled Trial
 - Randomized Controlled Trial, recruit & deny/delay
 - Randomized Encouragement Designs
 - Randomized Events (DR analyses)
- If not possible, quasi-experimental
 - Within subjects
 - Matching approaches
 - Variation in adoption

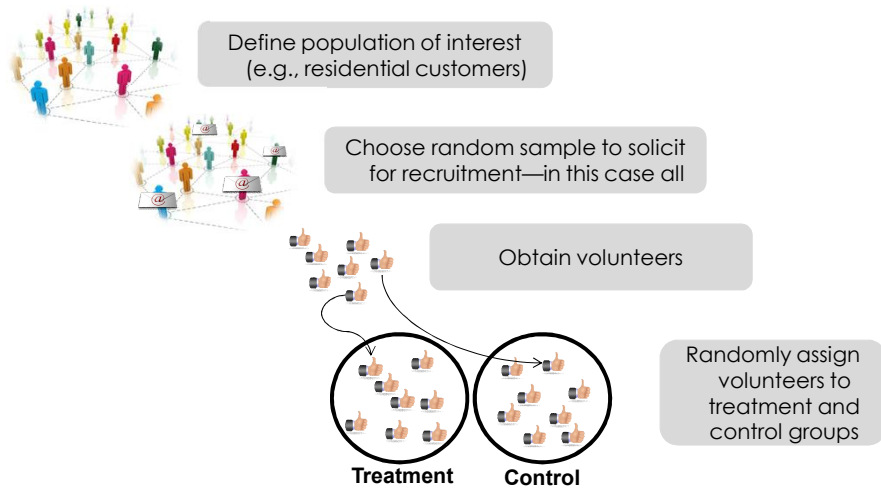


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Randomized controlled trial, recruit and deny EE/DR impacts



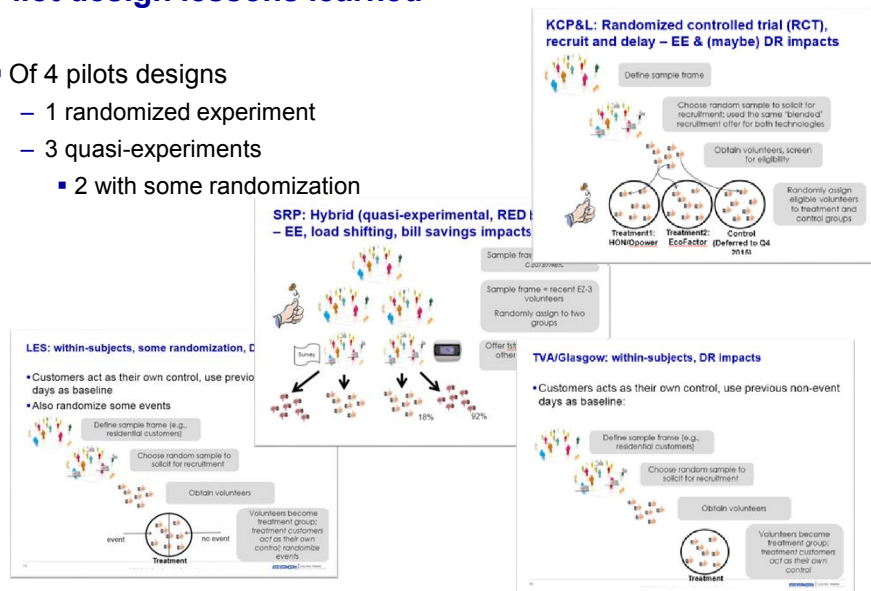
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Pilot design lessons learned

- Of 4 pilots designs
 - 1 randomized experiment
 - 3 quasi-experiments
 - 2 with some randomization



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Data From Devices



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The new data paradigm – opportunities and complexity

- Many types of customer data analytics
 - With different asynchronous data streams
- Gather customer preferences
- A key part of the Integrated Grid
- Enables mid-stream pilot and program adjustments

Time stamp to be synced		AMI Data	Device 1 data		Weather data		Device 2 data		Survey data
User ID	Time	Meter Read (kWh)	Indoor Temp	Set point	Out door temp	Cool Run time (min)	Fan On time	Over-ride	Expected DR set point
1234	4/5/2015 5:00 PM	13456.2	72.3	76	94	0	15	No	78
1234	4/5/2015 5:15 PM	13458.4	72.4	76	95	0	15	No	78
1234	4/5/2015 5:30 PM	13460.2	72.4	76	94	5	5	No	78

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Emerging use cases for data from devices



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Environmental
Indoor Temp
Outdoor Temp

Customer Preferences
Set Points
Schedules
Changes
Event
Overrides

Energy
HVAC Runtime
Building usage

**Pay-for-performance
program models**

**Energy Efficiency
standards**

**Locational Demand
Response**

DR Verification

**Winter DR – Aux heat
control in heat pumps**

**Customer
segmentation**

**Buildings – Grid:
Passive Storage**

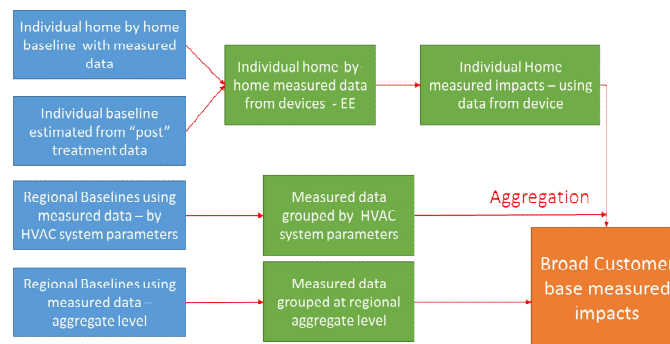
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Use Case 1: Developing baselines for energy efficiency

- Using HVAC data can reduce pilot sample size
- Challenge with baselines – data parameters from devices (runtime, indoor temp) vs. meter data
- Pre-casting indoor temps can overestimate savings

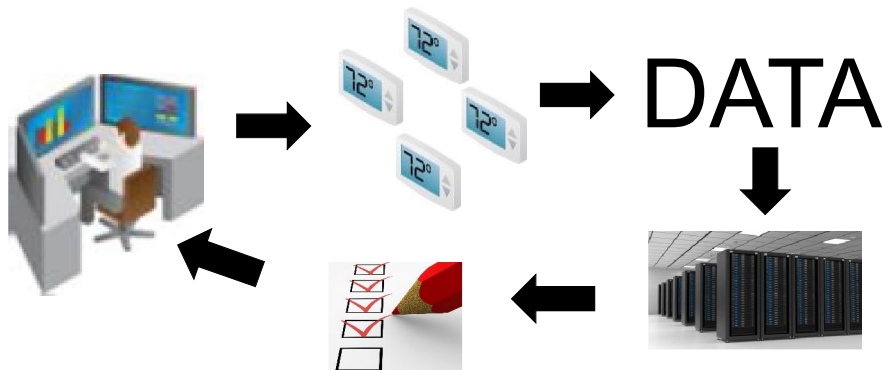


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Use Case 2: Verifying demand response management system



- Data directly from vendor DRMS
- DRMS performance validation using data
- Corrective actions to complete customer DR event
- Total time: 9 days

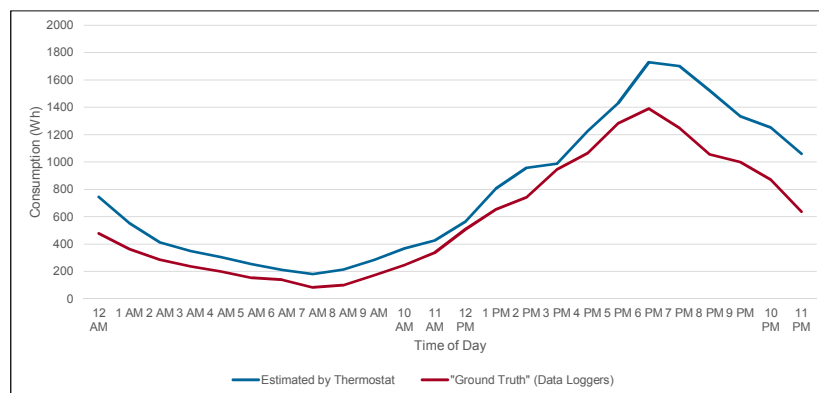
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Use Case 3: Extending runtime to kW for impact analysis

- Substantial value for utilities without AMI
- Method developed to extend runtime to kWh impacts
- Verification against installed data loggers



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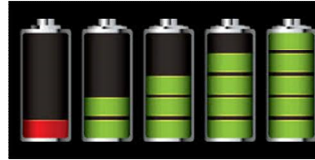
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Use Case 4: Enabling the integrated grid – understanding energy storage capability of homes and buildings

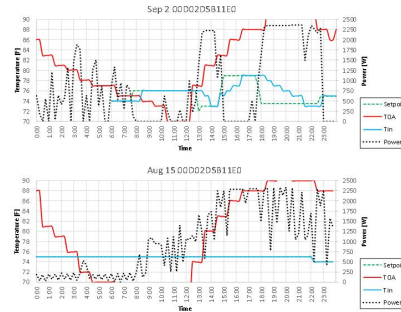


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- Smart Thermostats enable homes to operate as grid batteries
- Storage capacity varies based on occupant preferences and measured over large sample sets
- Example results from upper Midwest show each home is equivalent to **1 kW, 3.6 kWh** battery



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Market transformation: stakeholder workshops

Enhancing the customer relationship



Customer as a grid resource – good relationship is key

- KCP&L
- LES
- SRP
- SCE
- CPS
- DTE
- Duke
- Southern
- Westar
- BPA
- BGE
- TVA
- LG&E
- Pepco
- Dominion
- HydroOne
- Entergy
- SREMC
- GTI
- NC EMC
- Oglethorpe
- VEIC

- EPA
- DoE
- AHRI
- Smart Grid Consumer Collaborative
- National Labs – NREL and LBNL
- Program Implementers
 - Franklin Energy
 - ICF
 - iTron

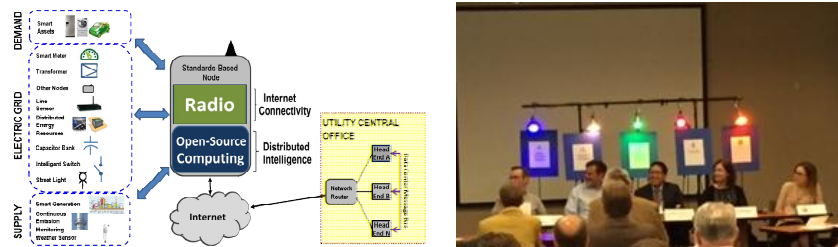
- Honeywell
- EnergyHub
- nest
- Trane (IR)
- EcoFactor
- Schneider
- Comverge
- Emerson
- Ecobee
- Kitu Systems
- SmartThings
- WeatherBug Home
- Daikin Goodman
- Carrier
- ThinkEco

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- All stakeholders recognize greater customer engagement and energy awareness through connected devices
- Interoperability a barrier to industry growth and adoption
- Regulatory recognition of non-energy benefits?
- Need to understand what data is useful and how to use it
- Privacy and security implications are in evolution



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Ram Narayanamurthy
rnarayanamurthy@epri.com
650-492-9576

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