AMI and HEMS: The Odd Couple?

Bethany Sparn, NREL
Ethan Goldman, VEIC

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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1977 – 2017





AMI and HEMS: Past, Present and Future

Bethany Sparn

Residential Buildings Research Engineer, NREL

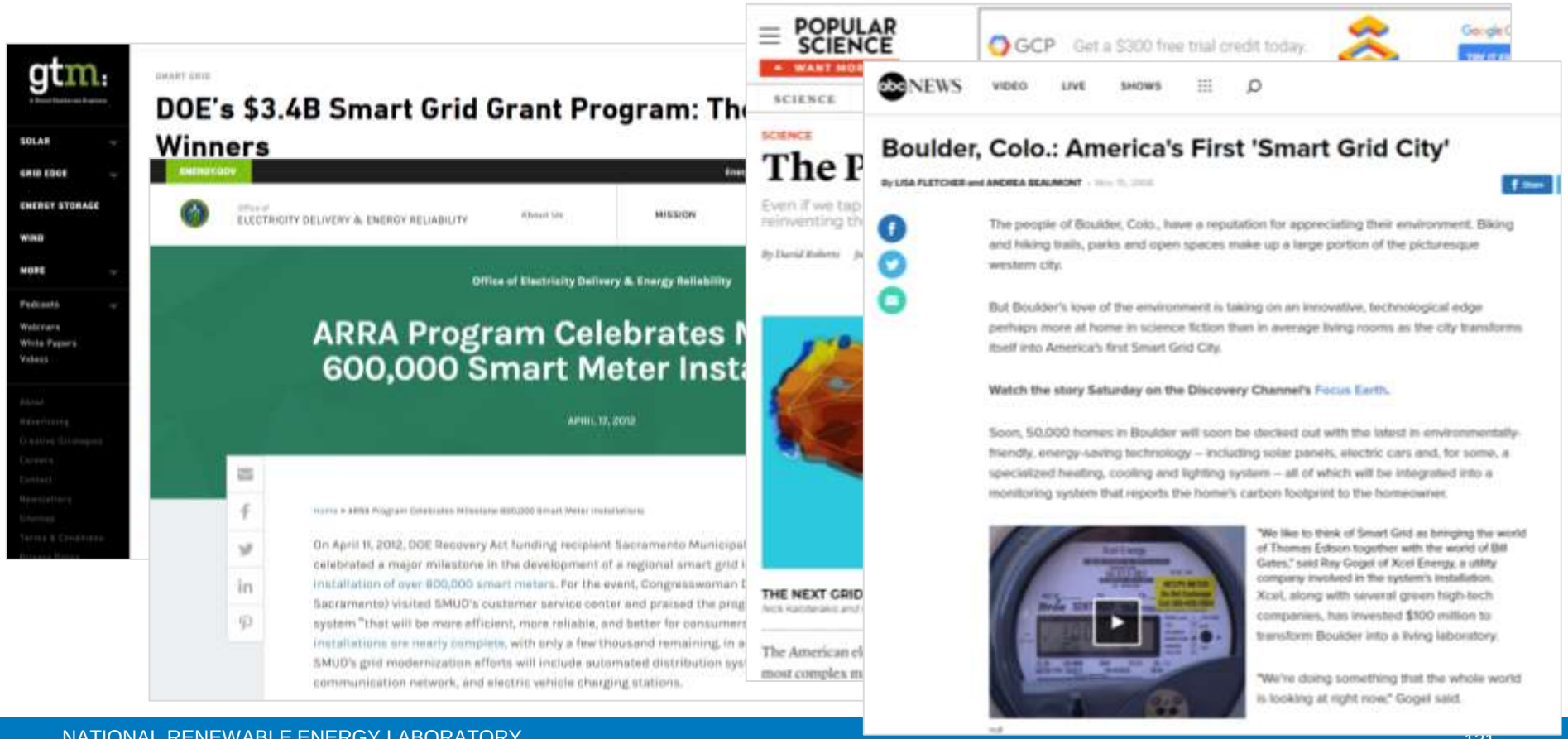
December 13, 2017

Presentation Outline

- **Past:** Retrospective on what we expected from AMI and HEMS.
- **Present:** Evaluate the current state of AMI as it relates to HEMS
- **Future:** Explore the drivers that could make AMI and HEMS be mutually beneficial

AMI Rollout and ARRA

- Rewind several years (~2009-2010):
  - Utilities were rolling out AMI in large numbers due to $3B+ in ARRA funding

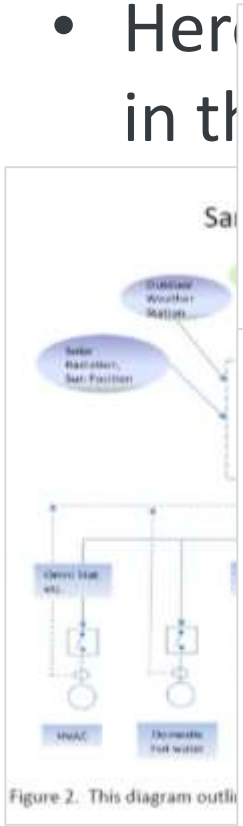


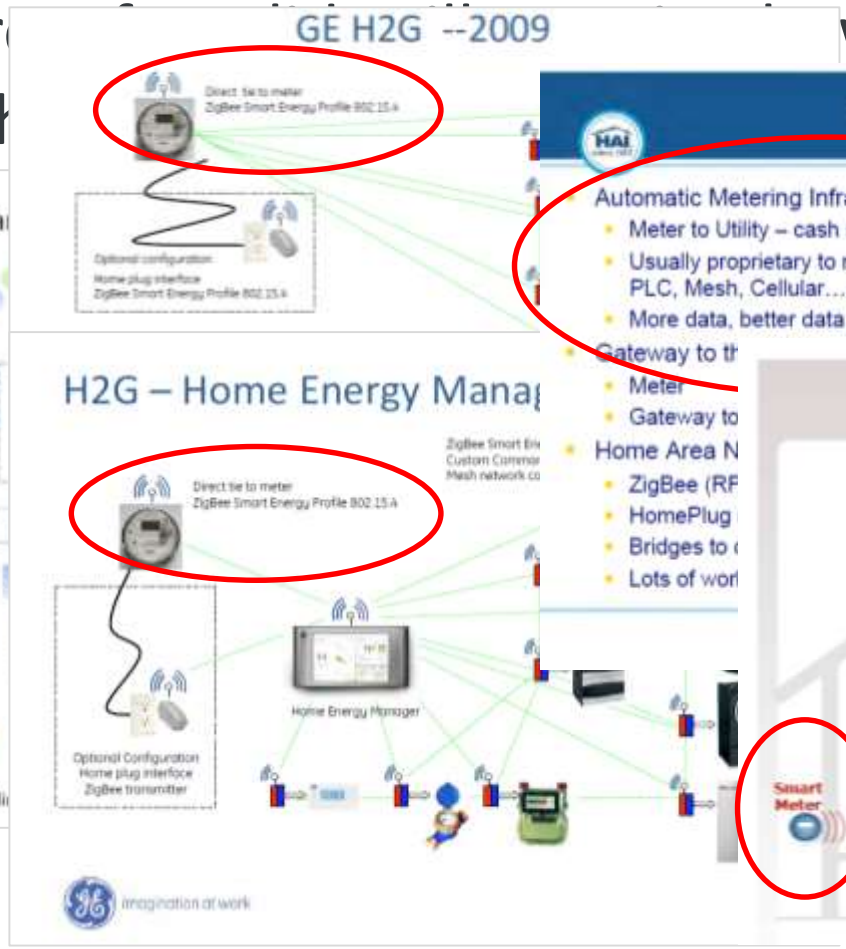
AMI Rollout via Recovery Act

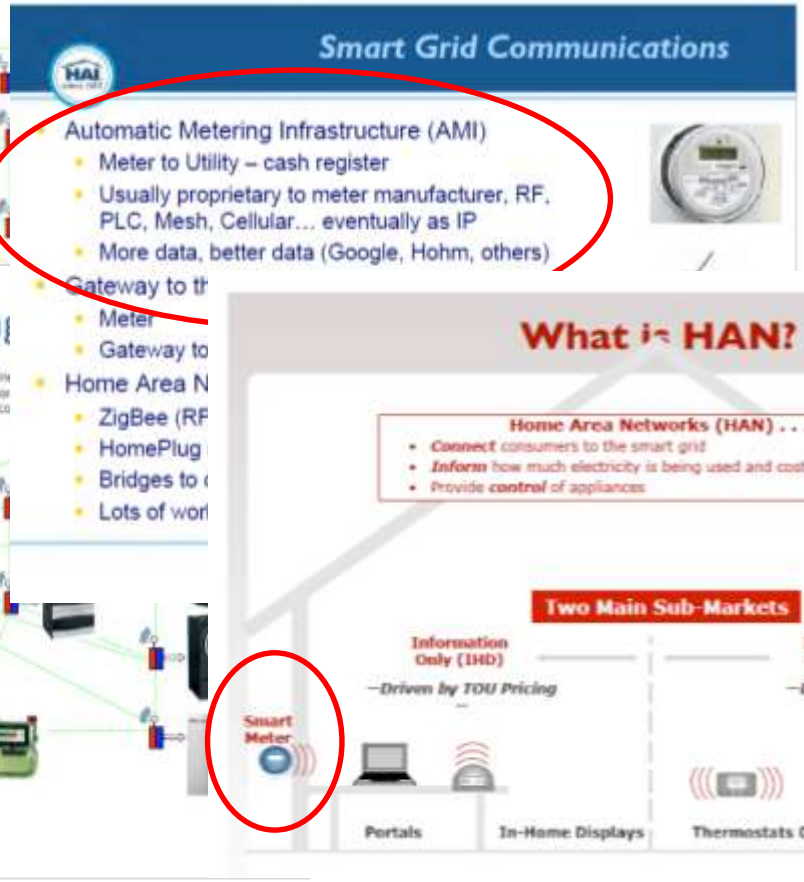
- **Rewind several years (~2009-2010):**
  - Utilities were rolling out AMI in large numbers due to $3B+ in ARRA funding
  - AMI was going to enable a whole new world of HEMS, with the meter at the center
  - Zigbee radio installed in AMI meter to communicate with HAN
  - A big selling point was that consumers would have access to their energy data and cost information via in home devices connected to AMI meter

AMI: A Central Component to HEMS

- In late 2009, NREL hosted an expert meeting on HEMS (or AHEM).
- Her[illegible] w ingrained AMI was in th[illegible]







NREL Laboratory focused on HEMS

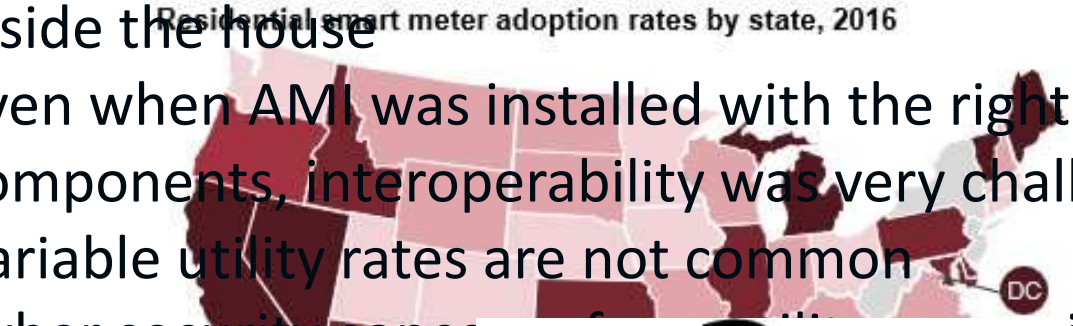
In 2012, NREL built a lab focused on evaluating functionality, interoperability, control strategies for HEMS.

- We needed AMI meters to make it all work!! (Right??)
- It was ***VERY*** difficult to buy a small number of meters for research.
- Eventually, we found a good contact at Itron and we bought 5 AMI meters, including software to send signals through the meters
- … And we've never used them.

So what happened?

HEMS development has progressed without AMI. **Why?**

- AMI rollout was slower and less complete than anticipated
  - Bad publicity probably contributed to current AMI coverage levels
- Many utilities did not install the radio needed to send data inside the house
- Even when AMI was installed with the right communication components, interoperability was very challenging.
- Variable utility rates are not common
- Cyber security conce… …ing Up meter to talk to house opens up p… …uld be accessed by oth…
- **Bu… …*yet*)**



Variable or TOU rates

HEMS & Smart Appliances

Current HEMS infrastructure

- The main reason that HEMS does not rely on AMI now is that it does not need to.
  - HEMS are largely focused on convenience, not efficiency or grid services.

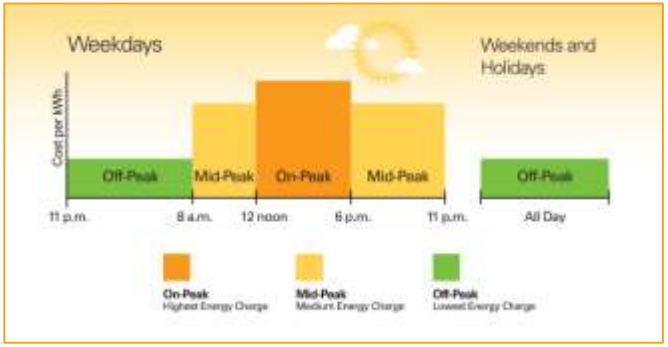
This design means that all functionality is lost if internet is down. Ideally, you want system that can function without internet (like smart thermostats) but has added features (like app control) when internet is active. Requiring cloud connections also opens cyber security vulnerabilities.

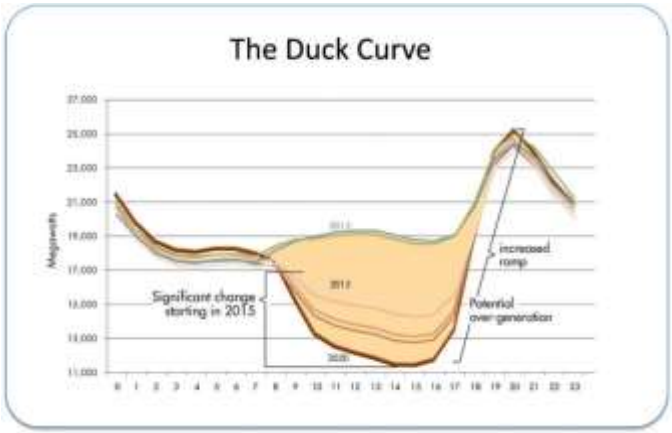
  - Wi-Fi has become dominant communication protocol
    - Exception is for devices, like smart bulbs, that often come with a hub to connect to many devices – hub-to-device communication is generally Zigbee

What's next?

While HEMS have largely not needed AMI thus far, that will likely change.

- **TOU utility rates** will motivate the use of HEMS to lower shift load to cheaper times (original driver for HEMS+AMI)
- If **solar back-feeding** to grid is penalized, HEMS can coordinate consumption using real-time whole house power data.
- If utilities start paying residential customers to **provide grid services**, HEMS can control loads and communicate back to utility.





Future of AMI and HEMS

- None of these examples explicitly need a connection to the meter, but will require:
  - Real-time price information,
  - Real-time whole-house power/energy data,
  - Way to exchange signals for grid services.

Core AMI functionality?

- Utilities are swimming in AMI data – Can HEMS help make use of all that data? (M&V 2.0, identifying retrofits, energy efficiency)
- AMI is critical to the success of HEMS
  - While HEMS may enable some energy savings, bigger benefit comes from control over ***when*** energy is used

    - Needed to enabling more renewable power on grid.
  - Without AMI meters to track energy use and enable variable pricing, HEMS will be stuck where it is today: a bunch of gadgets that provide convenience.

Thank you!

Bethany Sparn

bethany.sparn@nrel.gov
303-384-7442

www.nrel.gov

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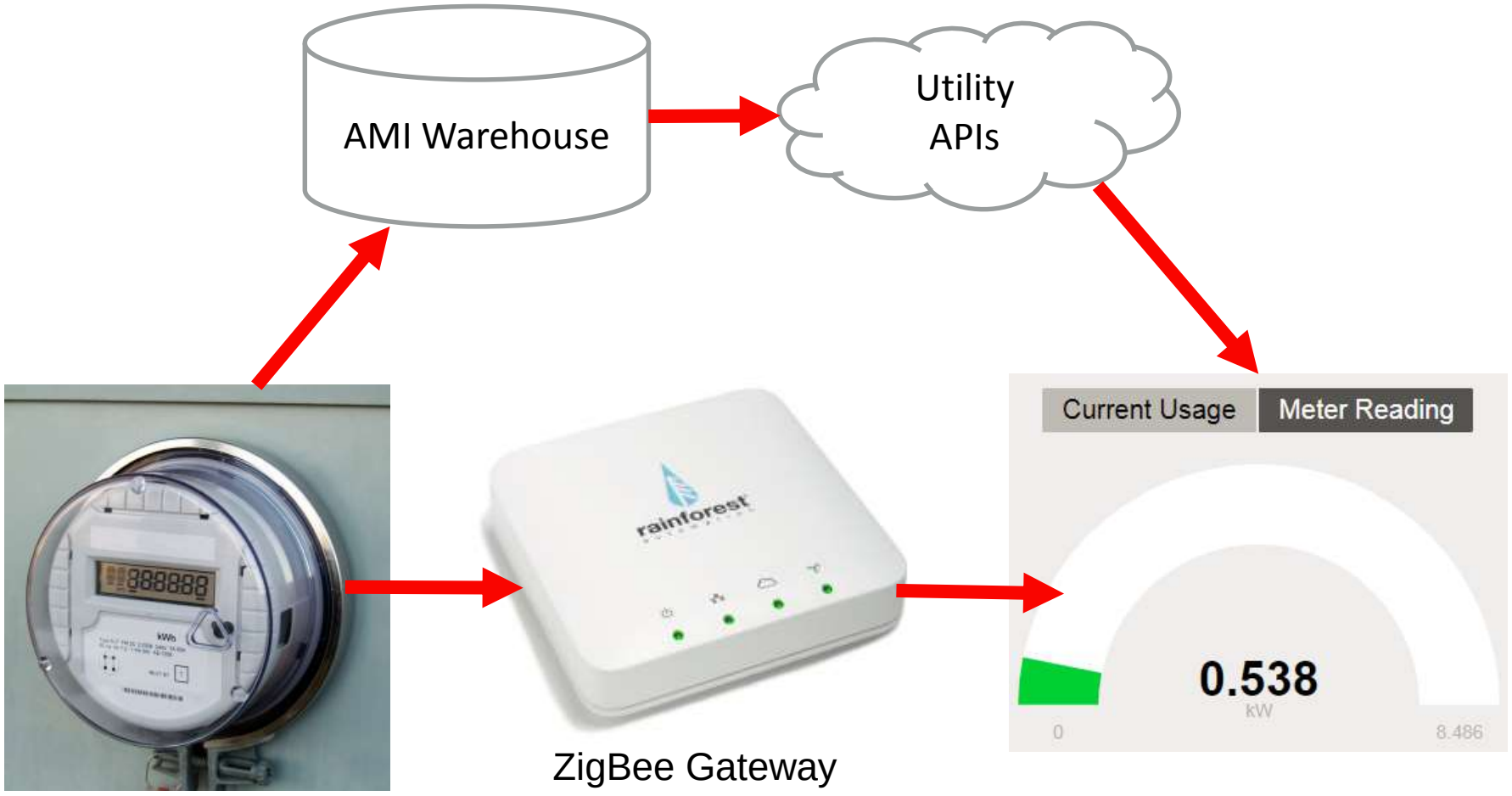
AMI and HEMS: Are We Asking the Right Questions?

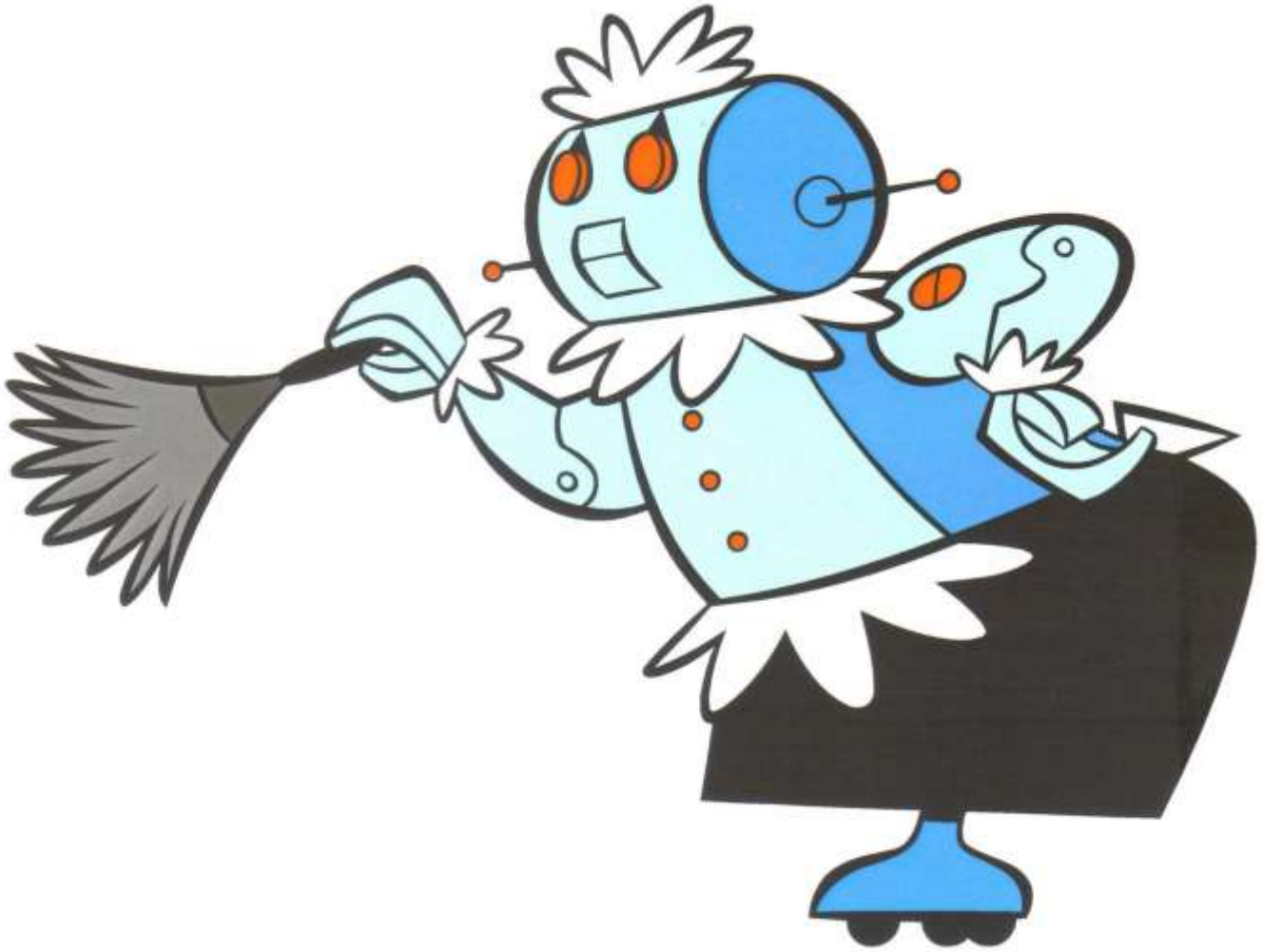
Ethan Goldman
December 2017

Vermont Energy Investment Corporation

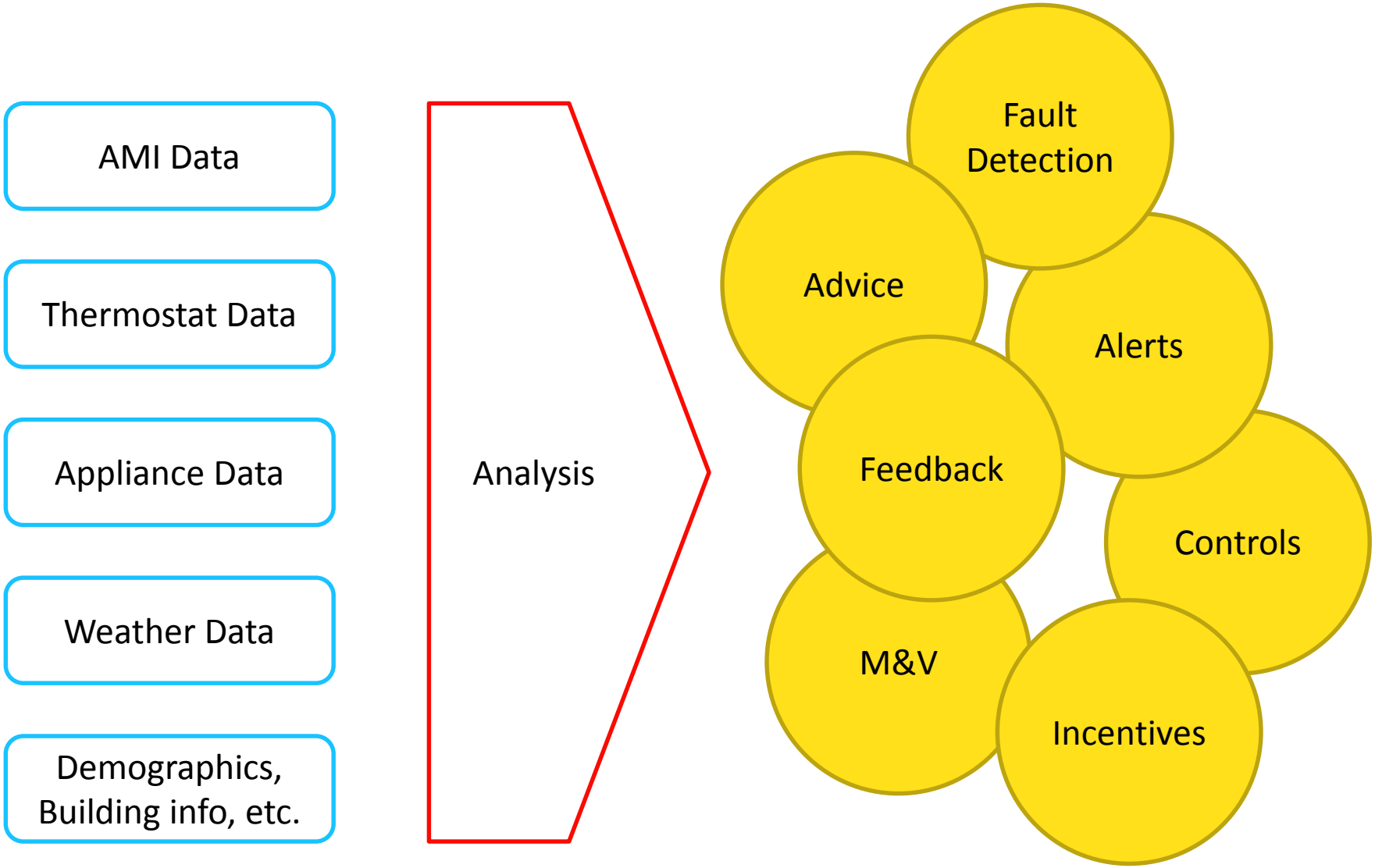
How Can We Get AMI to Talk to HEMS?



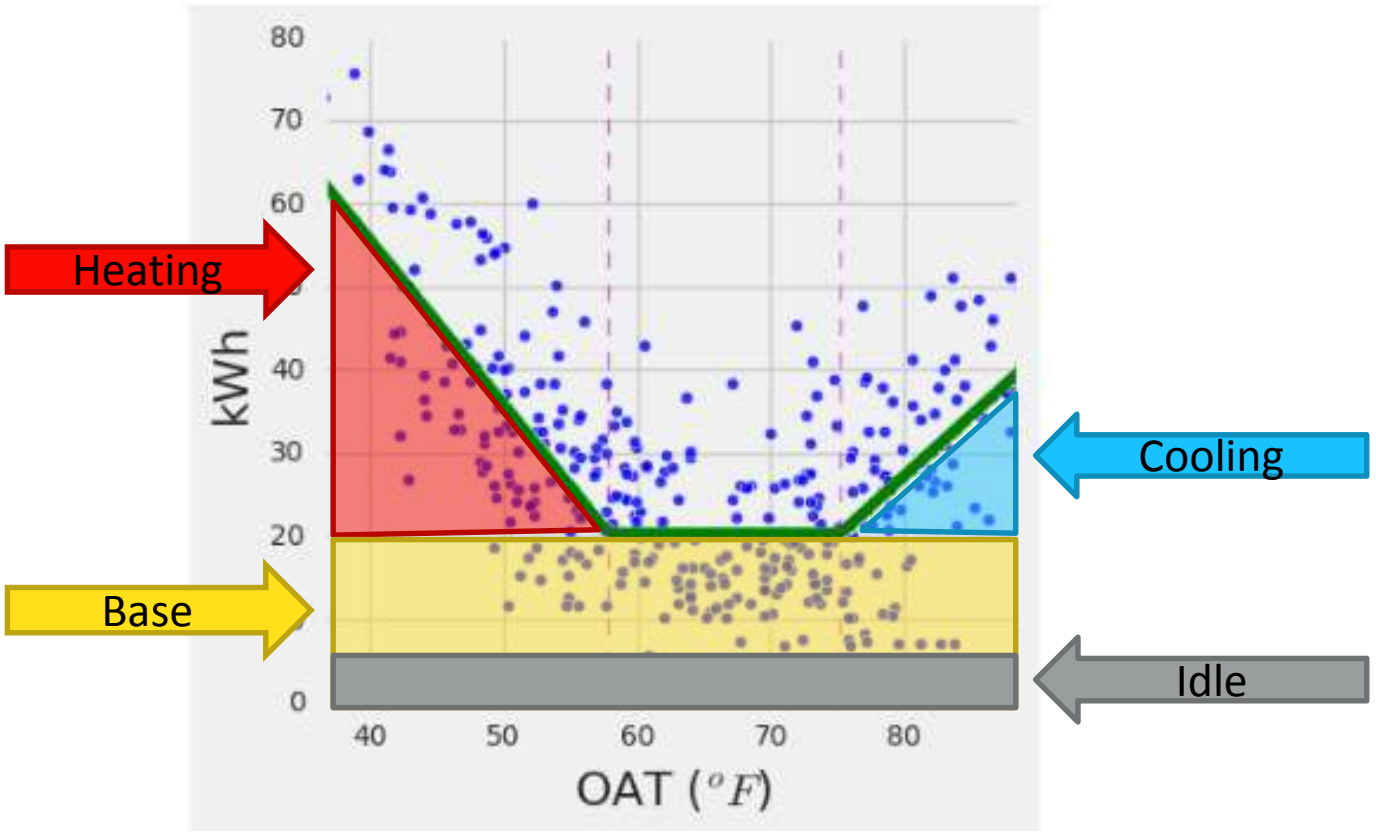
Will HEMS be Used for More Than Convenience?



What Are We Going to Do With the Data?



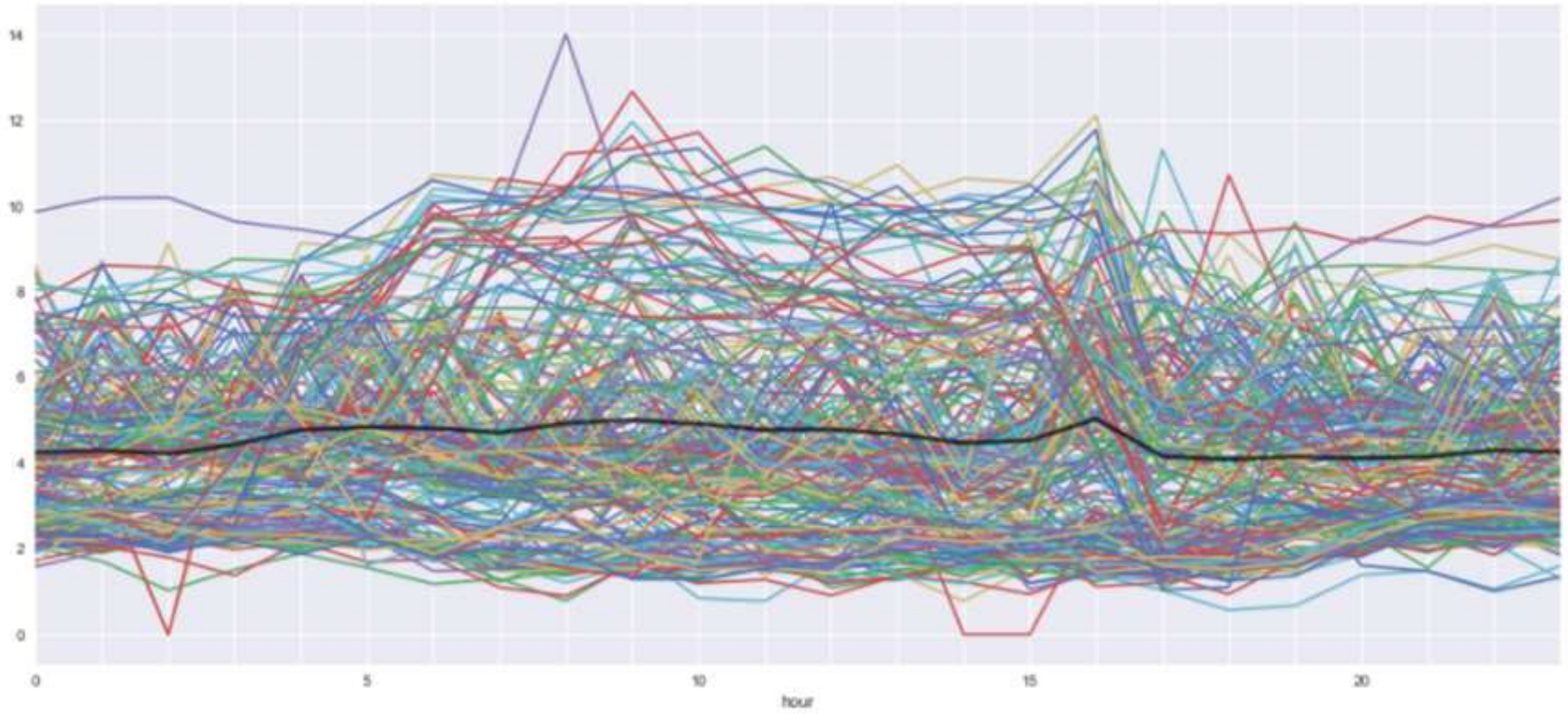
What Can AMI Interval Data Do for HEMS?



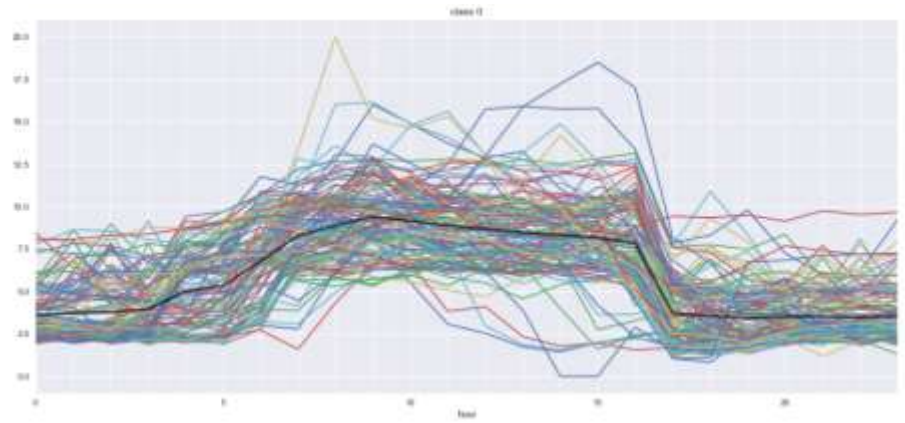
Data Tsunami!

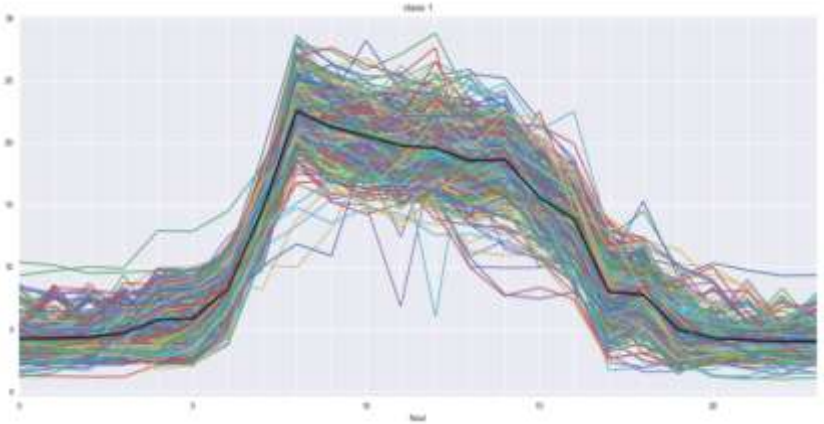
Finding Subtle Patterns

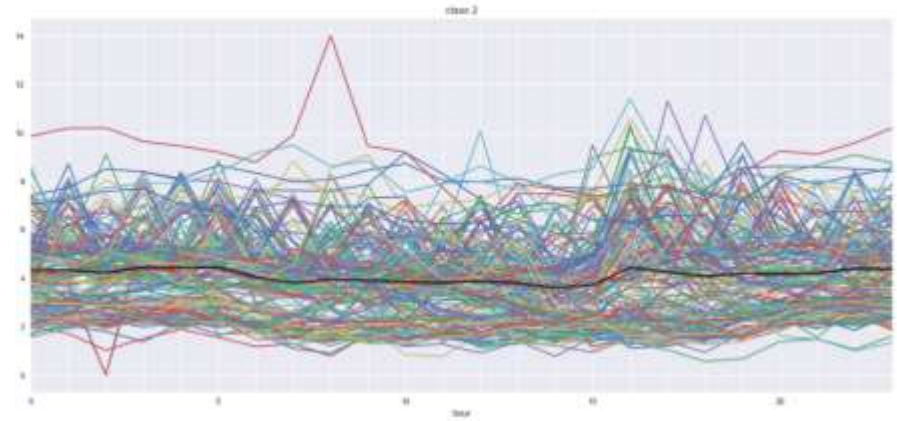
Raw Data is Messy

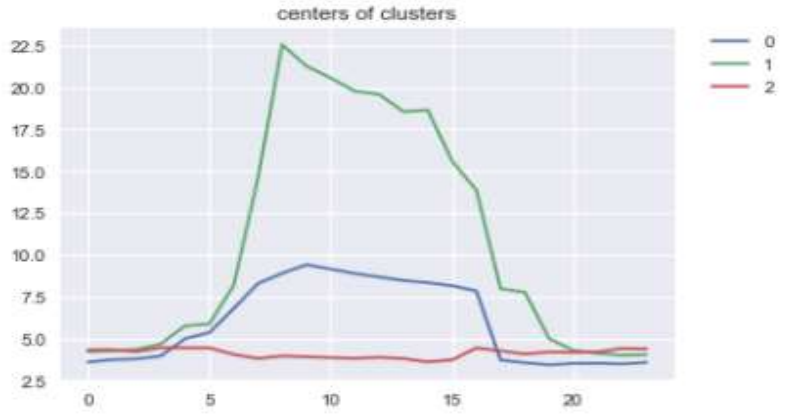


Solution: Cluster Days by Loadshape

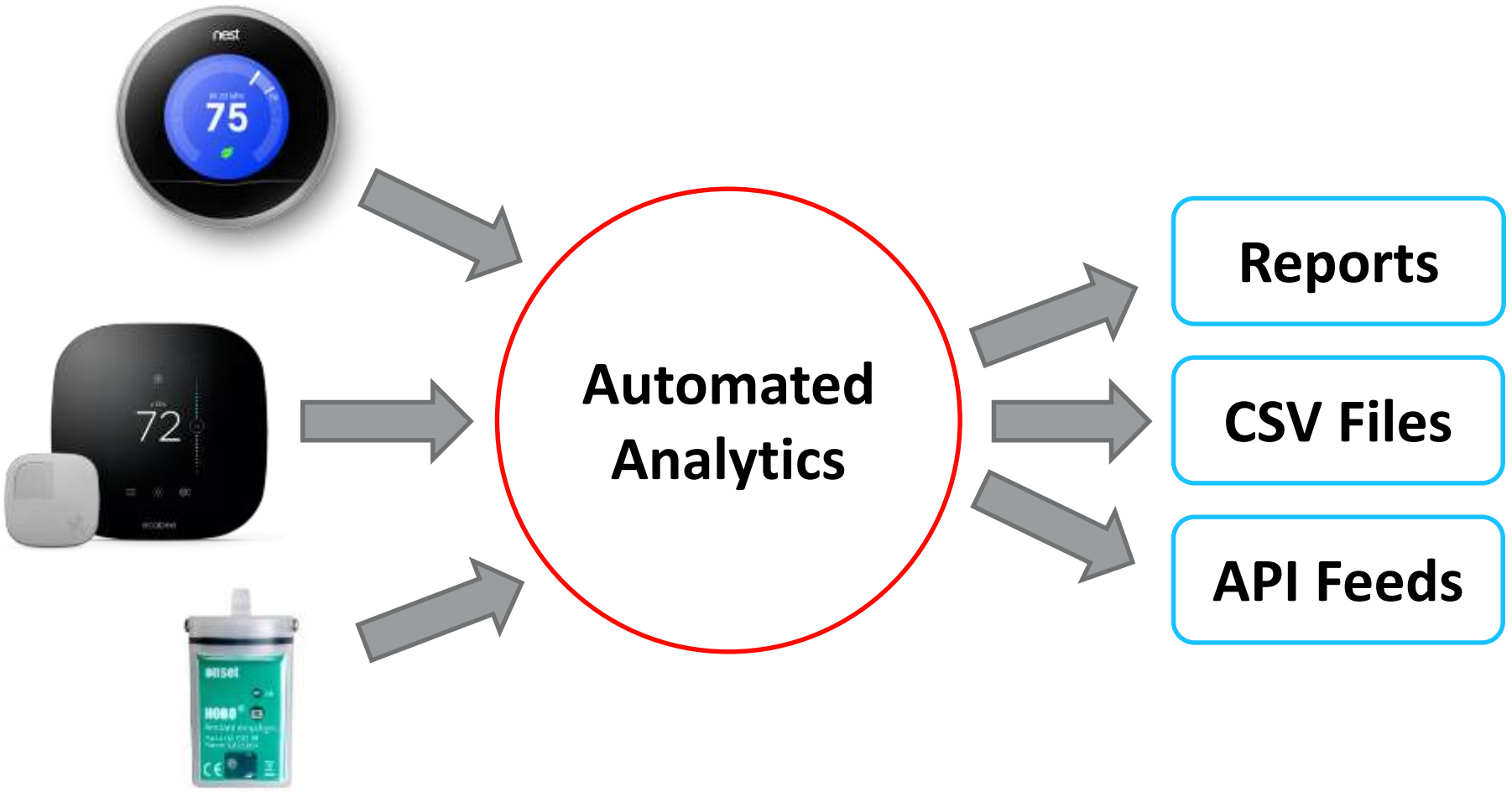




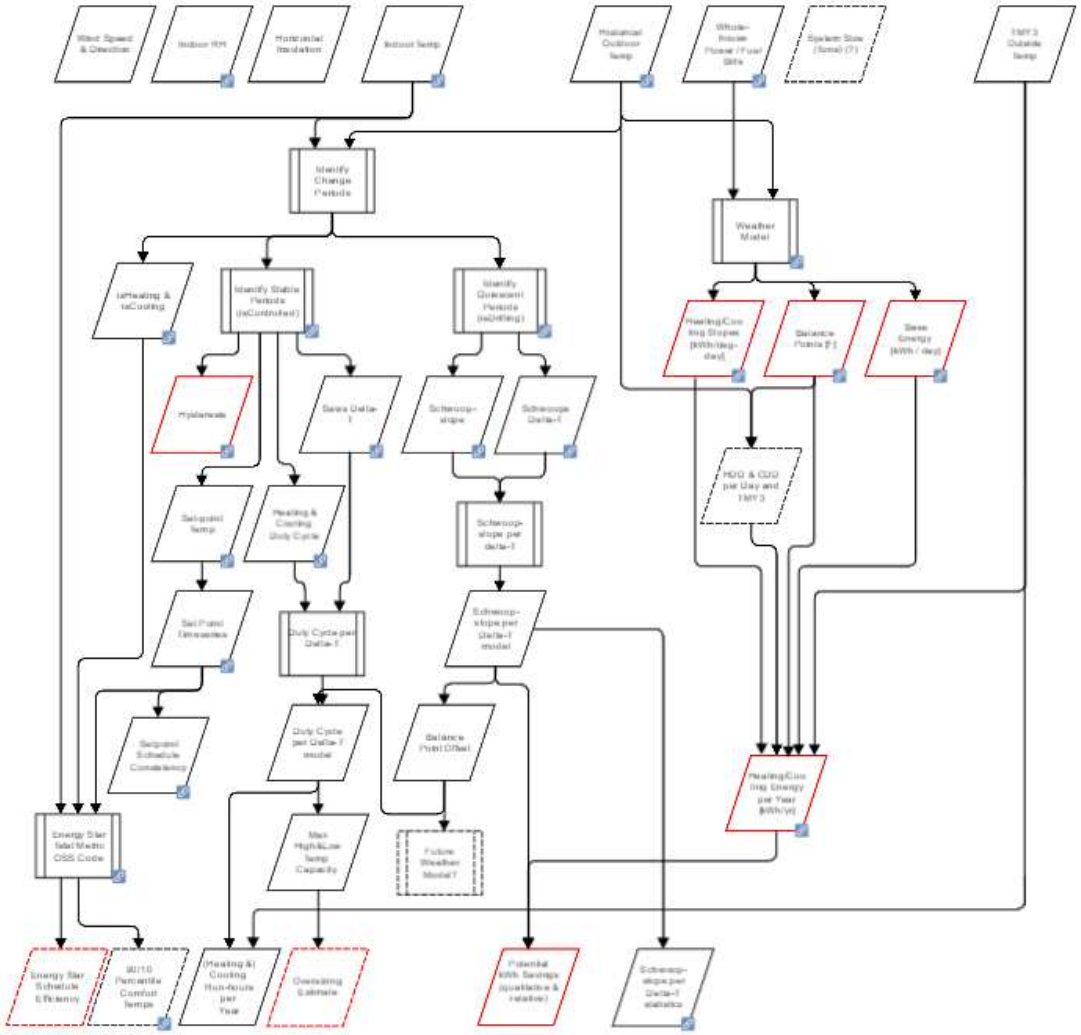




STAT: Smart Thermostat Analytics Toolkit



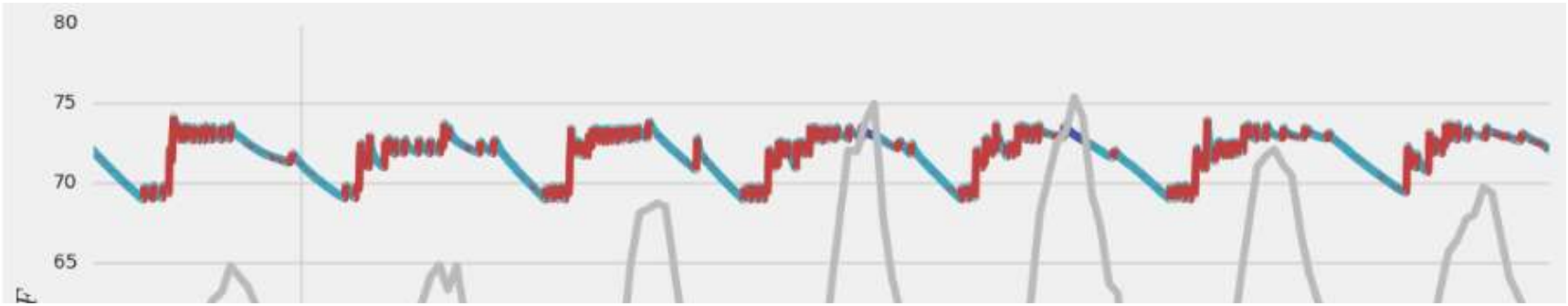
Managing and Automating Iterative Analysis

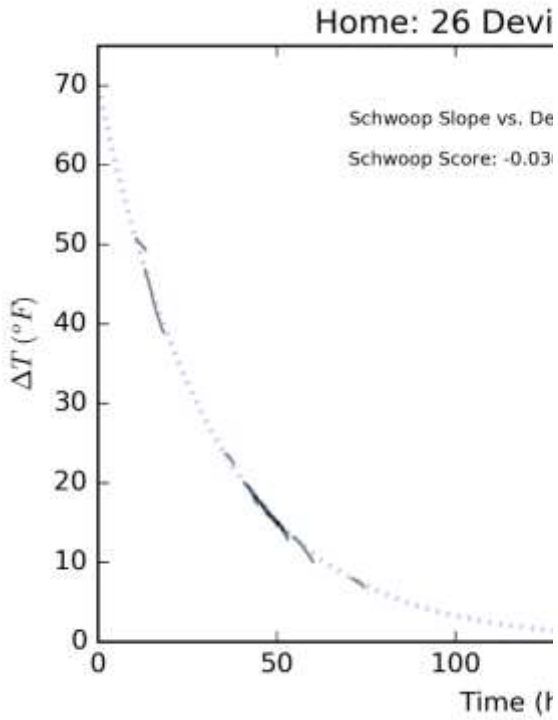


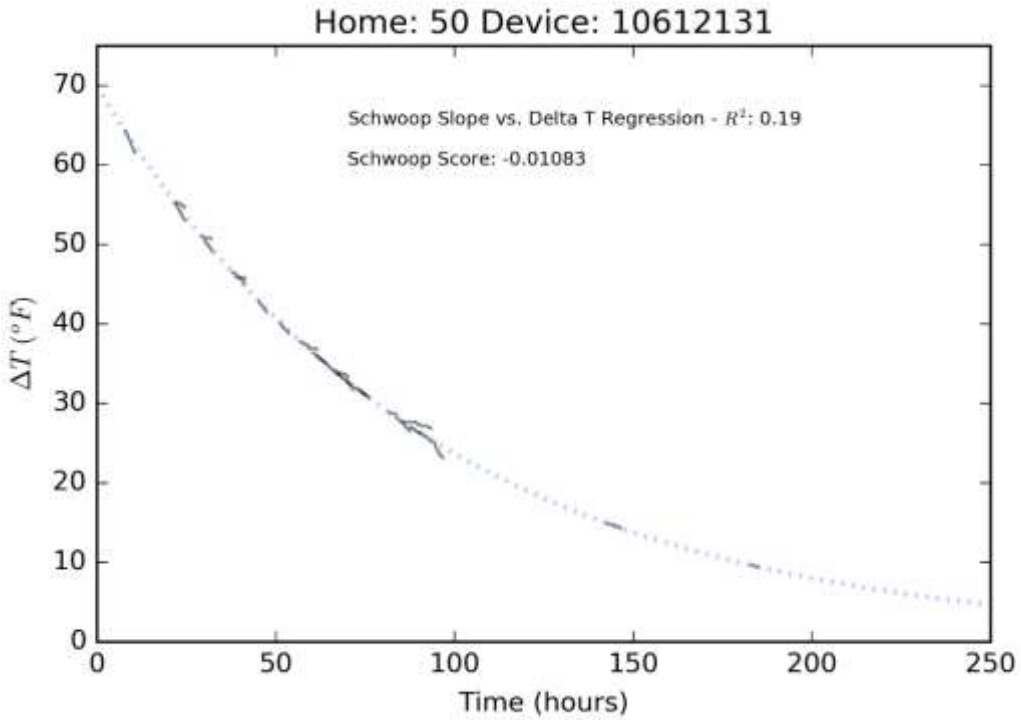
Metrics Calculated by STAT

Thermal flow rate	Estimated savings	Oversizing
Runtime reduction	AMI disaggregation	kW & kWh savings

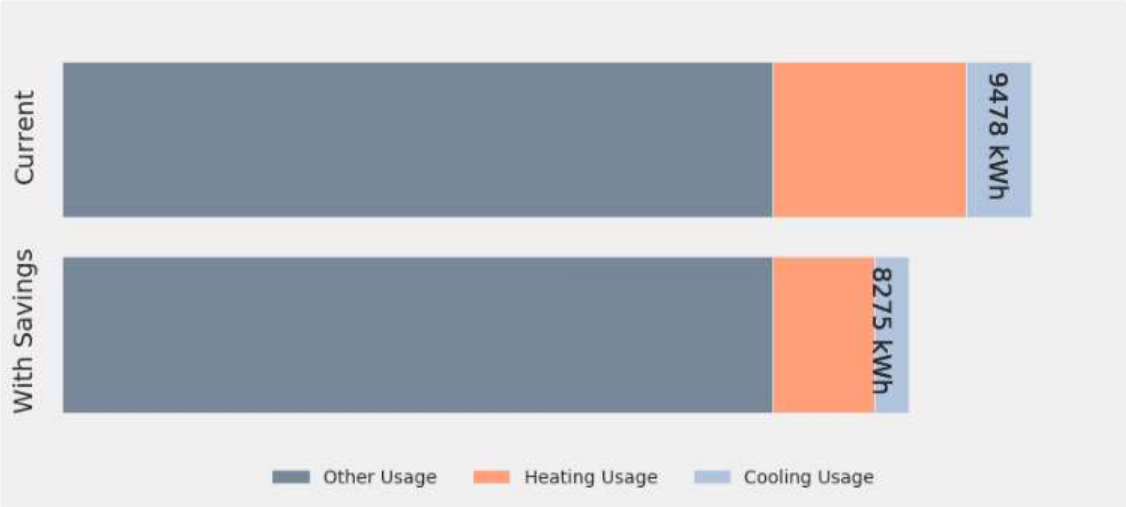
Shell Performance from Temperature Trends







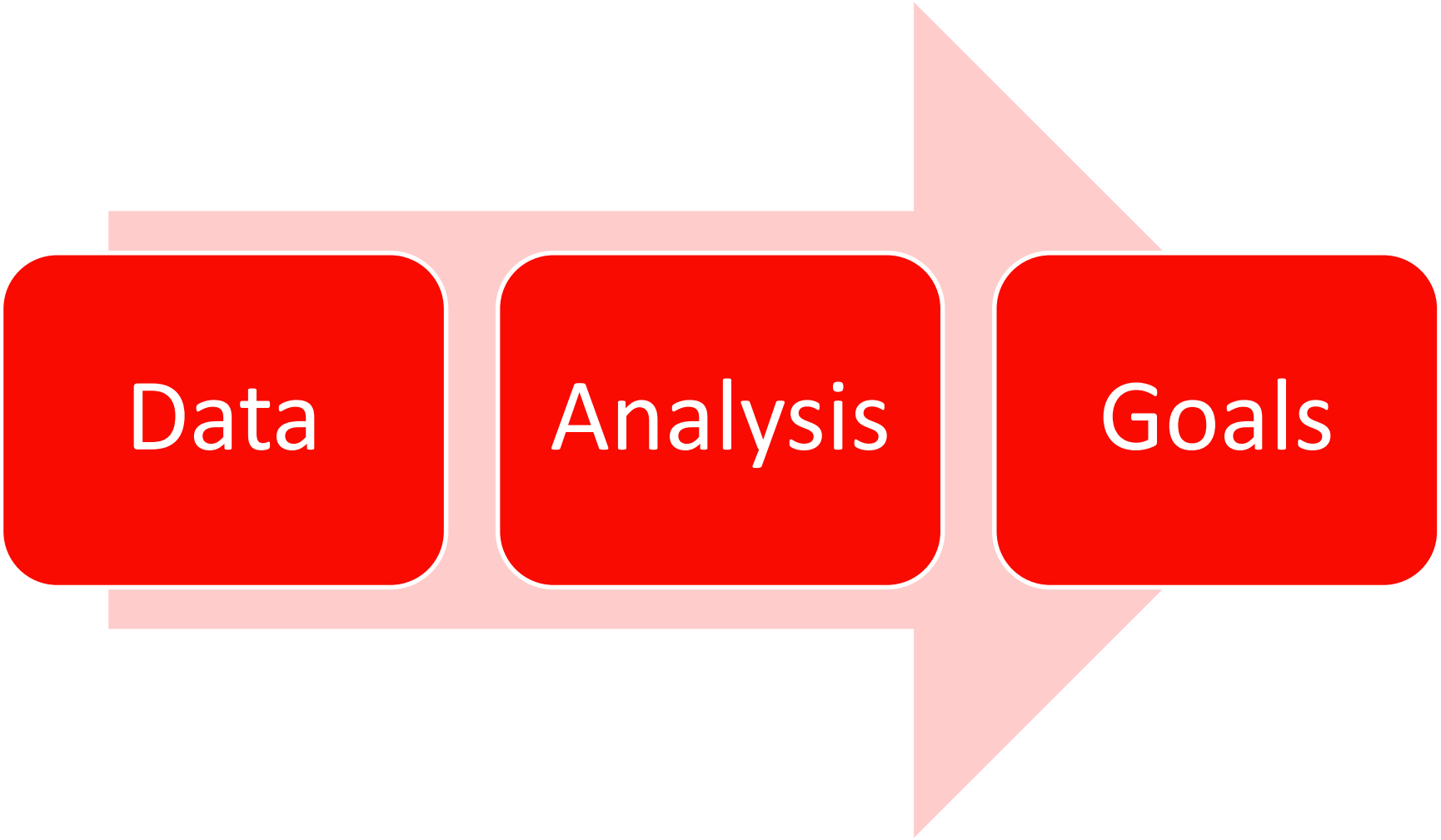
Annual Savings Potential from Tstat Analysis, Scaled to kWH and Dollars with AMI-Weather Models



	Current Modeled Use		Estimated Savings	
	kWh	$	kWh	$
Heating	1,895	$236	901	$112
Cooling	637	$79	302	$37
Other	6,946	$868	0	$0
Total	9,478	$1,183	1,203	$149

Total Savings: 48%

Work Backwards



Thank you

Ethan Goldman
egoldman@veic.org

Vermont Energy Investment Corporation


PRESENTATION FINISHED
...ANY QUESTIONS?
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