

The logo for Grid-Interop, featuring the text "Grid-Interop" in a bright green, sans-serif font. Below the text is a white graphic of a power plug with a wavy line extending from it. A small "TM" trademark symbol is located at the bottom right of the logo.

Grid-Interop™

The background of the slide is a light blue color with a network diagram. A central red sphere is connected by white lines to several yellow rectangular blocks. Some of these blocks are further connected to other yellow blocks, creating a web-like structure. Several stylized figures of men in business suits are standing on the yellow blocks, some holding briefcases. The overall theme is interconnectedness and business.

Interoperability Lessons Learned from Residential Smart Grid Deployments

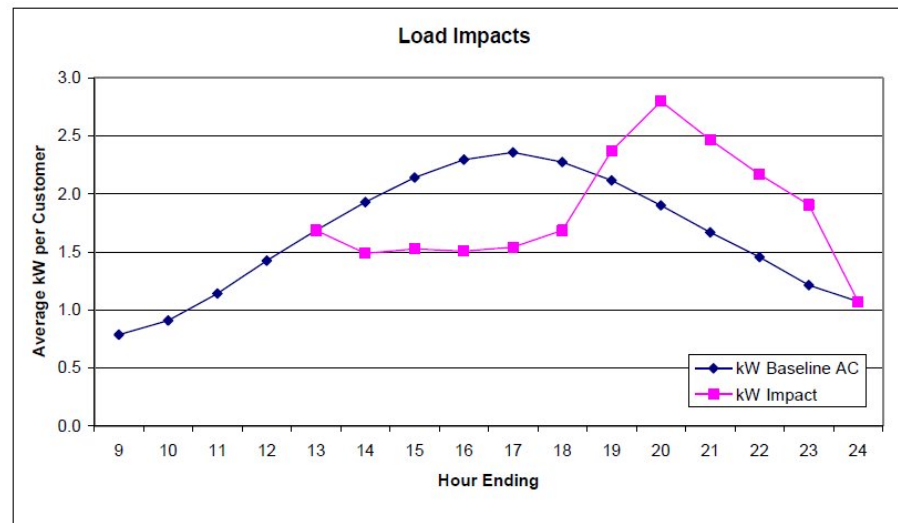
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- Ongoing programs
 - Each in 2nd year (of 4-5)
 - Learnings are preliminary, but interesting
- Two from DSM evaluation perspective
 - 1. Deliver cost effective “AMI” with existing AMR
 - Customer broadband + smart grid HAN
 - 2. Examine technology options and combinations
 - Smart meters with broadband vs. backhaul + HAN
- One from customer perspective
 - 3. AMI + broadband + metering “overlay”

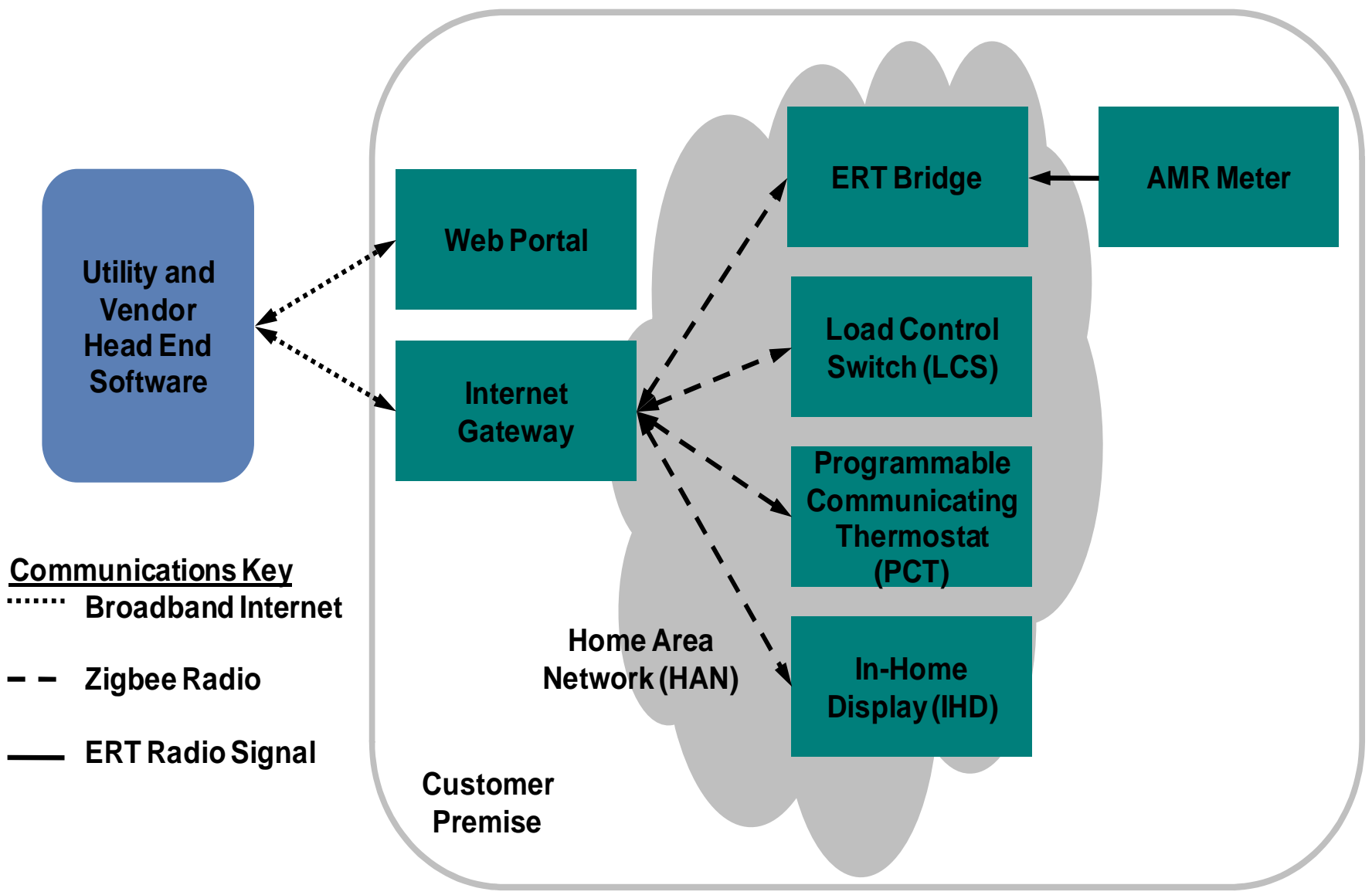
- Rough process description...
 - Commission establishes demand and/or energy reduction targets
 - Utility develops and proposes programs (including pilots) with targets
 - Commission approves programs (or suggests modifications)
 - Utility implements program
 - Evaluator measures impacts and provides assessment
 - Commission approves program cost recovery

- Process evaluation
- Impact evaluation
 - Demand
 - Energy

$$kWh_{jt} = \alpha_j + \beta \mathbf{X}_{jt} + \gamma_1 CDH_t + \gamma_2 Morn_{jt} + \gamma_3 kWhlagged_{jt} + \varepsilon_{jt}$$



- *Technology assessment*
 - Performance and reliability
 - Customer acceptance
 - Cost effectiveness



- Communications Key**
- Broadband Internet
 - - Zigbee Radio
 - ERT Radio Signal

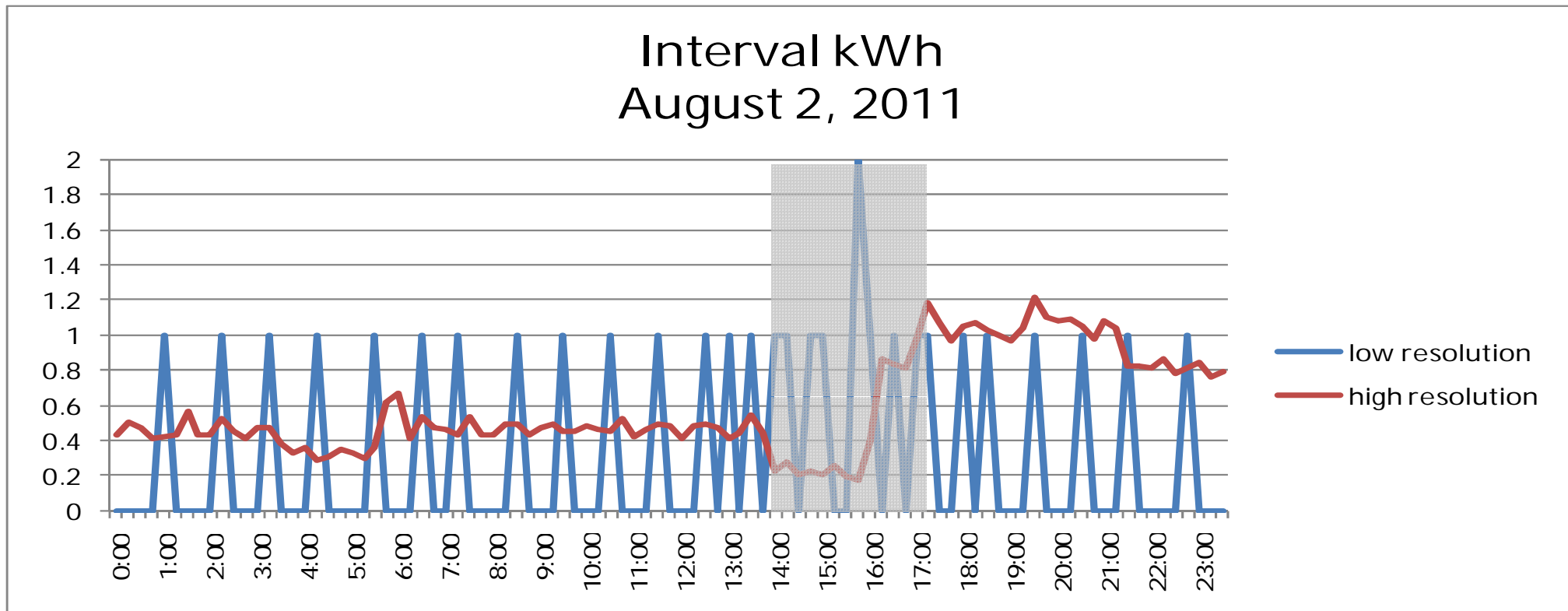
Description	AMI w/HAN	Upgraded AMR w/HAN
Interval Data	X	X
Customer Information	X	X
Direct Load Control	X	X
Temperature Setbacks	X	X
Remote Upgrades	X	X
Revenue Protection	X	X*
Meter Diagnostics	X	X*
Remote Disconnect	X	
Automated Outage Reporting	X	X**
<p>*Interval data can be used to determine some level of revenue protection and meter diagnostics. **Future enhancement proposed.</p> <p>Source: Based on assessments by utility's engineering team, third-party vendor, and consultants.</p>		

Technology + Pricing Options

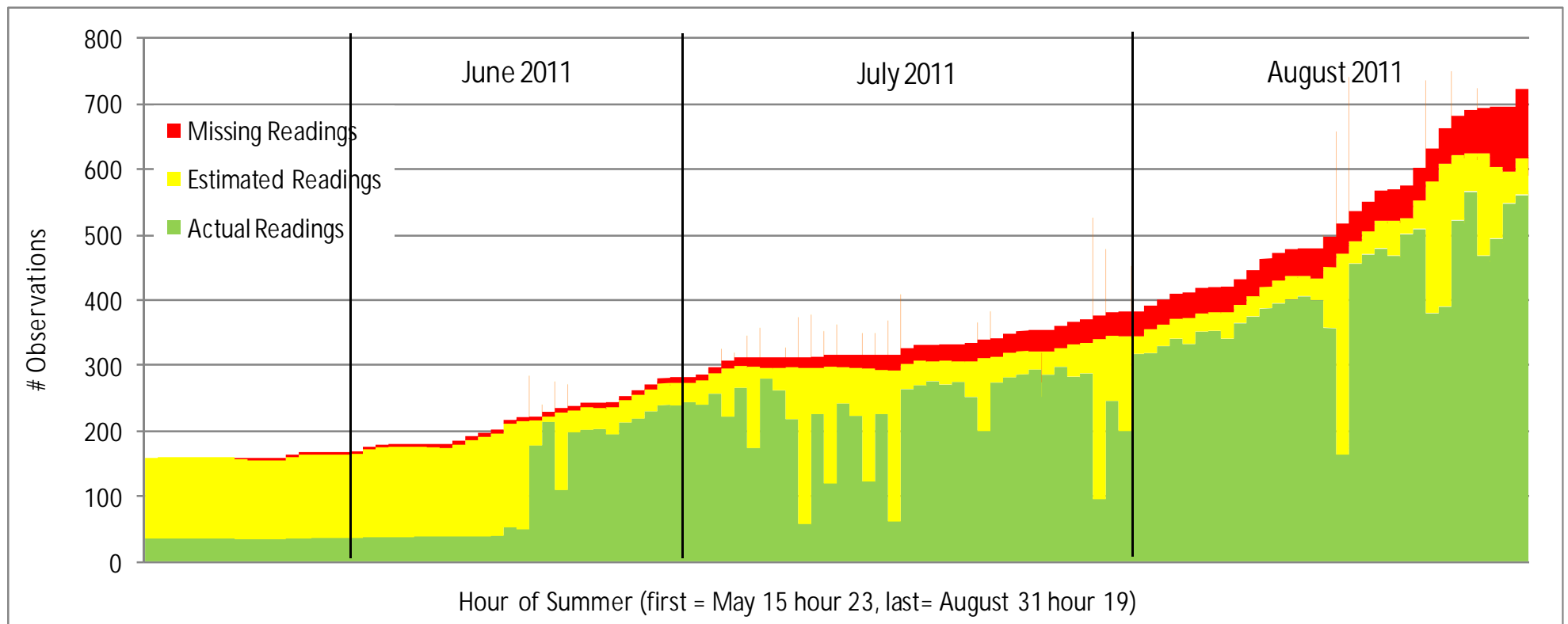
#	Treatment Group	AC Load Control?	Target Enrollment
1	TOU Rate plus Critical Peak Pricing (CPP)		700
2		X	700
3	Critical Peak Rebate	X	700
4	Technology-Only		700
5	Control Group		250
	Total		3,050

Note: All groups except the control group will receive an Internet gateway and an in-home energy display.

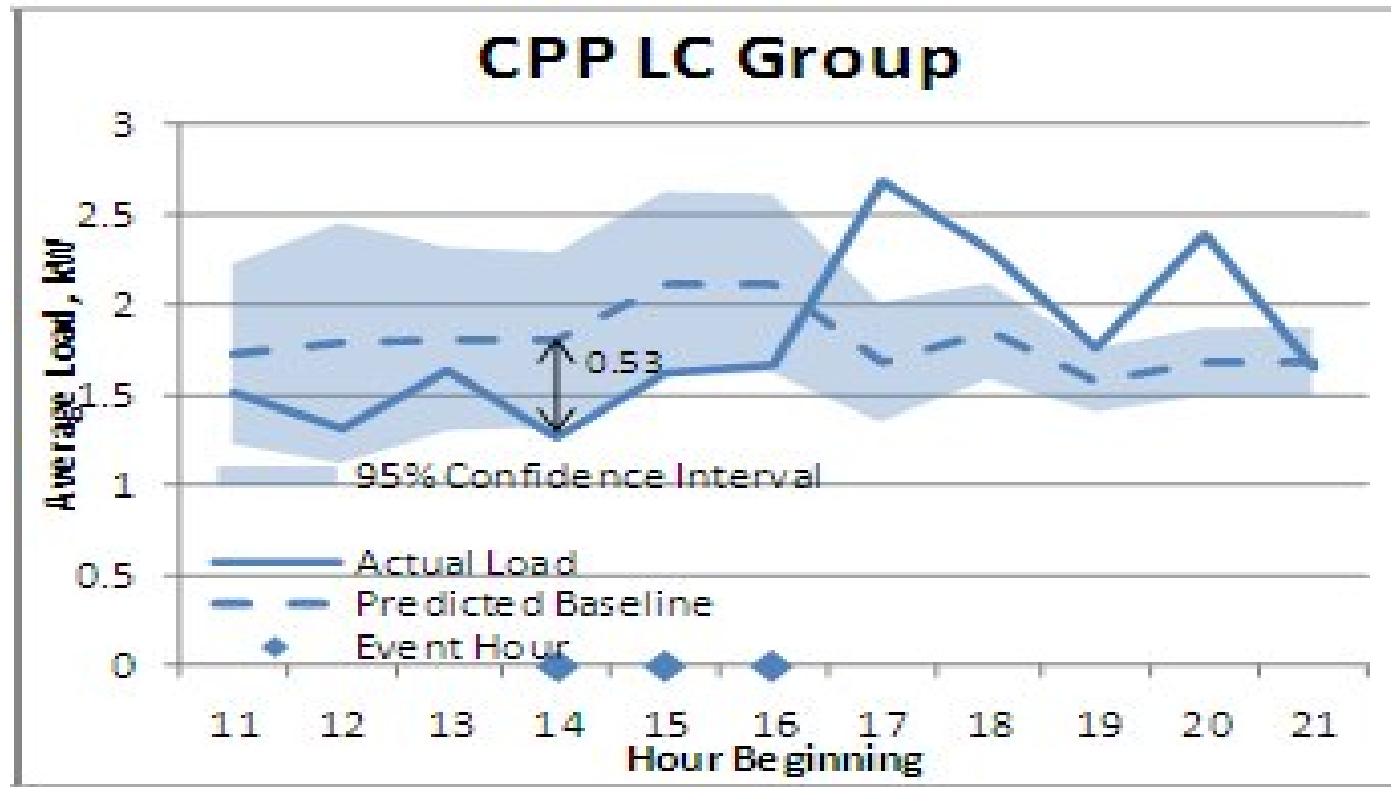
- Two resolutions: Wh and dWh
- Makes data *choppy*



- ERT “Chirps” snapped to 15 minute boundaries
- Gaps filled



- Meter data can be used successfully for impact evaluation...



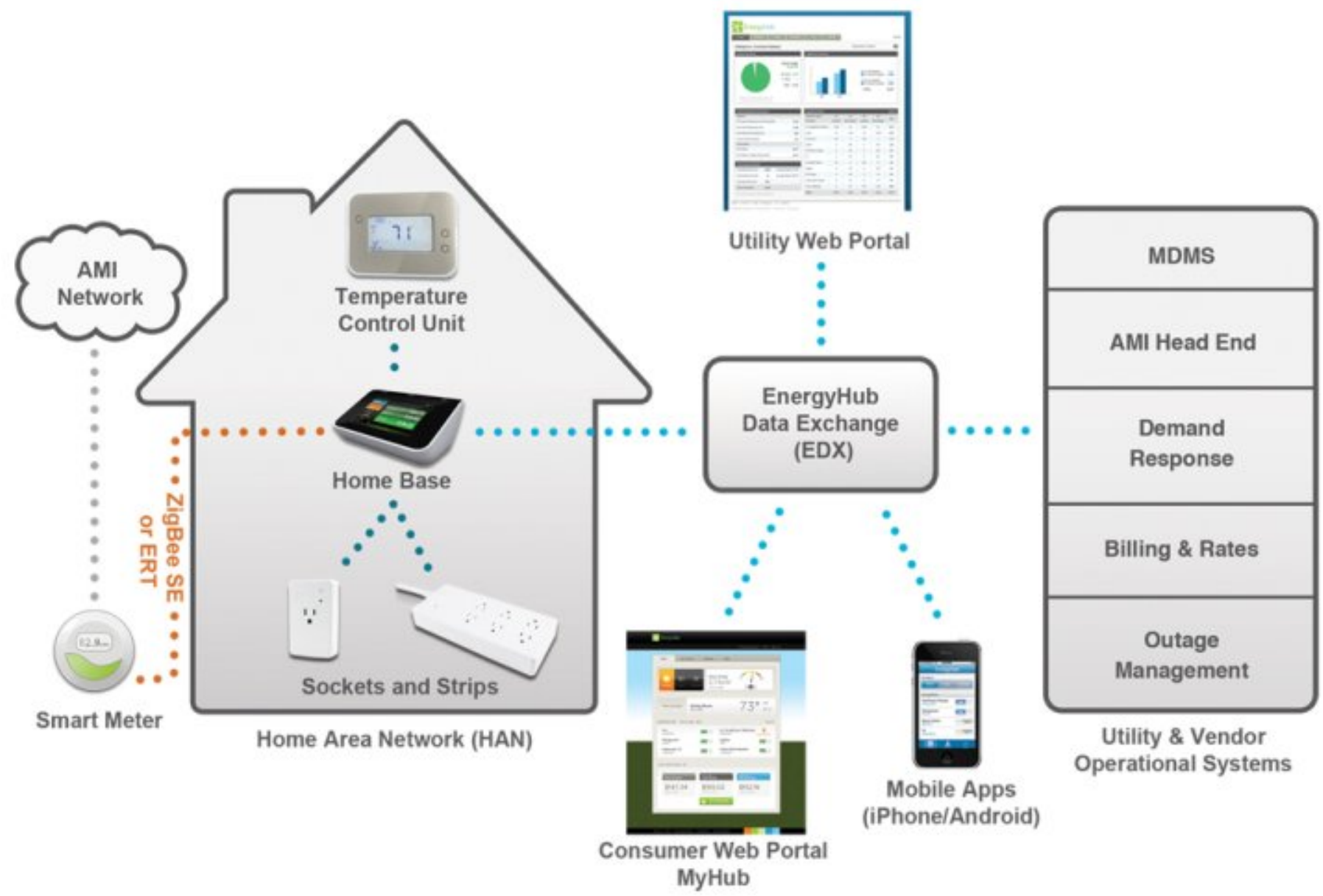
- Now, what about billing?

Technology + Pricing Options

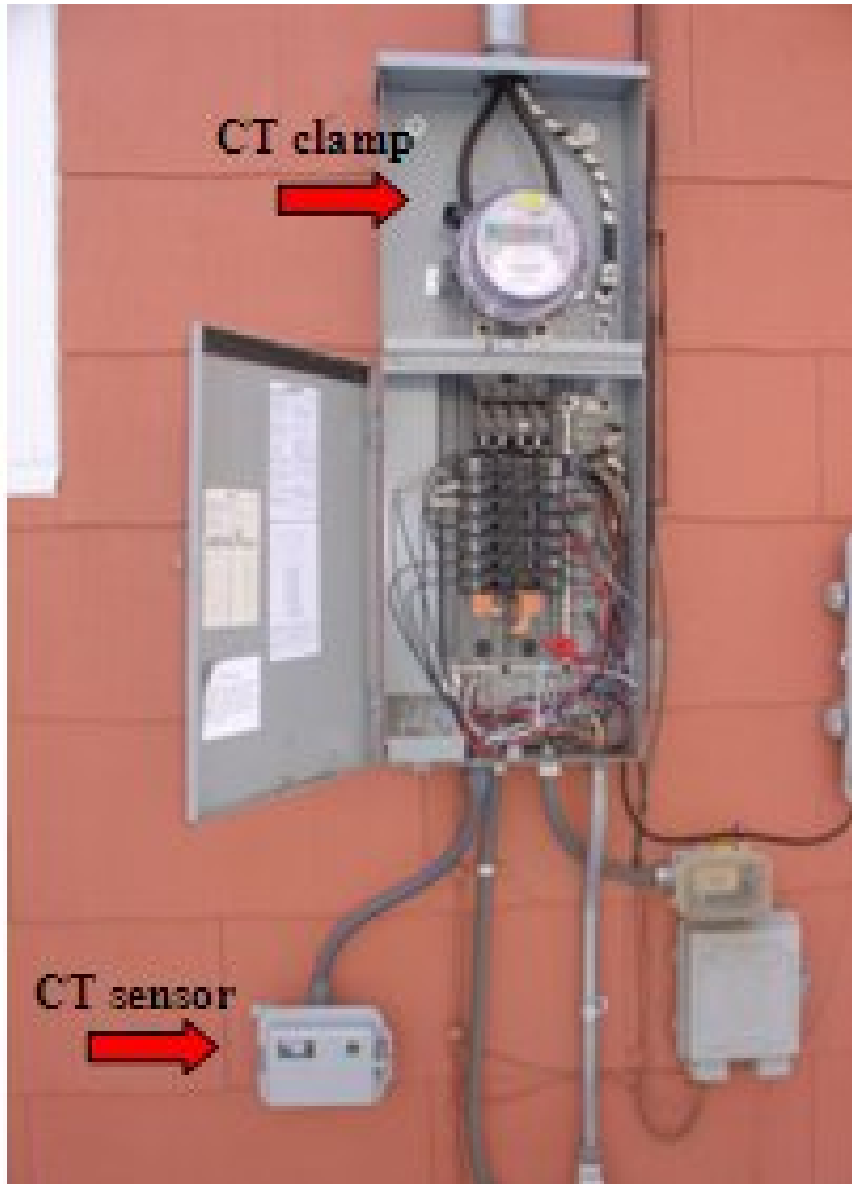
#	Group Description	Equipment	Target Enrollment
1	CPP with Customer Energy Control Device	Vendor A PCT:AMI vs. Vendor B PCT: BBand	300
2	In-Home Energy Information Display	Vendor A IHD: AMI vs. Vendor B IHD: AMI	300
3	Direct Load Control	Vendor A PCT:AMI vs. Vendor B PCT: BBand	300
4	Smart Phone or PDA App	Home gateway: BBand	300
	Total		1,200



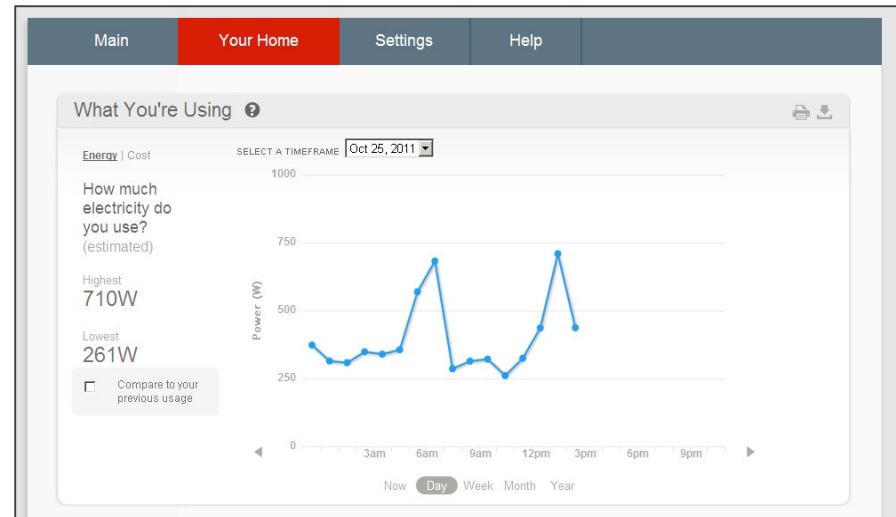
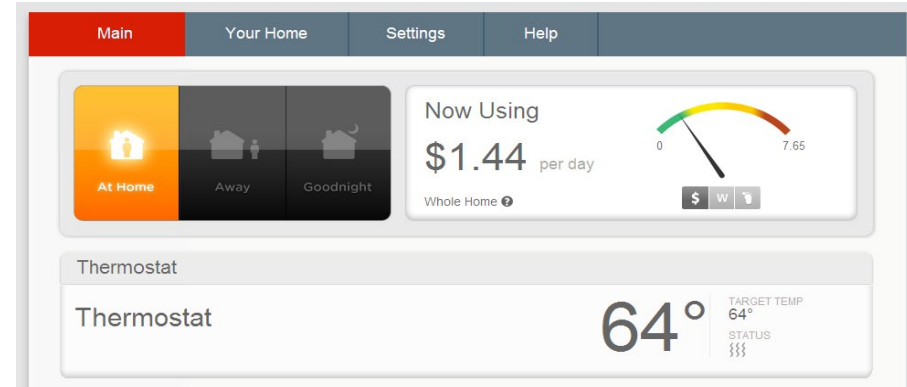
- Train is still at the station!
 - System software delays (AMI vendor)
 - Now starting to move slowly...



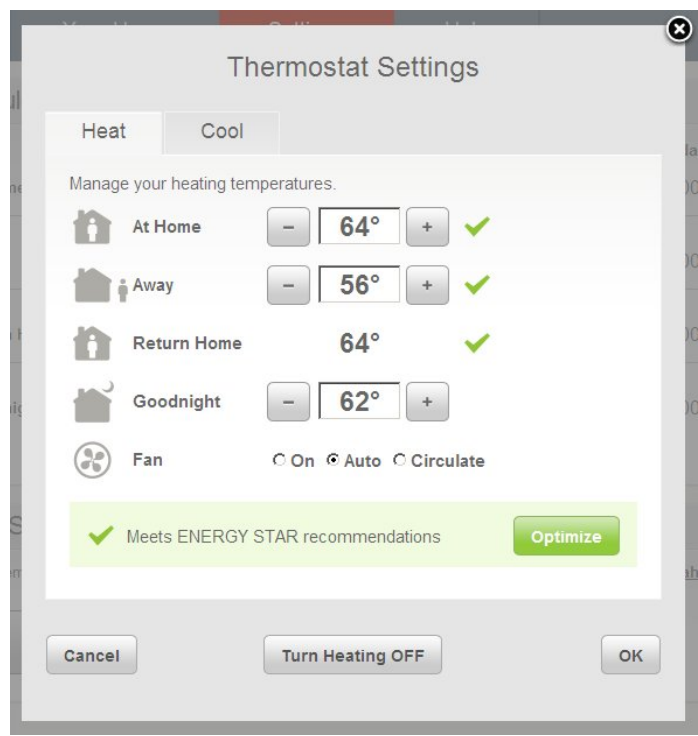
- Current Transformers (CTs)
 - Requires professional install
 - Note: solution also leverages smart meter



- Energy consumption display(s)
 - Local and remote
- Higher resolution possible in local display
 - More dynamic
 - Enables another level of feedback



- Central A/C load
- Selected plug-load
 - “smart dishwasher”



- Major consumer advantage--near real-time visibility and feedback, but...
- Installer must be an electrician AND have working knowledge of HVAC and IT(!) AND available tele-support
- Lengthy install time effects economics
 - And reliance on customer technology & configuration (e.g., WiFi) presents lots of opportunity for walk-aways
- These factors make system expensive
 - Utility advertizes system as “\$1200 value”
 - Cost must come down to scale solution

- Residential smart grid is *creeping* forward...
- Pilots and trials present extremely important learning grounds
 - Technology is making progress, but maturity and availability of key interoperability points can impact entire project
 - Interoperation with *production* systems not yet being significantly tested
 - Nevertheless, this experimentation is critical to moving interoperability and the industry forward
- Business case is TBD
 - Pilot vs. production scale economics
 - Uptake on opt-in capabilities is critical factor