

EE 295

Smart Grid and the Retail Customer

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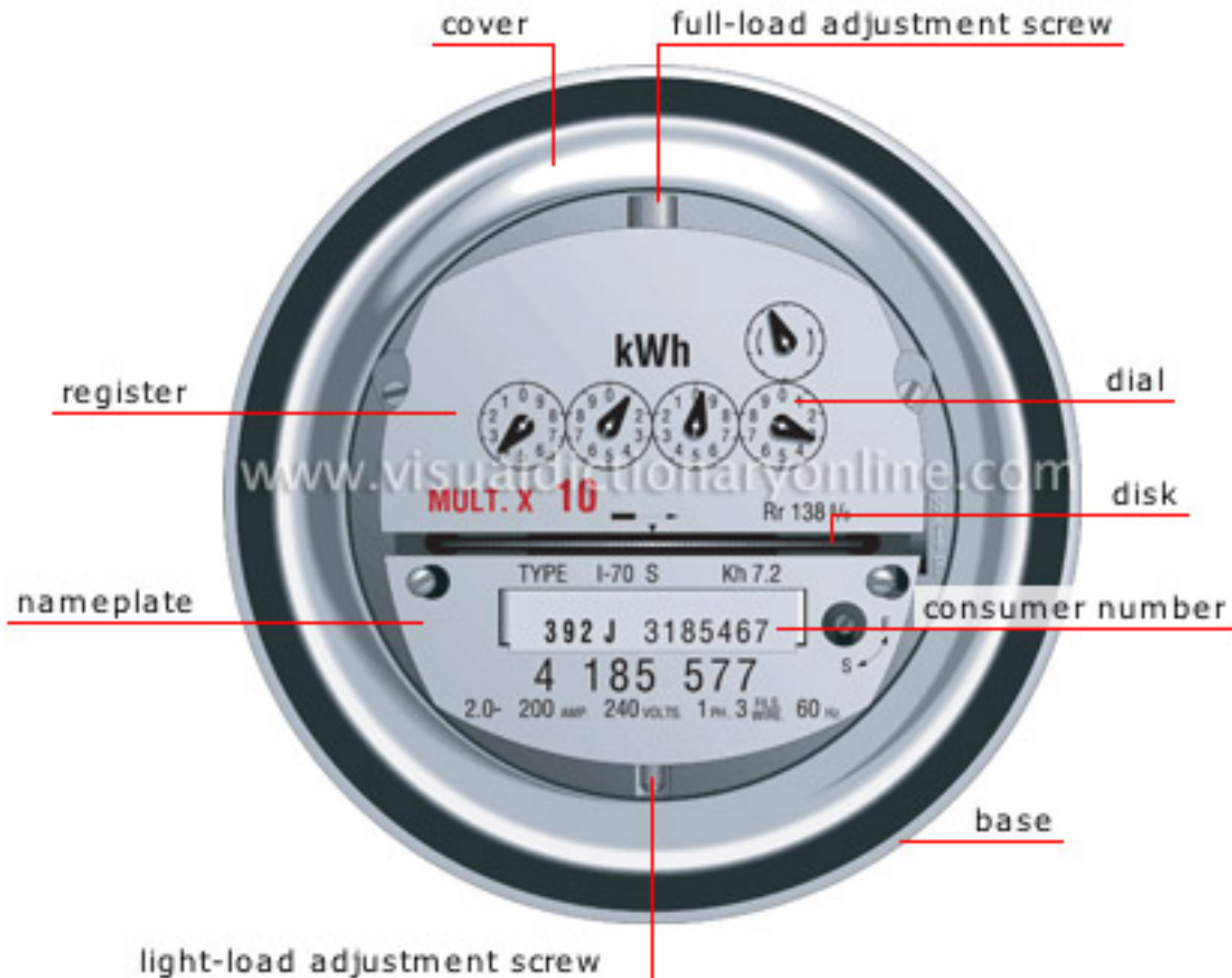


The electric meter

- "Our children will enjoy in their homes electrical energy too cheap to meter... It is not too much to expect that our children will know of great periodic regional famines in the world only as matters of history, will travel effortlessly over the seas and under them and through the air with a minimum of danger and at great speeds, and will experience a lifespan far longer than ours, as disease yields and man comes to understand what causes him to age."
 - Lewis Strauss, Chairman of the United States Atomic Energy Commission, in a 1954 speech to the National Association of Science Writers



The electrotromechanical meter



Features of an E-M meter

- Records typically monthly total energy
- Sometimes has separate registers for peak/off-peak
- Communication is limited
- The problem:
 - Does not enable responsive load, which we already know is important
 - Cannot be remotely disconnected
 - Does not alert the utility when the power is out (or when tampered with).
 - Cannot separately measure outward and inward flows (some old meters actually count them the same)



The smart meter

Utility side

Consumer side

Prices,
control
commands



Consumer
Preferences
meter-
readings



Load, DG
control

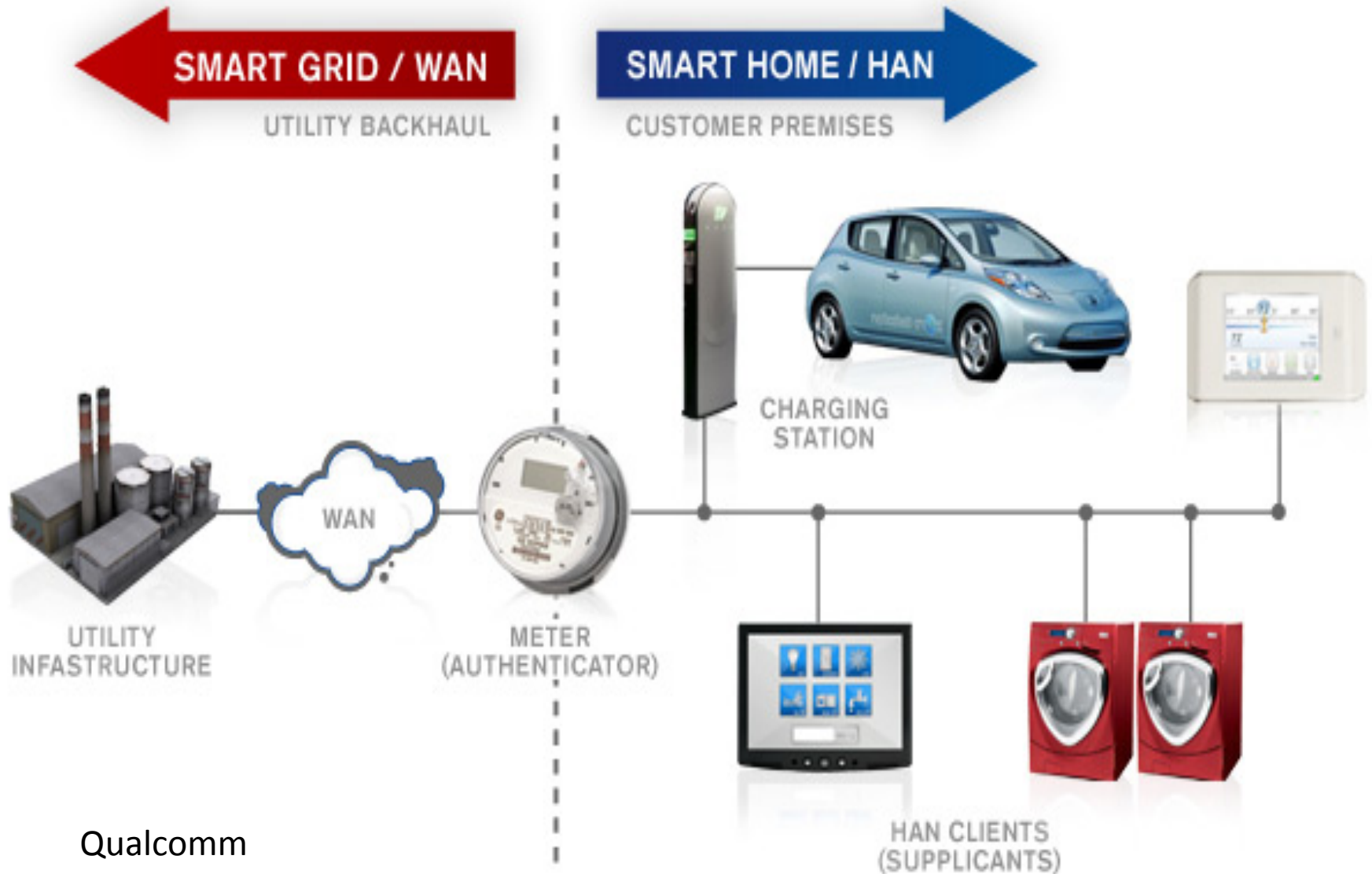


Price info

disconnect



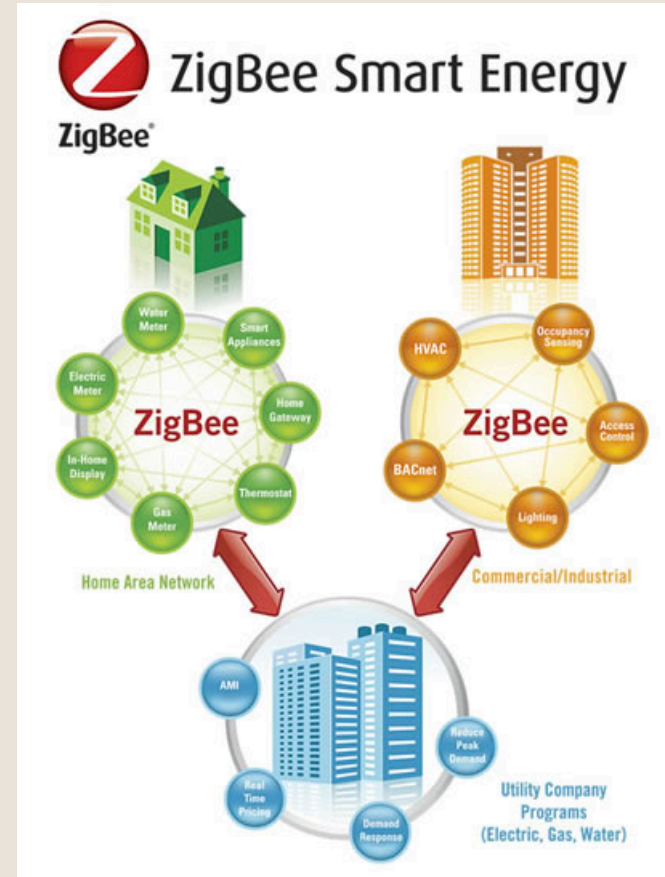
Home Area Networks



Qualcomm

Comm. protocols

- ZigBee (IEEE 802.15)
 - Low bandwidth (250kb/s), low power protocol for device-to-device communication
 - Used to form mesh networks
 - A majority of smart meters include a ZigBee radio
- WiFi (IEEE 802.11)
 - Preferred by some, because of its ubiquity and higher bandwidth
- Utilities and appliance industry never agreed on one standard



And the wired option

- HomePlug Green PHY



With HomePlug technology, the electrical wires in your home can now distribute Smart Energy applications.



Attempting to merge the three (four)

CSEP Consortium for
SEP 2 Interoperability



The Smart Energy Profile 2 is the forthcoming standard for applications that enable home energy management via wired and wireless devices that support Internet Protocol.

To ensure interoperability of products, the members of the Consortium for SEP 2 Interoperability are working together to develop common testing documents and processes for certifying SEP 2 interoperability

The Founding Members of the Consortium for SEP 2 Interoperability (CSEP) are industry alliances: ZigBee Alliance, Wi-Fi Alliance, and HomePlug Alliance.



The promise

GE and Sears 'connect' for smart appliance line

Sears is the first — and for now, only — retailer to carry the GE Nucleus Home Manager along with the device's first compatible appliance: The super-efficient GeoSpring Hybrid Water Heater.

Wed, Oct 24 2012 at 11:15 AM



The reality

Utility Pilot Customers



The Nucleus energy manager and its associated family of products are no longer available, but

Utility customers will continue to be supported through the duration of their pilots.

For questions related to utility pilots or retail purchase, please visit our [Nucleus Support Page](#).



ANSI/CEA-2045

- Modular Communications Interface for Energy Management



Benefits of AMI

- Demand response
 - Reduce peak-hour power consumption
 - Reduces need for new capital, which is ~ half of total costs
 - Potential benefits under high penetration renewables scenarios
- Remote meter reading
 - Fewer meter readers
- Storm response
 - Utility can see exactly where to dispatch crews after an outage
- Remote disconnect
 - No need to send out a truck when a disconnection or reconnection is needed
 - Valuable when used in areas with high customer turnover, or low payment rates.
 - Equity issue?
- Distributed Renewables (rooftop PV)
 - Can allow utilities to know how much generation is on the system, and to separately meter renewables (or at least separately meter in and out flows)



Direct Costs of AMI

- New meter is ~\$100-200
- Old EM meter is <\$50
- New comm. infrastructure is needed



SCE Benefit-Cost analysis

Table II-1
Project Cost Benefit Analysis Results
(\$Nominal and 2007 Present Value of Revenue Requirement, in Millions, Rounded)

	Nominal	PVRR
Benefits		
Operational Benefits		
During Deployment Years	278.2	
During Post-Deployment Years	4,299.0	
Demand Response Benefits		
During Deployment Years	216.2	
During Post-Deployment Years	2,792.6	
Subtotal Operational Benefits	4,577.2	
Subtotal Demand Response Benefits	3,008.8	
Total Benefits	7,586.0	2,076.0



Costs		
Phase II Costs (Pre-deployment)	45.2	
Deployment Costs		
Acquisition of Meters and Communication Network Equipment	838.0	
Installation of Meters and Communication Network Equipment	296.6	
Implementation and Operation of New Back Office Systems	191.2	
Customer Tariffs, Programs and Services	112.1	
Customer Service Operations	84.1	
Overall Program Management	45.6	
Contingency	147.3	
Post-Deployment Costs		
Billing	127.1	
Call Center	93.5	
Meter Services	399.1	
Back Offices Systems	344.4	
Customer Tariffs, Programs and Services	245.0	
Subtotal Pre-Deployment Costs	45.2	
Subtotal Deployment Costs	1,714.9	1,627.0
Subtotal Post-Deployment Costs	1,209.0	340.0
Total Costs	2,969.1	1,967.0
Total Benefits Less Total Costs	4,616.9	109.0

The argument for net metering

- Customers generally pay $\sim 15\text{c/kWh}$ for electricity in VT
- Average lifetime cost of solar in VT is $\sim 20\text{c/kWh}$
- With a small subsidy, solar can be on par with electricity from the grid
- Allow people to “net meter” to zero out their electric bill
 - Perhaps with a small bonus for surplus electricity produced. ($\sim 6\text{c}$ in GMP)



The challenge of net metering

- Utilities purchase electricity wholesale for ~5-10c/kWh
- And then sell for ~15c/kWh
- The net revenue is used to fund the “wires” business.
 - Wire repairs, ancillary services, new transmission lines, etc.
- Meme: the poor subsidize rich who have enough to get tax credits for solar panel installs



For example...

theguardian

a view from science

arts | Comment | Culture | Business | Money

deal

MONBIOT'S

Saturday, August 7, 2010

Government Energy Subsidies: Poor Paying the Rich

[Previous](#)

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The green deal is a useless, middle-class subsidy

This deal is in no way green – it's just one of the means by which money is being taken from the poor and given to the rich



Discussion: how do we solve this? Can smart grid help us?



Types of electric rates

- Time of Use
- Critical Peak Pricing
- Peak Time Rebate/Critical Peak Rebate
- Variable Peak Pricing
- Real Time Pricing



Talk about Herter paper

- Groups:
 - ATC
 - TOU+CPP Rate only
 - TOU+CPP + ATC



Vermont experiment

Group	Year 1	Year 2	IHD	Notification	Sample Size
1	CPR	CPR		X	390
2	CPR	CPR	X	X	195
3	CPP	CPP		X	390
4	CPP	CPP	X	X	195
5	CPR	CPP		X	390
6	CPR	CPP	X	X	195
7	Flat	Flat		X	390
C1	Flat	Flat		X	390
C2	Flat	Flat			1200
Totals					3735



Stuff to add

- Olympic penninsula
- CA Demand response



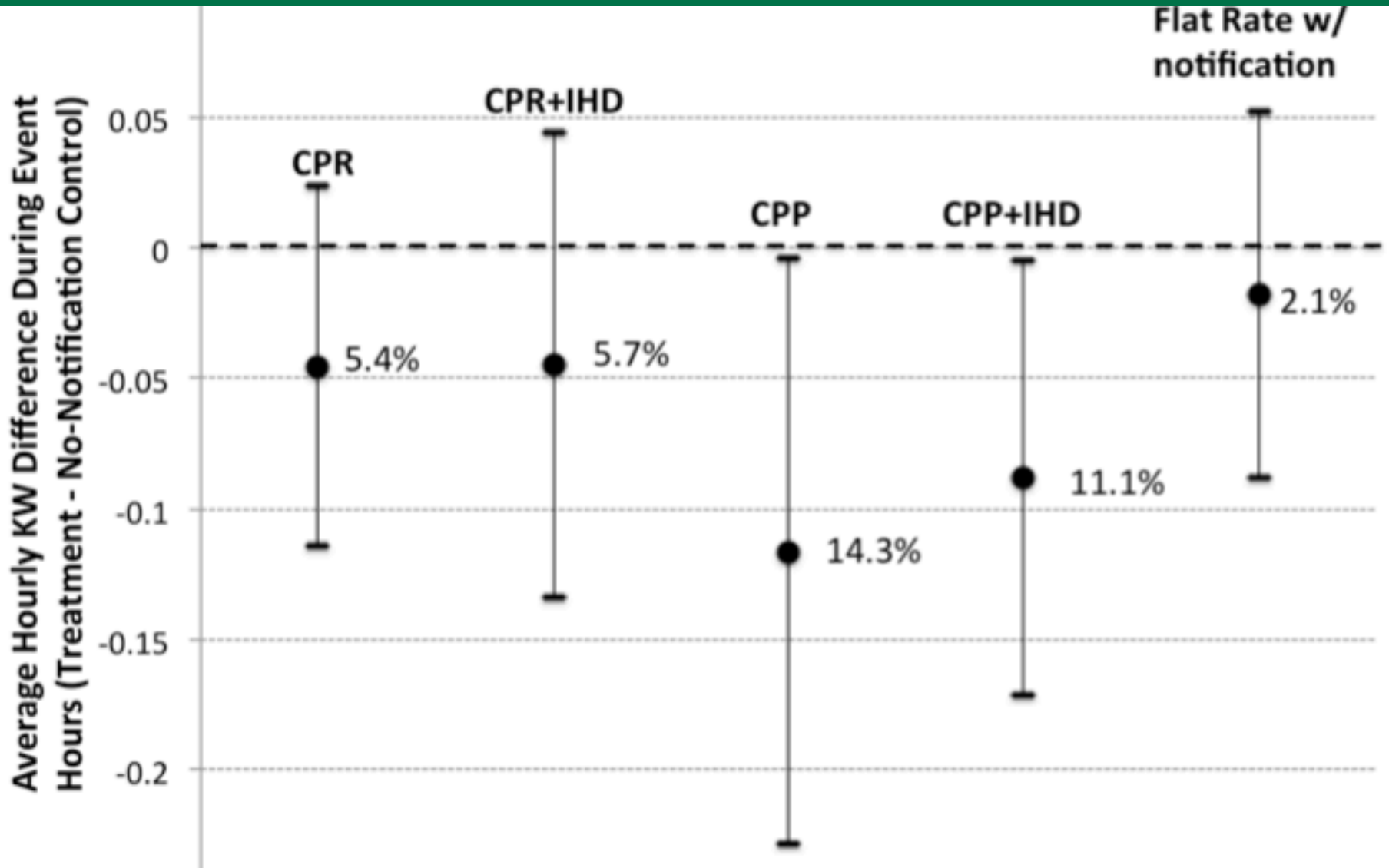
Summary of results

Table E-1: Summary of results from four peak events in 2012

Rate	Technology	Event savings (kW)	Event savings (% of control group peak-event kW)	Bill savings (\$ per customer per event)	Satisfaction (1-5)
Flat (with notification)	--	0.018	2.10%	\$0.13	4.0
CPR	--	0.045	5.40%	\$0.20	3.5
CPR	IHD	0.045	5.70%	\$0.19	3.6
CPP	--	0.116	14.30%	\$0.42	3.8
CPP	IHD	0.088	11.10%	\$0.34	3.7



In graphical form



Customer satisfaction

