Smart Meter Fort Collins

Welcome

Big Picture View

- What is a Smart Grid?
  - – Dr. Pablo Bauleo (FCL&P)

- A National Perspective
  - – Mark Michaels (Enspiria Solutions)

Break

Smart Meter Fort Collins

Break continued

The Fort Collins program

- Overview of Smart Meter Fort Collins
- FortZED: RDSI
  - – Dennis Sumner (FCL&P)

What Does it Mean to Me?

- – Gary Schroeder (FCL&P)

City of Fort Collins

Project Vision

High Level aspirations – what does success look like?

"Smart Meter Fort Collins is a key foundation to transform our ability to support, inform, inspire and empower our community."

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The first step….

a starting point,

a foundation

from which to proceed

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Goals this morning:

- Broad overview
- Details on Fort Collins
- Q&A: Moderated Parking Lot – John Phalen

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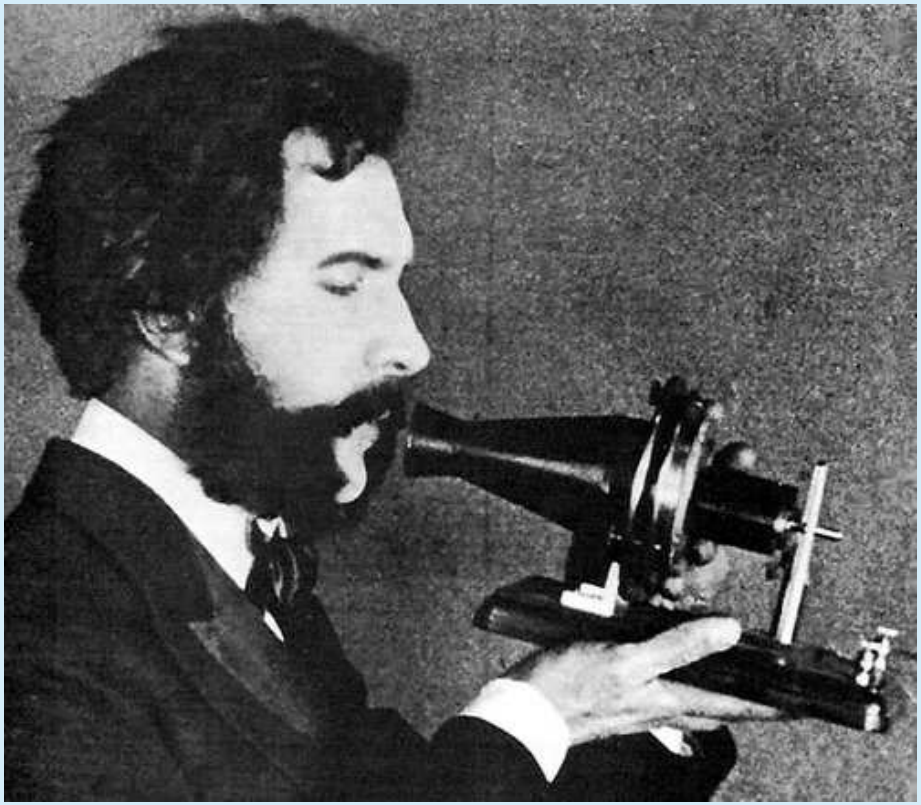
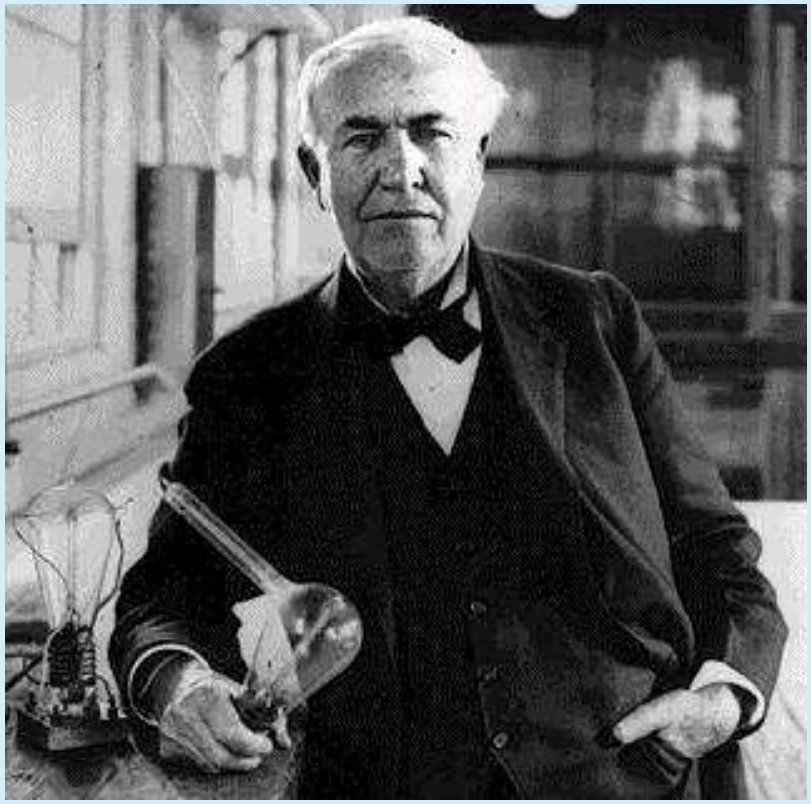
What is a Smart Grid?

Pablo Bauleo, Ph.D.
Fort Collins Utilities

“On the Origin of the Technologies”

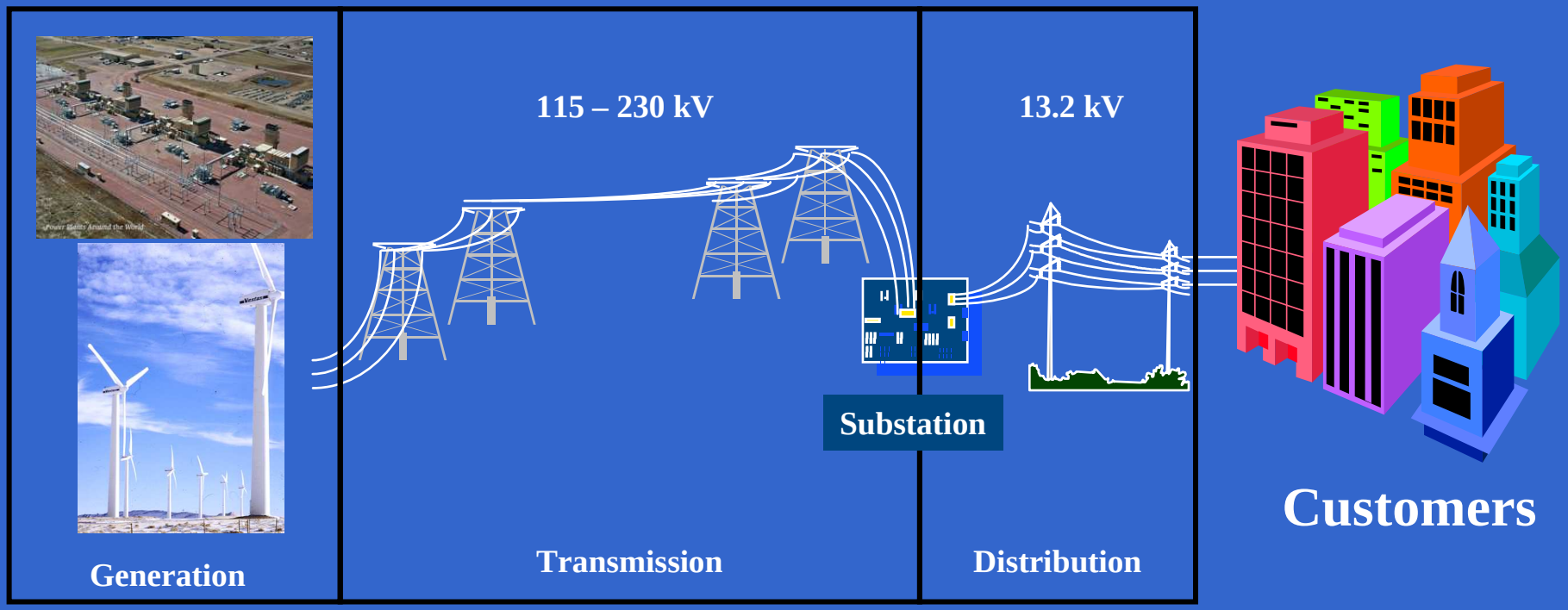


Alexander Graham Bell
1847 - 1922



Thomas Alva Edison
1847 - 1931

Electric Grid



← Platte River Power Authority →

← Fort Collins Utilities →

Outage Impact & Reliability Needs

1960s: Electric clock would be late

1970s: Electronic clock would blink “12:00”

1980-90s: Computers would reboot

2000s: E-Commerce &
Stock Markets collapse

amazon.com

ebay

Google

Northeast blackout of 2003 → $6 billon loss

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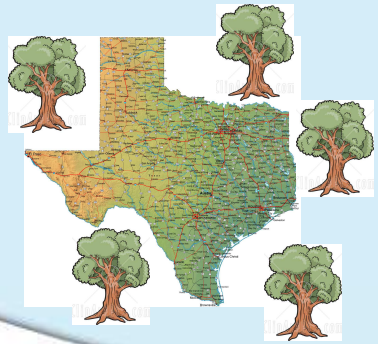
Smart Grid

- Smart Grid is a label for a *communication layer* in the electric grid in order to
  - Enable **flexibility and automation** of the electric grid
  - Provide real-time feedback to users/utilities
  - Capable of reducing energy use by 10% (nationwide)
    - CO_2 reduction equivalent to
      - Remove ~50 millions cars from the roads
      - Plant trees in an area equivalent to Texas



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Source: U.S. Department of Energy

Paradigm Shift & New Benefits

- Central power generation
- Limited energy storage
- Limited real-time data
- Reactive outage management
- One monthly reading

Smart Grid Technologies

- Distributed generation
- Energy storage devices
- Real-time data
- Proactive outage management
- Detailed billing/usage information

Customer Benefits

- Improved reliability
- Affordability
- Increased efficiency
- Reduced environmental impact
- Enable customer participation

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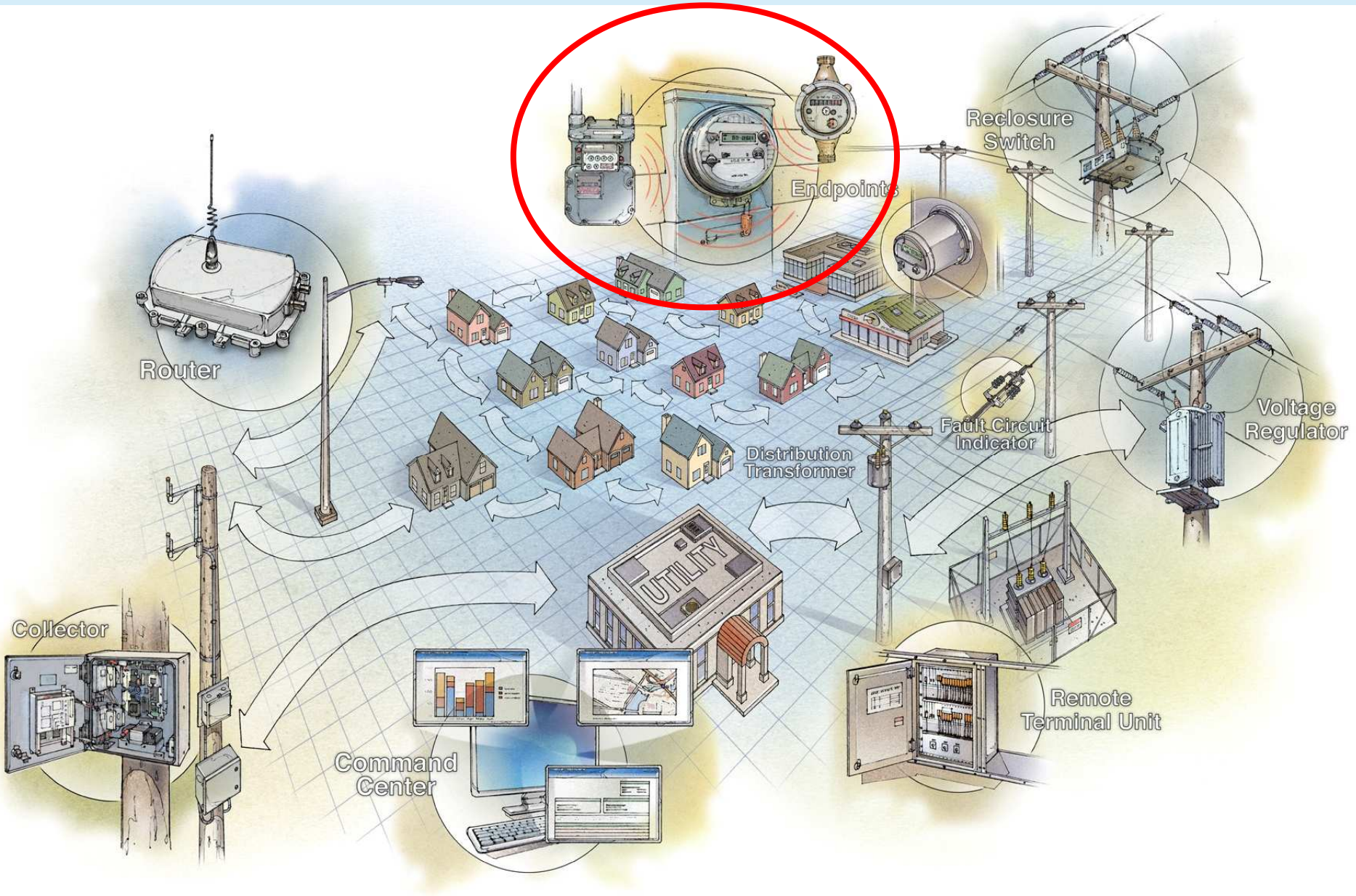
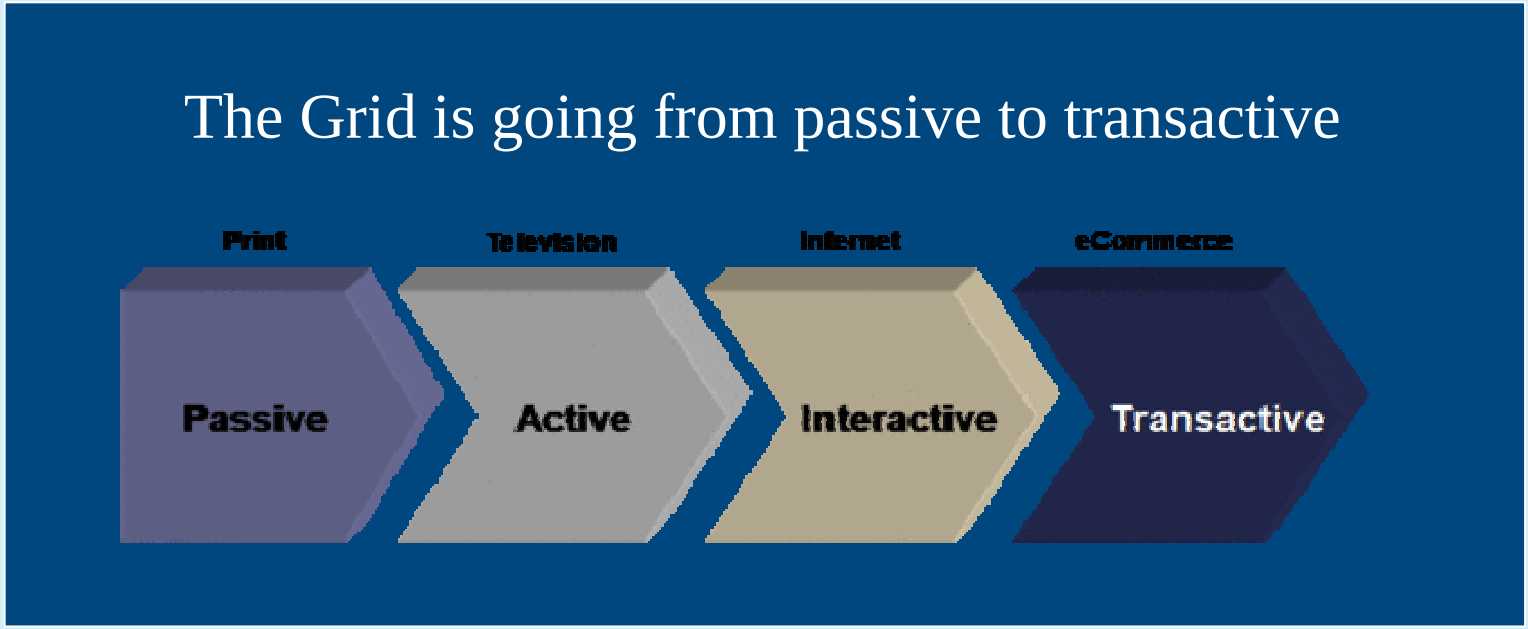
Smart Grid Vision



Smart Grid Main Areas



- Demand Response
  - Grid Flexibility (Renewable integration)
  - Residential Energy Management System (HAN)
  - Electric Vehicles

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Technologies integrated into Smart Grid

- The communication layer (control) of Smart Grid allows the integration and coordination of
  - Grid Automation
  - Distributed generation (renewables)
  - Energy storage (utility-scale and distributed)
  - Electric Vehicles
  - Real time feedback
  - Smart Home/Smart Business
  - …

Grid Automation

Fault indicator

Remotely operated
Pad mounted Switchgear

Power Quality monitoring

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Distributed Generation and Storage

"The power industry is like being in an ice-cream business without a refrigerated warehouse"

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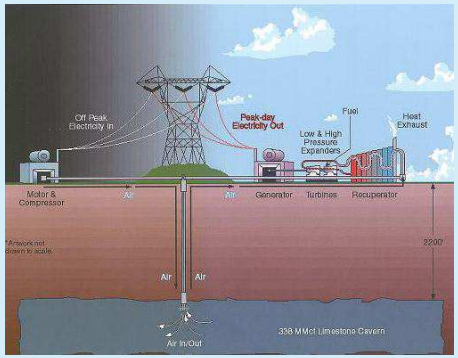
Utility-size Energy Storage

Flywheel (100 kW – 15 min)



Compressed Air
Alabama,
11,000 houses for 1 day

Sodium Sulfur Battery Bank (1 MW - 6 hs)

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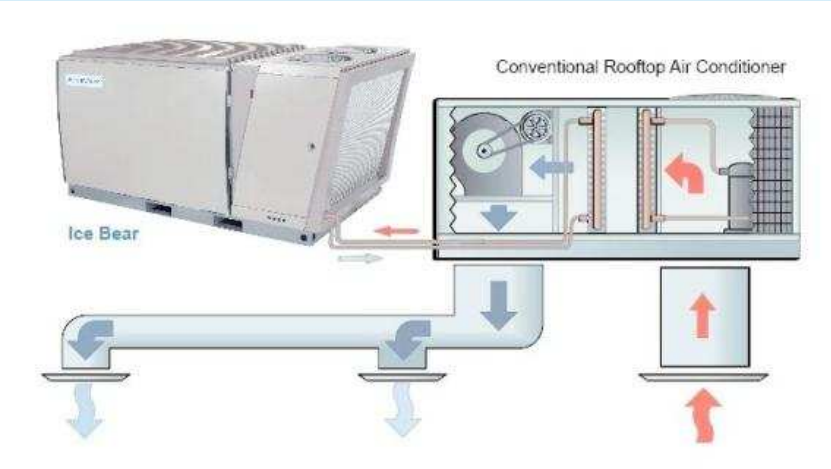
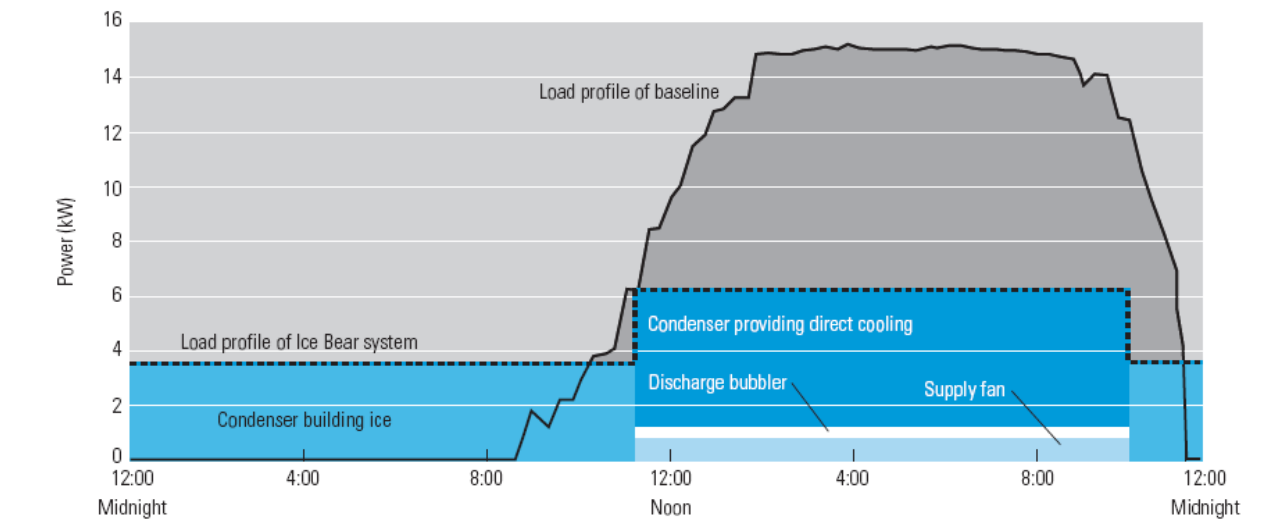
Thermal Energy Storage (Distributed)





"Ice-Bear"
Roof-Top Unit A/C

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Electric Vehicles

Tes

Ford

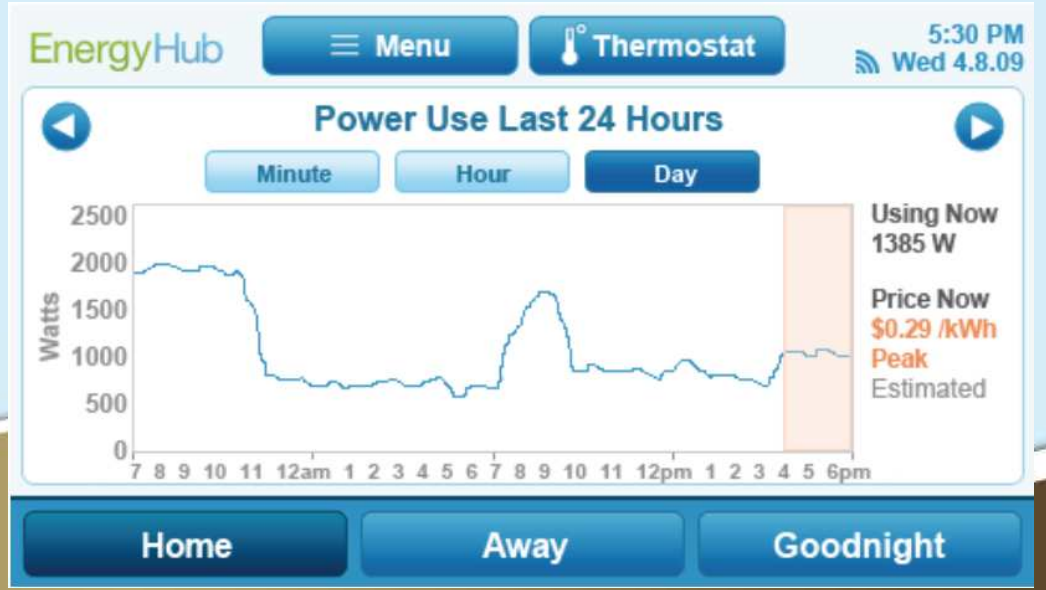
GEM e2 Vehicle

Electric Vehicles as Distributed Storage

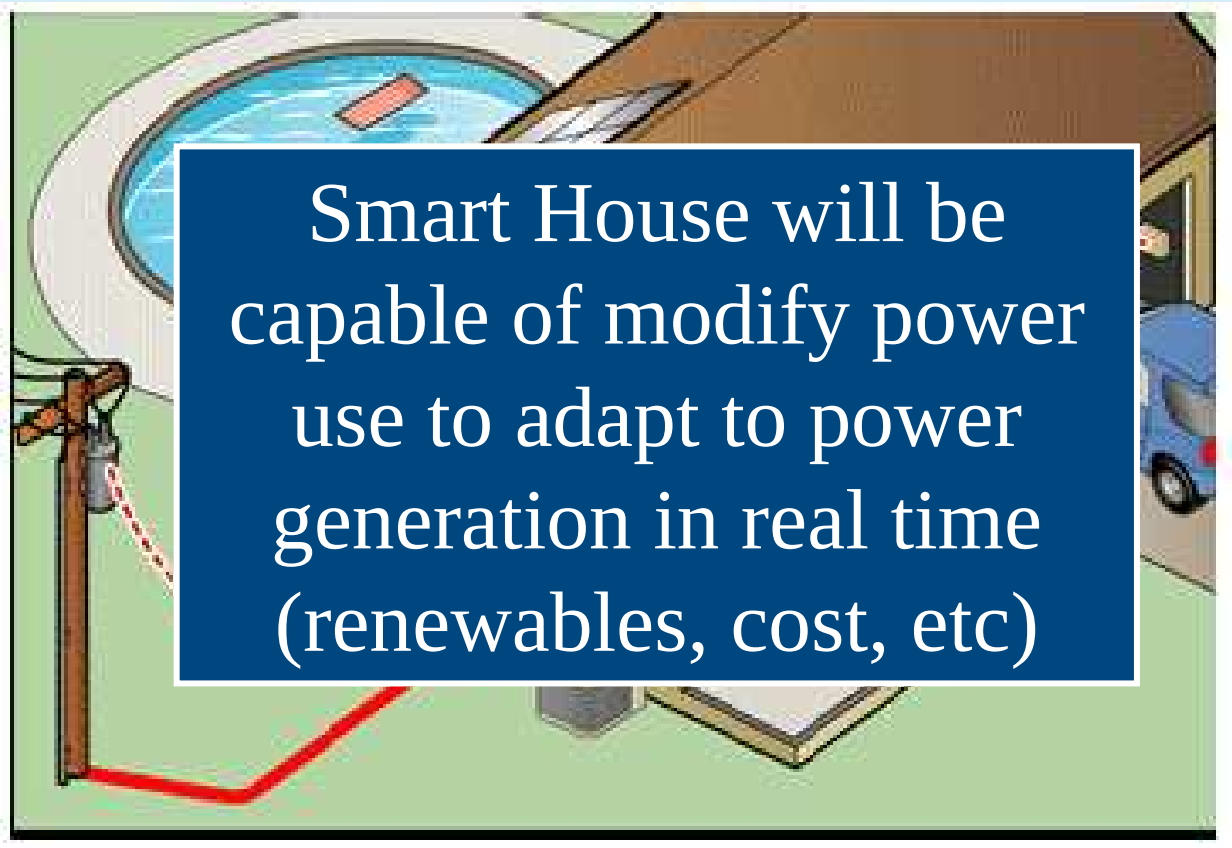
Electric car has a battery → Vehicle to Grid!

Real Time Feedback

- Empowers customer by providing access to information
- Real time data on energy use and cost of electricity



Smart House



Home Area Network (HAN)

enabled via Zigbee, HomePlug or LAN

Integration of

Electric meter
Water meter
Gas meter
In-Home Display
Thermostat
AC/Furnace
Lights
PV/Co-Gen
Electric Vehicles
Washer/Dryer
Dishwasher
…

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Smart House for Geeks

"The Big Bang Theory"
CBS TV Show
Season 1 – Episode 9

Smart House for Geeks

"The Big Bang Theory"
CBS TV Show
Season 1 – Episode 9

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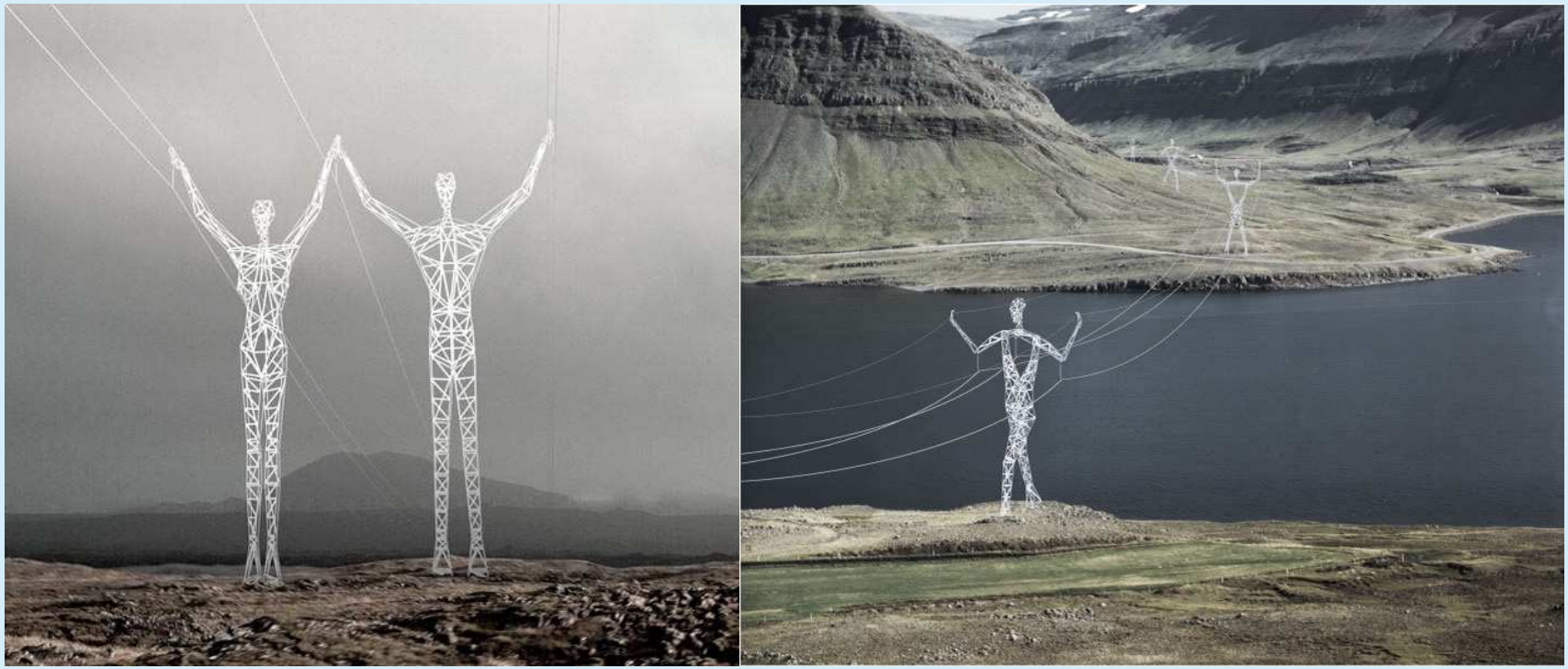
The Users Grid



Smart Grid will benefit from technologies integration but to realize its full potential the users have to embrace it

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Smart Grid: A National Perspective

Mark Michaels – Enspiria Solutions

Why Smart Grid?














1950 1960 1970 1980 1990 2000 2010 2020

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Growth of Electronic Device Use

1960 1970 1980 1990 2000 2010 2020

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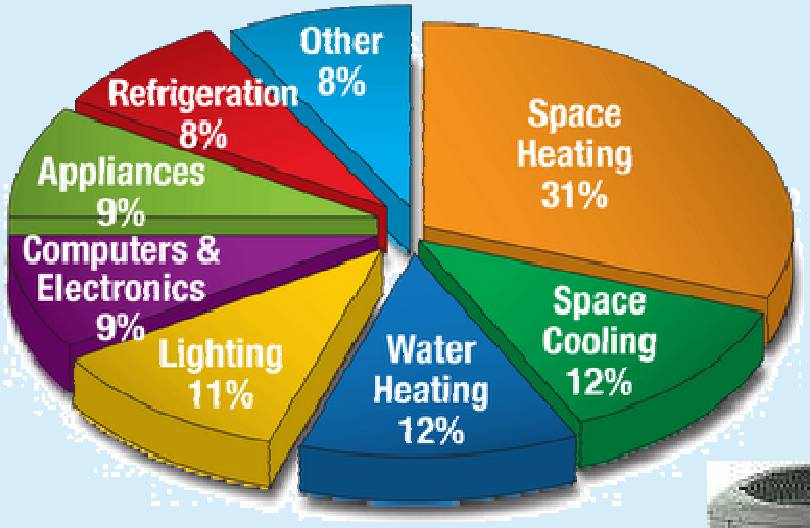
Space Heating & Cooling Use



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Customer Expectations

How can I reduce my carbon footprint?

Why is my bill so high?

How can I lower my energy costs?

WHAT CAN I DO?

Can you show me?

I don't understand – how many kilo-whats in a dollar?

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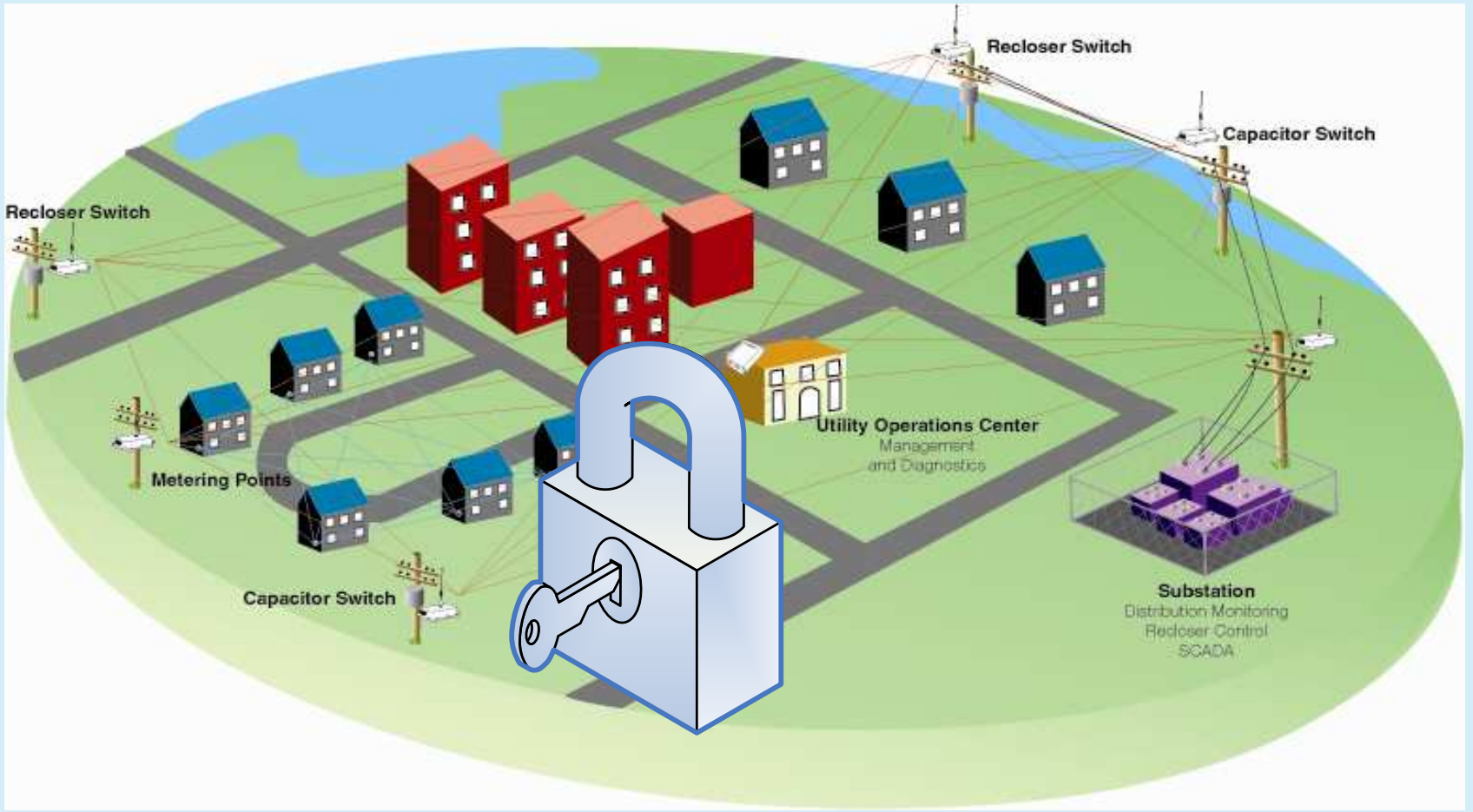
The Social Context is Changing

- Customer Engagement requires more timely information and knowledge
- Regulators at state and national levels are demanding that utility initiatives support social imperatives
- Social Acceptance, and expectation, of higher utility interaction is forcing new engagement strategies

Security



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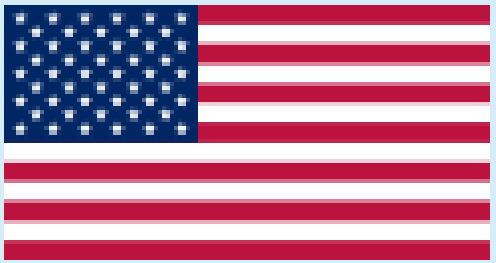
Regulatory Influences Are Shaping the Future

- US Federal
  - EPAct 2005
  - NARUC, FERC, DOE activities
  - NIST standards
  - ARRA (Stimulus)

State Initiatives:

- California: An early mover that has evolved
- Texas: Additional requirements due to market design
- Pennsylvania & Maryland: Pushing utilities to move forward

American Recovery & Reinvestment Act: 2009



- The Programs:
  - Smart Grid Investment Grants
  - Smart Grid Demonstration Projects
- The Focus: Jobs
- The Deal:
  - Administered by DOE
  - Grants to co-fund projects
  - Detailed metrics monitoring and record keeping
  - Limited time horizon to complete

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Smart Grid Projects

represents ARRA-funded smart grid investment grant projects (SGIG)

represents ARRA-funded smart grid demonstration projects (SGDP)

represents non-ARRA funded projects

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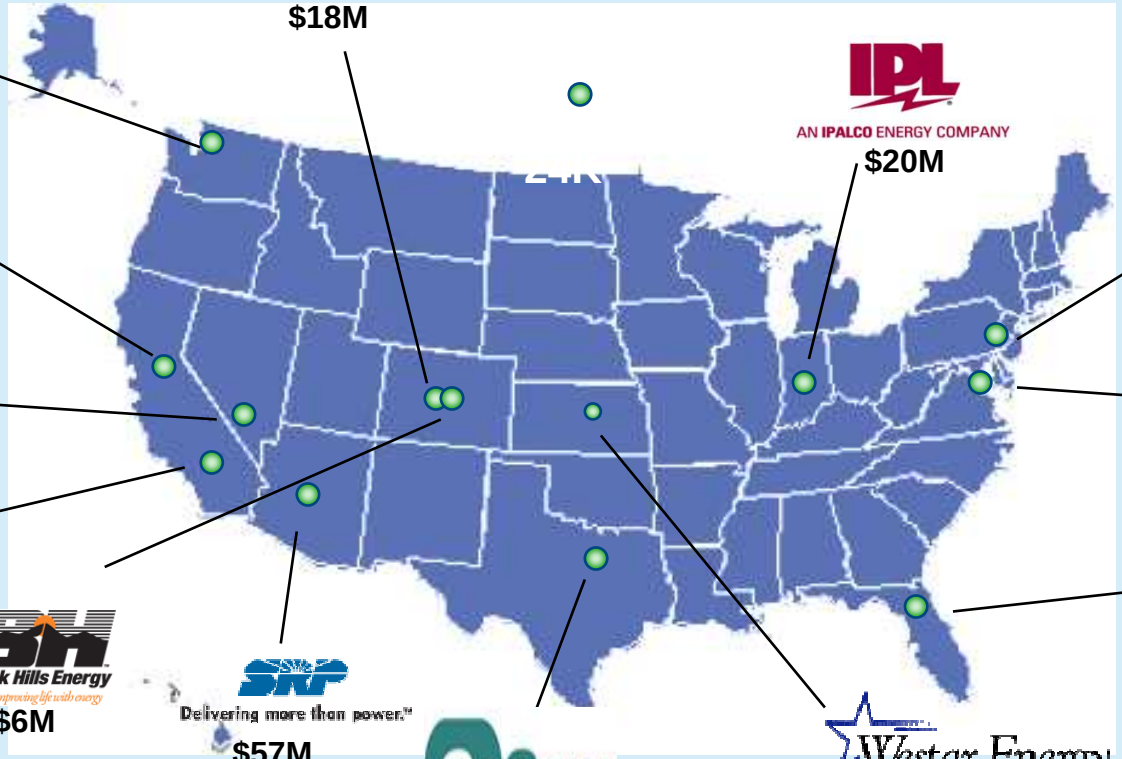
Selected Smart Grid Grants



Snohomish County PUD $16M

City of Fort Collins $18M

IPL AN IPALCO ENERGY COMPANY $20M

Exelon PECO Energy $200M

SMUD $127M

NVEnergy $138M

Pepco Holdings Inc $105M

Water and Power $20M

JEA $20M

Black Hills Energy $6M

SKF Delivering more than power. $57M

Westar Energy $19M

CoServ $17M

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(1) ARRA Awards

Status of AMI Deployments

Utility Classification	Available Meters	Meters Installed
Very Large (2.5M meters)	42.0M	8.4M
Large (1M to 2.5M meters)	19.5M	2.9M
Medium (500K to 1M meters)	6.1M	2.2M
Small (100K to 500K meters)	2.7M	0.9M
totals	**70.3M**	**14.4M**

- A snapshot of North American AMI Projects for utilities with more than 100,000 meters
- Only projects with signed and approved contracts included
- Excludes non-AMI systems
  - Drive-by: tens of millions
  - Fixed Network AMR: 15 million
  - First Generation powerline : 20 million

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Provides the foundation to support

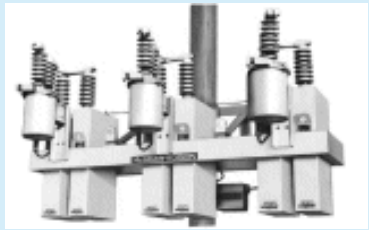
Smart Appliances

GE's smart best-in-class hybrid water heater

Plug-in Hybrid Electric Vehicles

Renewable Energy Sources

Smart Grid Devices, Theft Detection and Automation



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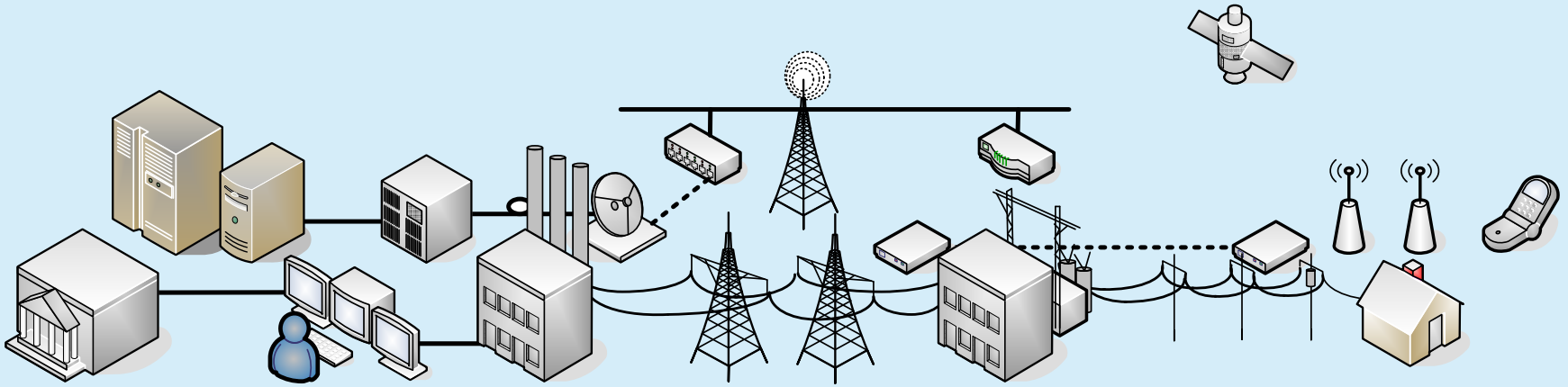
Driving Towards the Smart Grid



Control Center | Generation | Transmission | Distribution | Meter | In-Home

Advanced Metering Infrastructure

Demand Response and Dynamic Pricing

Distributed Generation and Alternate Energy Sources

Self-Healing Wide-Area Protection and Islanding

Asset Management and On-Line Equipment Monitoring

Real-time Simulation and Contingency Analysis

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Break!

Smart Meter Fort Collins

Fort Collins Initiatives:

- Smart Meter Fort Collins
- FortZED Jumpstart – RDSI Project

Dennis Sumner - Fort Collins L&P

Project Goals

- **Economic**
  - Control operational costs and demand costs
- **Social**
  - Give customers more information so that they can make informed financial decisions.
- **Environmental**
  - Help us meet Energy Policy and Climate Action Plan goals
    - 1.5% energy efficiency
    - Reduce Green House gas emissions
    - Demand reduction 5% by 2015
- **Prepare for the future**

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Major Project Areas

1. Advanced Metering Infrastructure and Meter Data Management Systems

2. Distribution Grid Automation

3. Cyber Security

4. Enhanced Demand Response Programs and Customer Engagement

Smart Grid Investment Grant Components

Grant Line Items ++:

• AMI Smart Meters	$19.0M #
• Demand Response Systems	5.5M
• Meter Data Mgmt System	2.0M
• CIS Billing System	0.9M
• Cyber Security	0.5M
• Subtotal	$27.9M
Other Items	3.5M **
Total Grant Proposal	**$31.4M**

Financial Benefits

Annual operational savings from AMI

Labor and operation expenses for meter reading	$495,755
Meter accuracy and registration	$347,944
Theft from manipulation of meters	$268,225
Load Control (avoided demand during PRPA peaks	$185,760
Labor dedicated to move-in / move-out and meter changes	$28,410
Purchase of Xcel data for rate design	$35,574
Subtotal	$1,361,668

Financial Benefits

Annual operation savings through SGIG

Enhanced Demand response program $1,074,240

One time benefit

One time savings related to improved cash flow. Reduced lag between meter reads and billing. $1,600,000

Using a 3.5% interest rate the payback is just over 7 years after grant assistance

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Advanced Metering and Meter Data Management

Electromechanical meter

New “Smart Meter”

Fort Collins Light & Power currently has 55,000+ in service

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Grid Automation

Fault indicator

Remotely operated
Pad mounted Switchgear

Power Quality
monitoring

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Cyber Security

- Objectives
  - Review Security policies & practices
  - Review standards
  - ID internal and external threats
  - Equipment vulnerabilities
  - Insure customer privacy
  - Comply with Industry Standards
    - National Institute of Standards and Technology (NIST)
    - North American Reliability Corporation (NERC)
    - Critical Infrastructure Protection (CIP)

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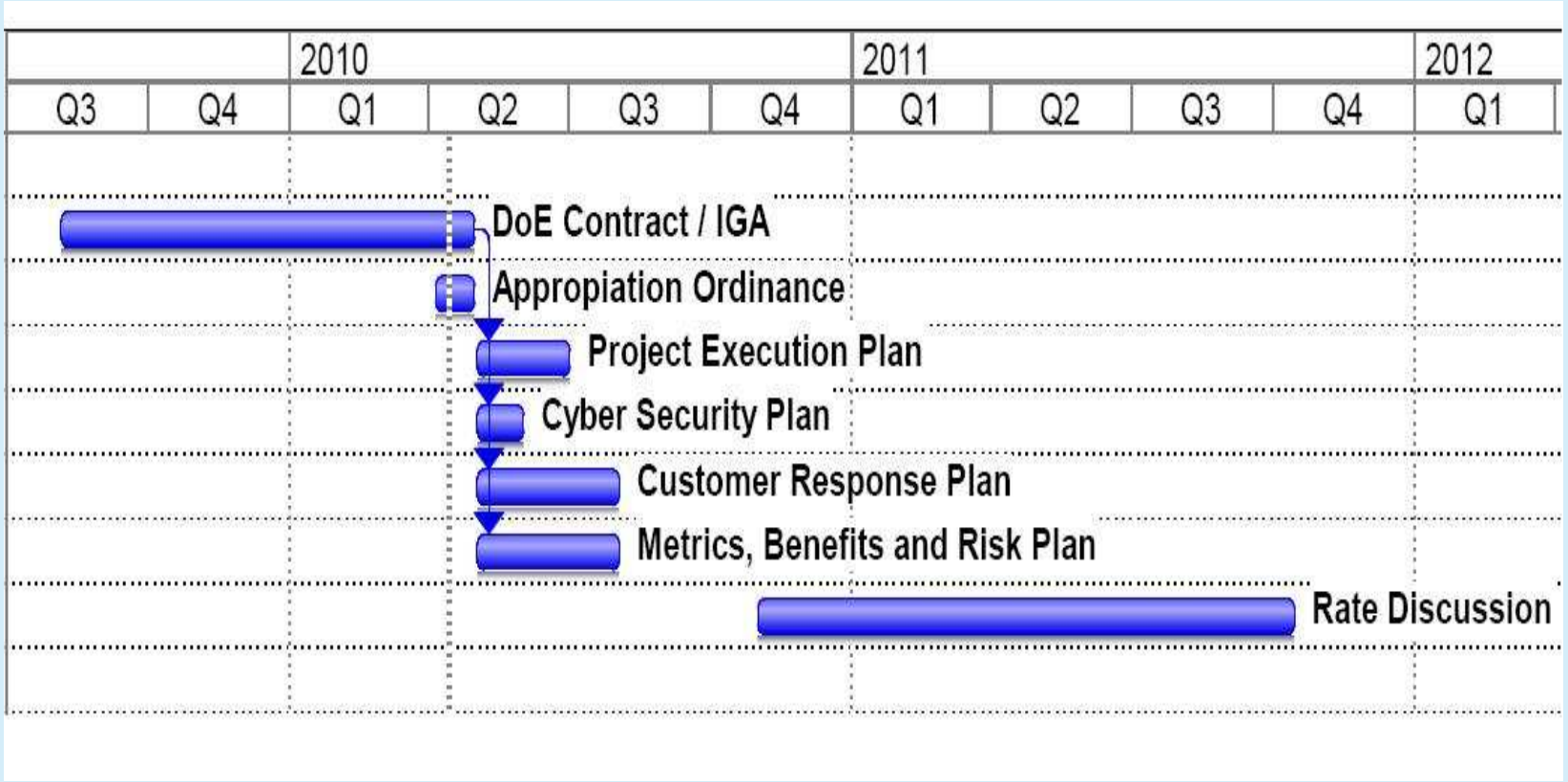
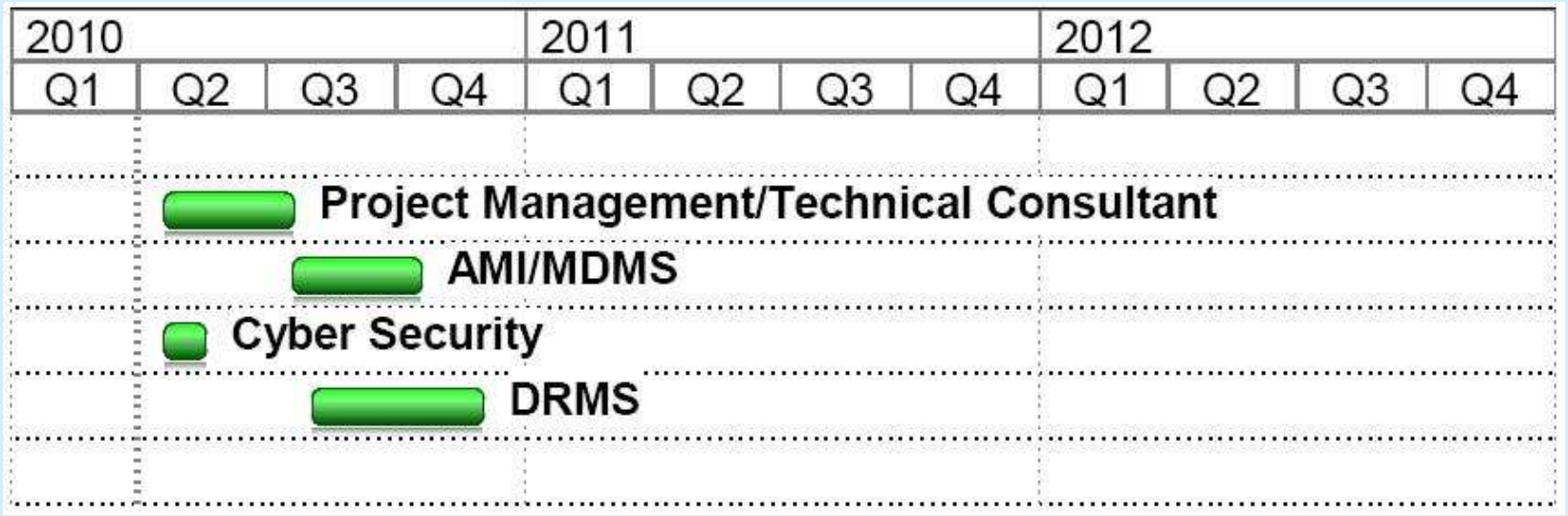
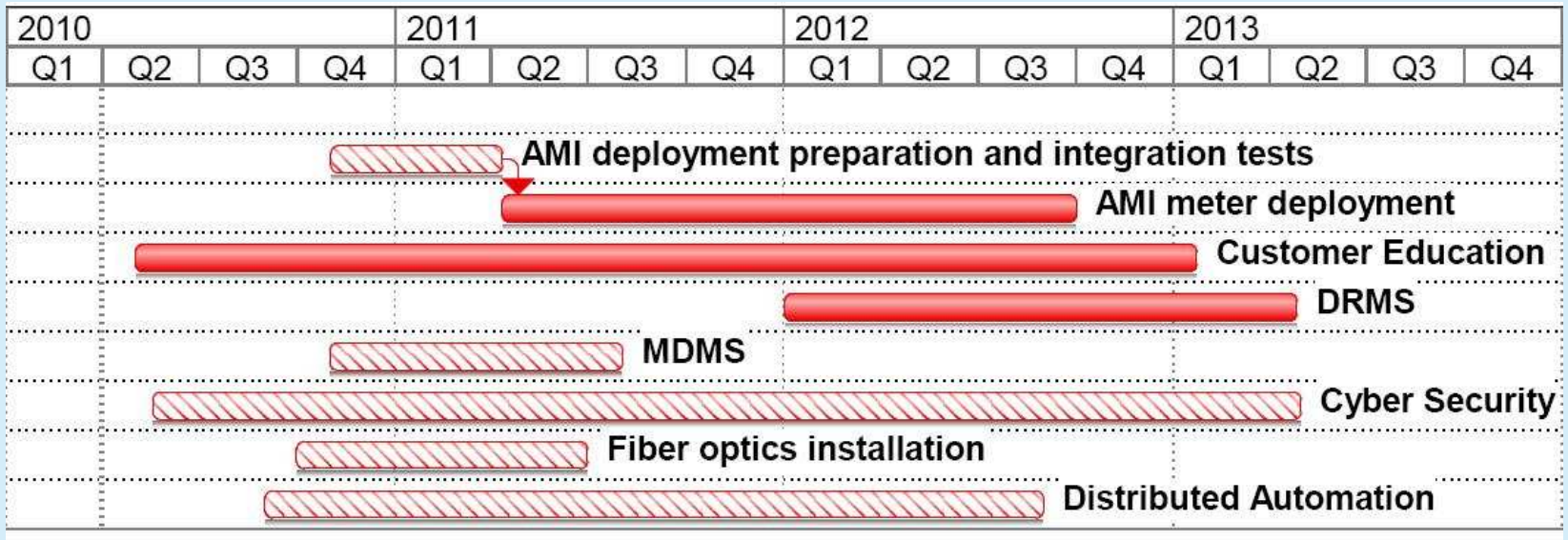
Timeline – Administrative



Timeline – Request for Proposals



Timeline – Major Project components



Smart Meters

It isn't just about the meter! They are important, but…

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Beyond Simple Meter Reading Applications

- Advanced billing capabilities:
  - Time of Use,
  - Critical Peak Pricing,
  - Interval Data,
  - Consolidated Billing, etc.
- Customer Engagement (not just data presentment)
- *Demand Response*
  - *Pricing Programs*
  - *Direct Load Control*
- Remote service connect and disconnect
- Outage Information
- Customer Service Enhancement
- Operational Improvements

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FortZED – Jumpstart / RDSI

Renewable and **D**istributed **S**ystems **I**ntegration

RDSI

DOE Collaborative Study

- **Nine Projects**
- **Projects are either microgrids or are developing technologies that will advance microgrids**
- **Objective: To encourage use of distributed resources to provide power during peak load periods and for other functions and services. Minimum 15% reduction in peak load on distribution feeder or substation.**
- **http://www.smartgrid.epri.com/doc/15%20DOE%20RDSI%20Project%20Update.pdf**

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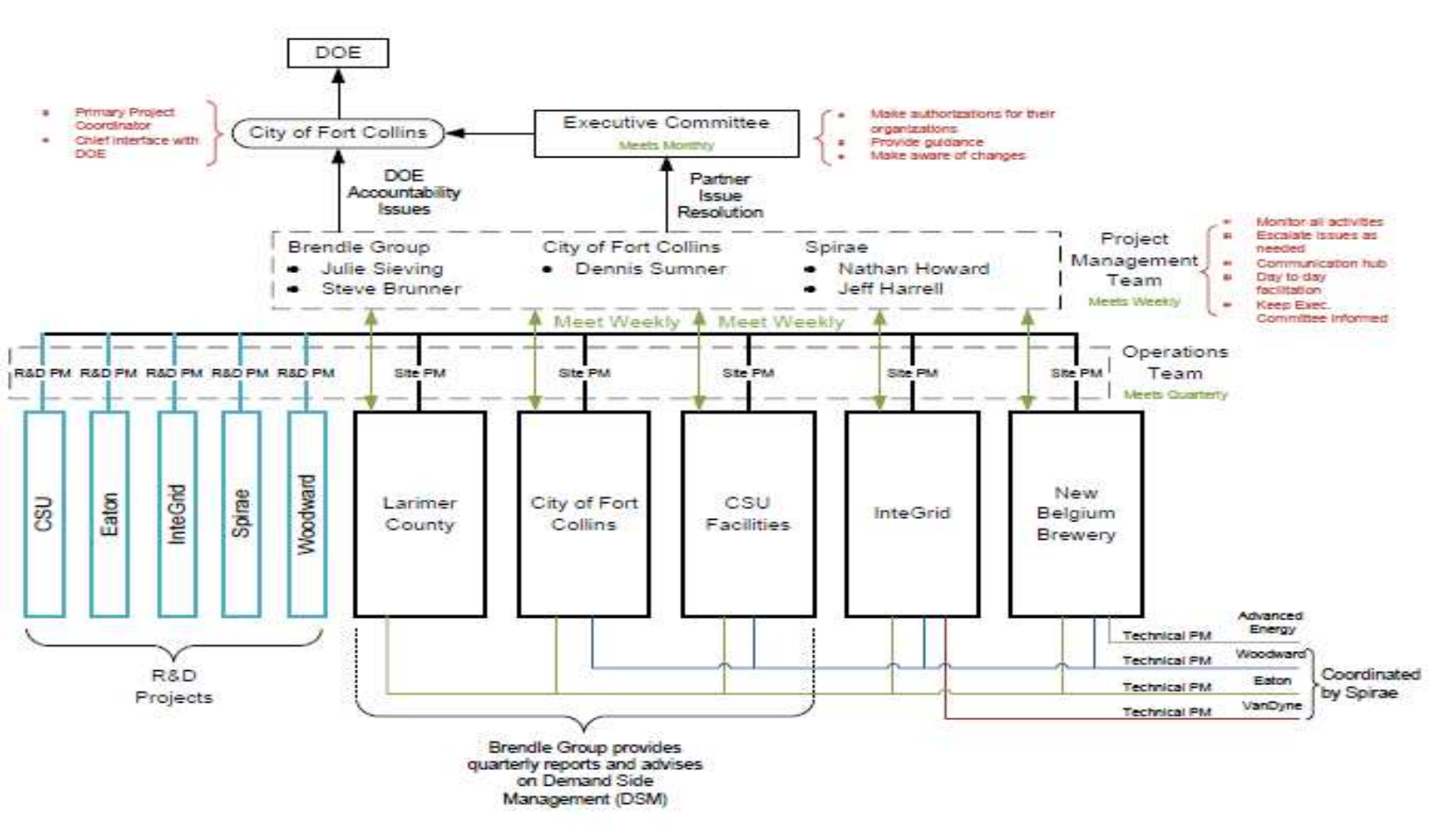
Project Team

Project Lead	
City of Fort Collins	Prime Contractor
Fort Collins Utilities	Utility Company
Demo Sites	**Resource**
City of Fort Collins	Thermal Storage, DG, DSM, PHEV-V2G
New Belgium Brewing	Solar PV, DG, and DSM
Colorado State University Facilities	Thermal Storage, DG, and DSM
Larimer County	Solar PV and DSM
InteGrid	VanDyne SuperTurbo, Fuel Cell, MicroTurbine, Conventional DG, Wind Sim, SC/SLC and others

Project Team Contd.

Tech Partner	Contribution
Spirae	Smart Grid Platform – DER/Power Management System
Brendle Group	Demand Management and Program Development
Colorado State University	Robust Controls and PHEV R&D
Advanced Energy	Photovoltaic Inverter
Woodward Governor	Power Management and Mixed Fuel R&D
Eaton	Switchgear/Power Components and Small Generator Switchgear R&D
InteGrid	Platform for Controls R&D, DER Integration and Simulation

Project Operational Structure



RDSI

Project Video

www.FortZED.com

Select: FortZED Jumpstart Project Video

Smart Meter Fort Collins

What does it mean for you and your business?

Gary Schroeder
Energy Services Engineer
Fort Collins Utilities

What's the landscape?

- Changing electric rate structures?
- Environmental issues
- City policies
  - Climate Action Plan
  - Energy Policy
  - Water Policy
- Lots of information from the smart grid

First - some background

Demand (how fast)

- 1,000 Watts = 1 kilowatt (kW)
- Relates to infrastructure – wires, switches, transformers, etc.

Energy (how much)

- 1 kW x 1 hour = 1 kilowatt hour (kWh)
- Relates to fuel – coal, natural gas, etc. (and therefore Carbon Dioxide & other emissions)

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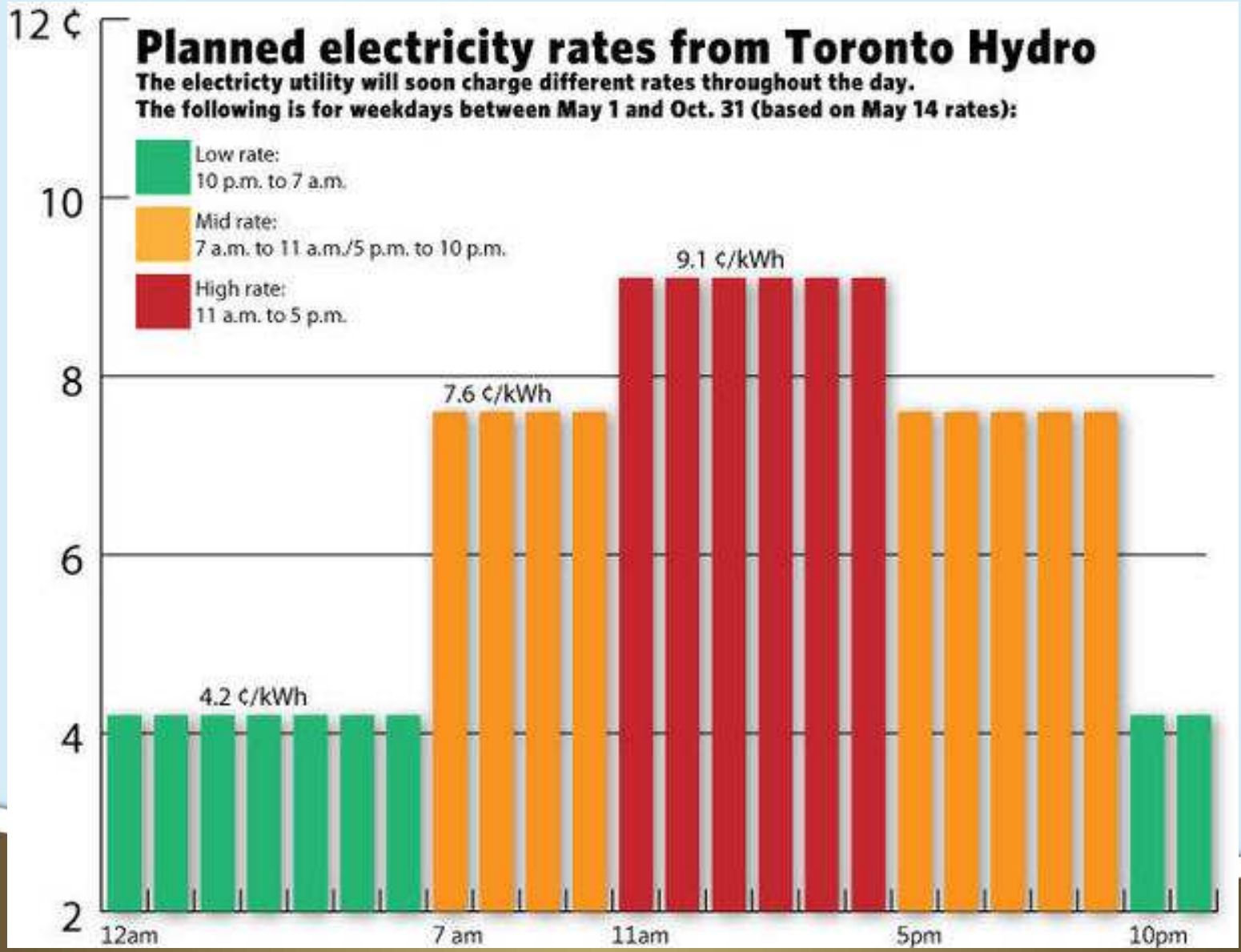
Current Rates

- **Energy**
  - Fixed $/kWh (residential)
- **Facilities Demand** (not time dependent)
  - Energy + $/kW charge (residential & small commercial)
- **Coincident Peak** (time dependent)
  - Energy + Facilities Demand + Coincident Peak charge (large commercial & industrial)
- **Water is Tiered**

New Rates???

- Time-of-Use (TOU)
  - Different prices at different times of the day
- Critical Peak Price (CPP)
  - Very high “critical peak” prices for certain hours on event days
- Peak Time Rebate
  - Like a CPP without TOU, but only one direction – Customer can get credit for load reduction, but no penalty if load increases
- Coincident Peak?

Time-of-Use Rate



Existing “Smart” elements

- Automated meter reading - Electri-Connect
  - 15-minute data – day after
- Voluntary Load Management Program – since 1982
  - Residential (about 3 MW controlled)
  - Commercial (about 2 MW controlled)
  - Saved $6 Million in purchase power cost since 1982

ElectriConnect

Daily Peaks

City of Fort Collins

Customer Information

Name:	City-FC/281 N.Coll.
Address:	281 N. College Ave.
	Fort Collins, CO
Acct. No:	
Meter No:	

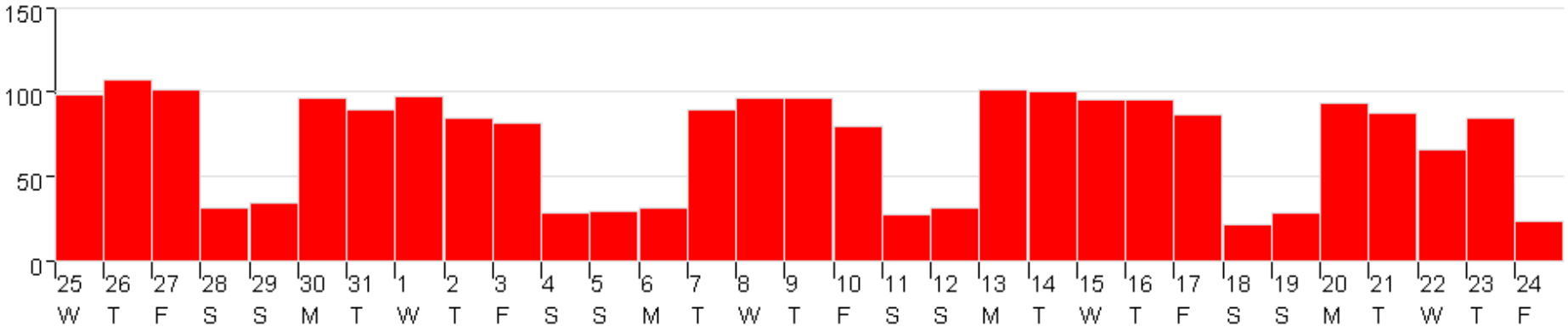
Wed Aug 25 2010 to Fri Sep 24 2010

Total Usage:	27,171.47 KWH
Max Demand:	106.61 KW
Occurred On:	Aug 26 2010 14:30
Load Factor:	35.338%
Date Range:	Aug 25 To Sep 24

KW (channel: 1 Set: 1)

Daily Peaks

01907800



Sat Sep 18 2010 02:45 = 21.12

ElectriConnect

Peak Day

City of Fort Collins

Customer Information

Name:	City-FC/281 N.Coll.
Address:	281 N. College Ave.
	Fort Collins, CO
Acct. No:	
Meter No:	

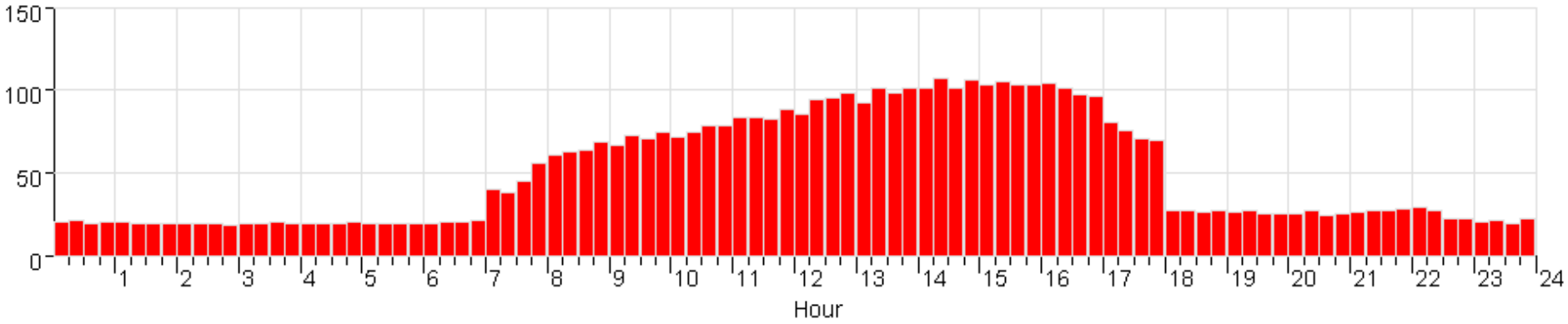
Data for Thu Aug 26 2010

Total Usage:	1,200.37 KWH
Max Demand:	106.61 KW
Occurred On:	Aug 26 2010 14:30
Load Factor:	46.915%
Date Range:	Aug 25 To Sep 24

KW (channel: 1 Set: 1)

Peak Day

01907800



Thu Aug 26 2010 19:15 = 26.38

Load Management Program

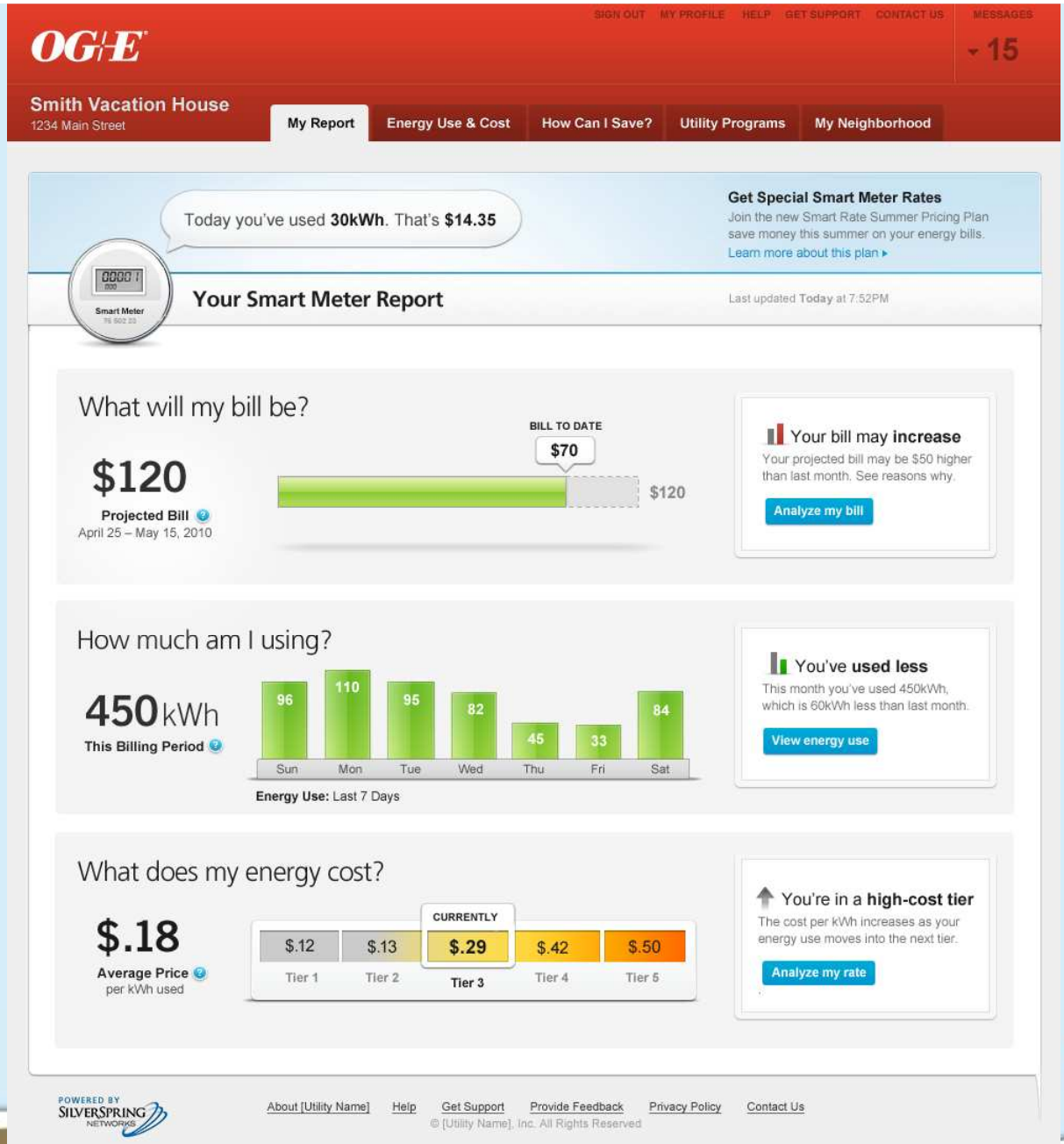
Basic customer elements

- Web portal, handheld devices
- In-home/In-business display (IHD)
- Programmable Communicating Thermostat (PCT)
- Gateway/Energy Management System (EMS)
- “Smart” plugs
- “Smart” appliances
- Load switches

Web Portal

What does it do?

- How and when you are using electricity
- Estimate monthly bill
- Look up electricity use history
- Get notifications (web &/or email)
- Understand your rate
- Compare your use to peers
- Advanced – program in-home devices


OGE
SIGN OUT MY PROFILE HELP GET SUPPORT CONTACT US
MESSAGES 15
Smith Vacation House
1234 Main Street
My Report
Energy Use & Cost
How Can I Save?
Utility Programs
My Neighborhood
Today you've used 30kWh. That's $14.35
Get Special Smart Meter Rates
Join the new Smart Rate Summer Pricing Plan save money this summer on your energy bills.
Learn more about this plan
Your Smart Meter Report
Last updated Today at 7:52PM
What will my bill be?
$120
Projected Bill
April 25 – May 15, 2010
BILL TO DATE
$70
$120
Your bill may increase
Your projected bill may be $50 higher than last month. See reasons why.
Analyze my bill
How much am I using?
450 kWh
This Billing Period
96
110
95
82
45
33
84
Sun
Mon
Tue
Wed
Thu
Fri
Sat
Energy Use: Last 7 Days
You've used less
This month you've used 450kWh, which is 60kWh less than last month.
View energy use
What does my energy cost?
$.18
Average Price
per kWh used
CURRENTLY
$.12
$.13
$.29
$.42
$.50
Tier 1
Tier 2
Tier 3
Tier 4
Tier 5
You're in a high-cost tier
The cost per kWh increases as your energy use moves into the next tier.
Analyze my rate
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OGE
SIGN OUT MY PROFILE HELP GET SUPPORT CONTACT US MESSAGES
15
Smith Vacation House
1234 Main Street
My Report
Energy Use & Cost
How Can I Save?
Utility Programs
My Neighborhood
Bill Analysis
Use and Costs
Rate Plan
Heating & Cooling
Time of Day Use
Environmental
Baseload Use
This bill your energy costs are $125
Efficient $149
YOU $125
Average $118
Congratulations! You are lorem ipsum
You spend 15% more than similar neighbors. Aenean fermentum, elit eget tincidunt condimentum, eros ipsum rutrum orci, sagittis tempus lacus enim ac dui.
Can I do better?
You could save up to $67
Quis que odio eros, feugiat non, era iaculis nec, lobortis sed, arcu lorem.
Show me
Energy use
Show: Energy Use & Cost Power
Energy use
May 31 – June 27, 2010
Cost
300 kWh
250
200
150
100
50
0
$30
25
20
15
10
5
0
June 12
USE 3.5 kWh
COST $.32
S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T
May Bill
June Bill
July Bill
What does this mean?
Description of graph above
Baseload is a measurement of the minimum amount of electricity your house requires to operate. Many devices in your home use energy twenty-four hours a day either because they are left on or are designed to operate that way. Reducing your baseload even small amounts can result in big savings over the course of weeks and months.
Helpful actions, tips or graph here
Cras sed ante. Phasellus in massa. Curabitur dolor eros, In hac habitasse platea dictumst. Cras eu mauris. Quisque lacus. Donec ipsum. Nullam vitae sem at nunc pharetra ultricies. Vivamus elit eros, ullamcorper a, adipiscing sit.
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OG&E
SIGN OUT MY PROFILE HELP GET SUPPORT CONTACT US
MESSAGES 15
Smith Vacation House
1234 Main Street
My Report
Energy Use & Cost
How Can I Save?
Utility Programs
My Neighborhood
Bill Analysis
Use and Costs
Rate Plan
Heating & Cooling
Time of Day Use
Environmental
Baseload Use
You are on a time of use rate plan with critical peak pricing
View by: Mon – Fri Sat & Sun
How it works
The price you pay for energy varies by time of day and from weekday to weekend.
Aenean fermentum, elit eget tincidunt condimentum, eros.
Pellentesque habitant morbi tristique.
Lorem ipsum dolor sit amet, consectetuer.
$.16 Average price per kWh used
On Peak
Off Peak
Critical Peak
CURRENTLY
$.16
$.16
$.07
$.07
$.04
$.04
12am
6am
12pm
6pm
This bill your total energy costs are $95
Your usage this bill by time period
Cras ultricies placerat eros. Phasellus imperdiet.
On Peak $74
Off Peak $51
Critical Peak $14
Your on peak use is 46% of your energy bill.
Similar neighbors spend less
By shifting when you use expensive Quis que odio eros, feugiat non, era iaculis nec, lobortis sed, arcu lorem.
Compare plans
What does this mean?
Description of graph above
Baseload is a measurement of the minimum amount of electricity your house requires to operate. Many devices in your home use energy twenty-four hours a day either because they are left on or are designed to operate that way. Reducing your baseload even small amounts can result in big savings over the course of weeks and months.
Helpful actions, tips or graph here
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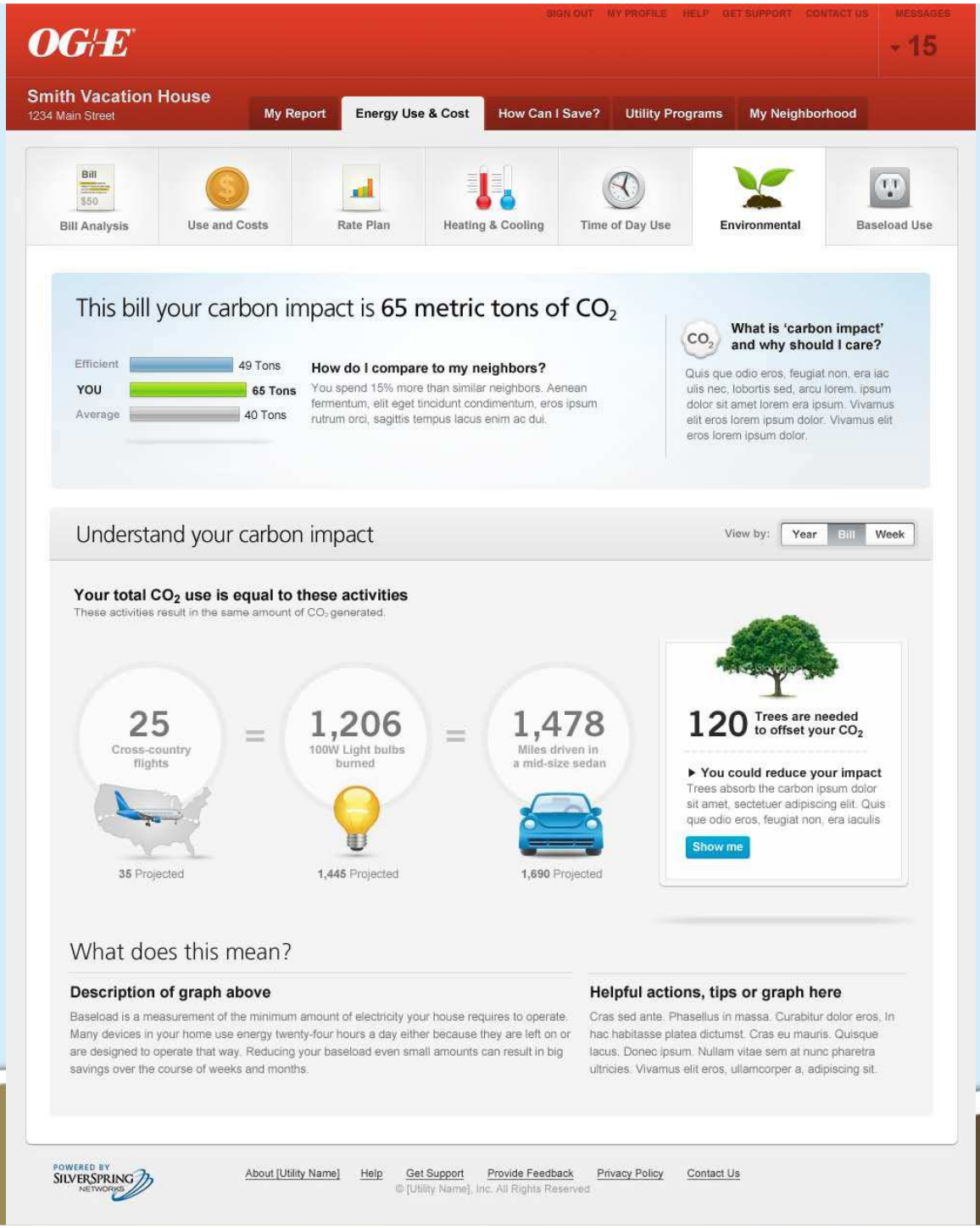
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Environmental
Baseload Use
This bill your carbon impact is 65 metric tons of CO2
Efficient 49 Tons
YOU 65 Tons
Average 40 Tons
How do I compare to my neighbors?
You spend 15% more than similar neighbors. Aenean fermentum, elit eget tincidunt condimentum, eros ipsum rutrum orci, sagittis tempus lacus enim ac dui.
What is 'carbon impact' and why should I care?
Quis que odio eros, feugiat non, era iac ulis nec, lobortis sed, arcu lorem, ipsum dolor sit amet lorem era ipsum. Vivamus elit eros lorem ipsum dolor. Vivamus elit eros lorem ipsum dolor.
Understand your carbon impact
View by: Year Bill Week
Your total CO2 use is equal to these activities
These activities result in the same amount of CO2 generated.
25
Cross-country flights
35 Projected
=
1,206
100W Light bulbs burned
1,445 Projected
=
1,478
Miles driven in a mid-size sedan
1,690 Projected
120 Trees are needed to offset your CO2
You could reduce your impact
Trees absorb the carbon ipsum dolor sit amet, sectetuer adipiscing elit. Quis que odio eros, feugiat non, era iaculis
Show me
What does this mean?
Description of graph above
Baseload is a measurement of the minimum amount of electricity your house requires to operate. Many devices in your home use energy twenty-four hours a day either because they are left on or are designed to operate that way. Reducing your baseload even small amounts can result in big savings over the course of weeks and months.
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In-Home (In-Business) Display (IHD)

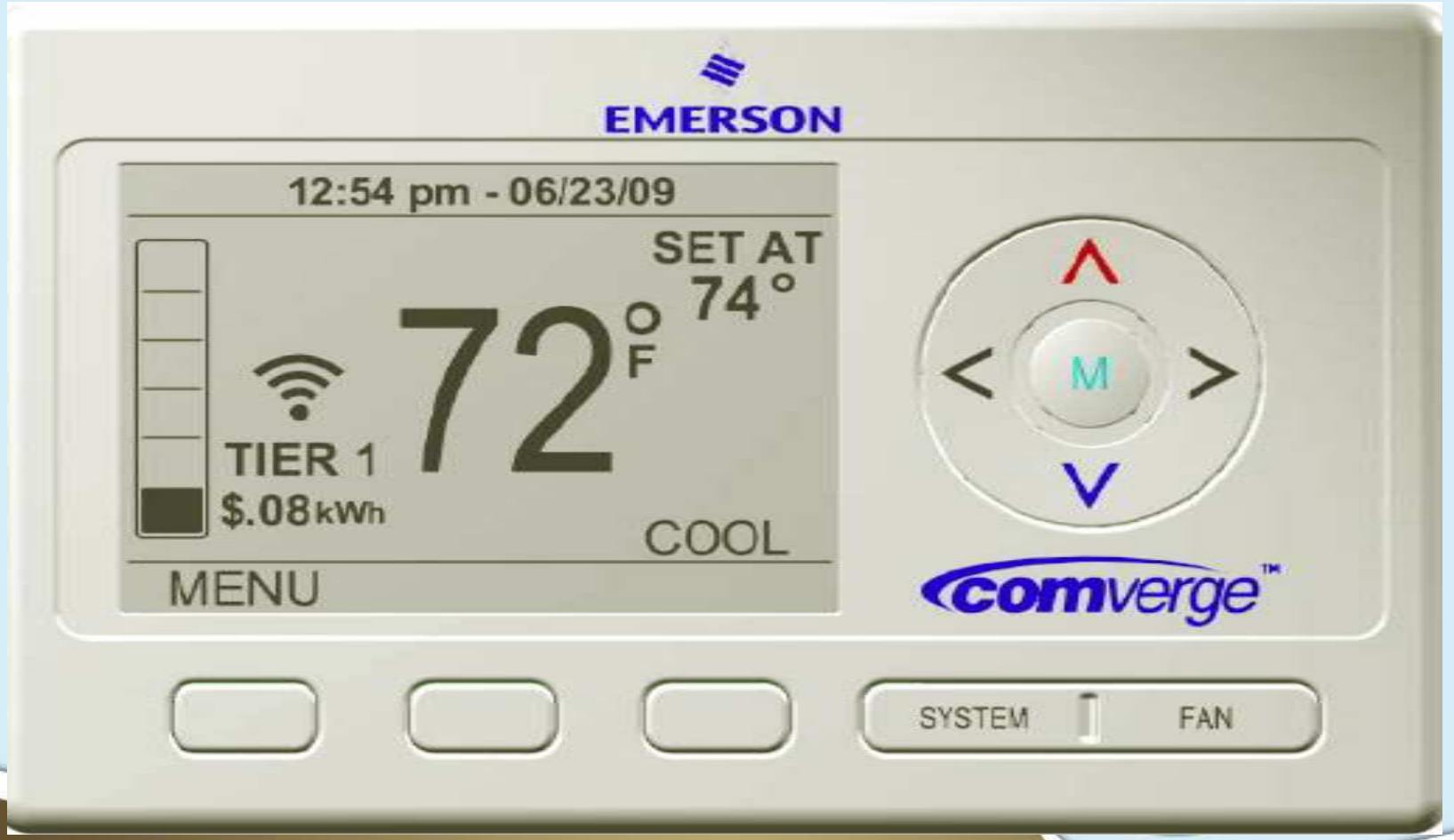
Sources: Comverge, AzTech, Blueline, Precision Data, HAI, LS Research, Tendril, The Energy Detective, Onzo, Landis+Gyr

Source: Wattson

Source: LS Research

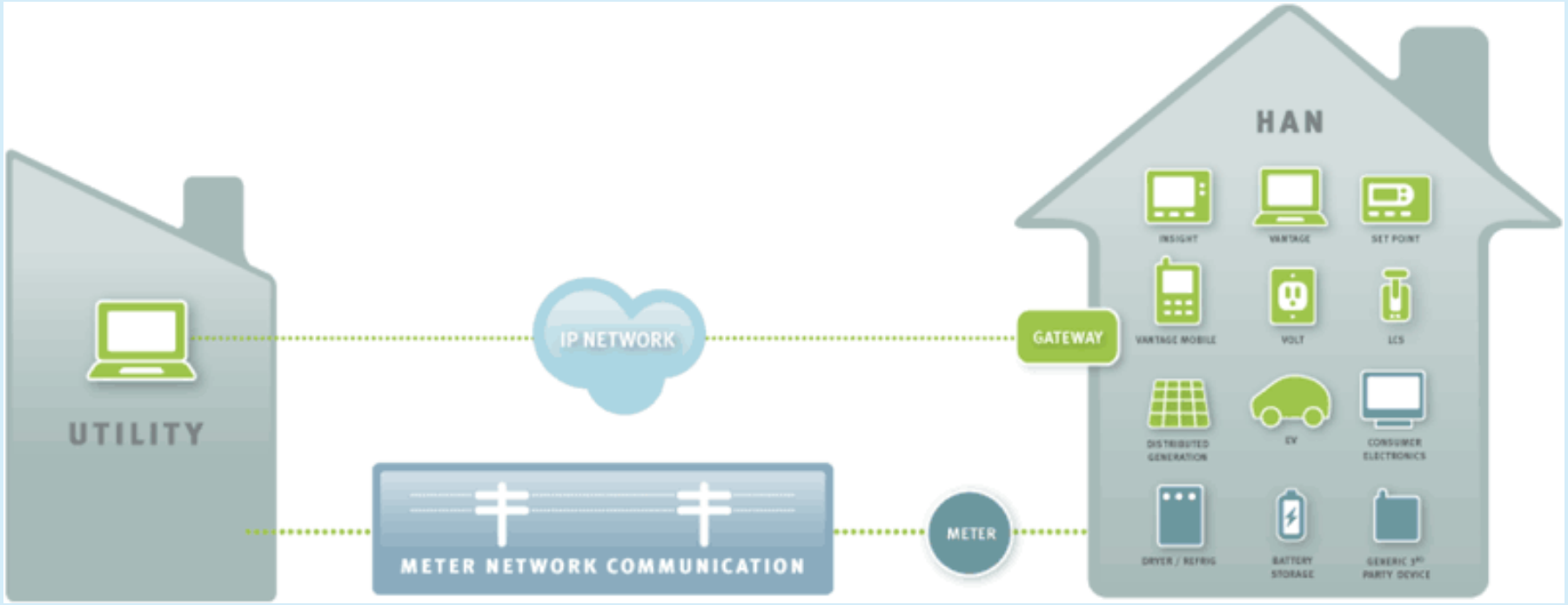
Source: Tendril

Programmable Communicating Thermostat (PCT)




Sun
Mon
Tue
Wed
Thu
Fri
Sat
8:15 am
09-04-08
76°
75°
Humidity: 38%
80°
FORECAST
MODE
SETTINGS
84°
Partly
Cloudy
High: 85°
Low: 77°
mode
select

Home Area Network (HAN) / Energy Management System (EMS)



Gateway / Energy Management System

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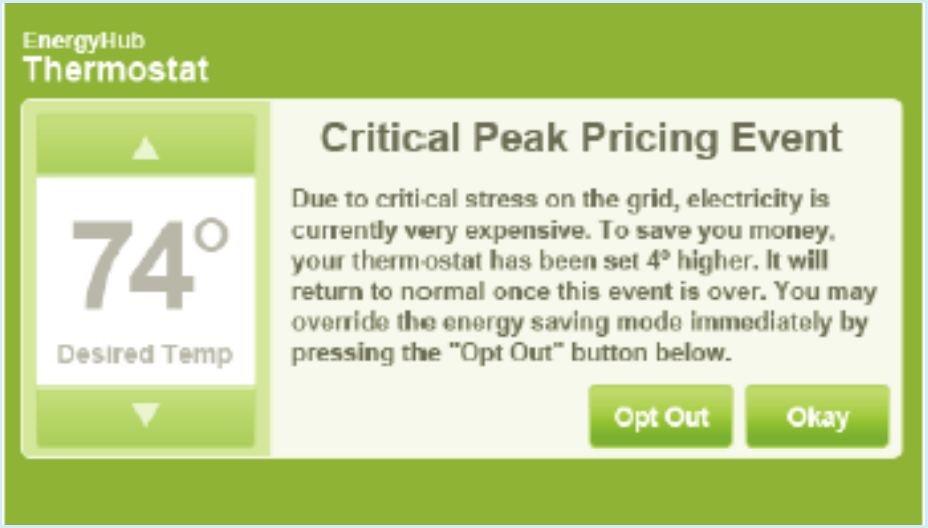

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Smart Appliances

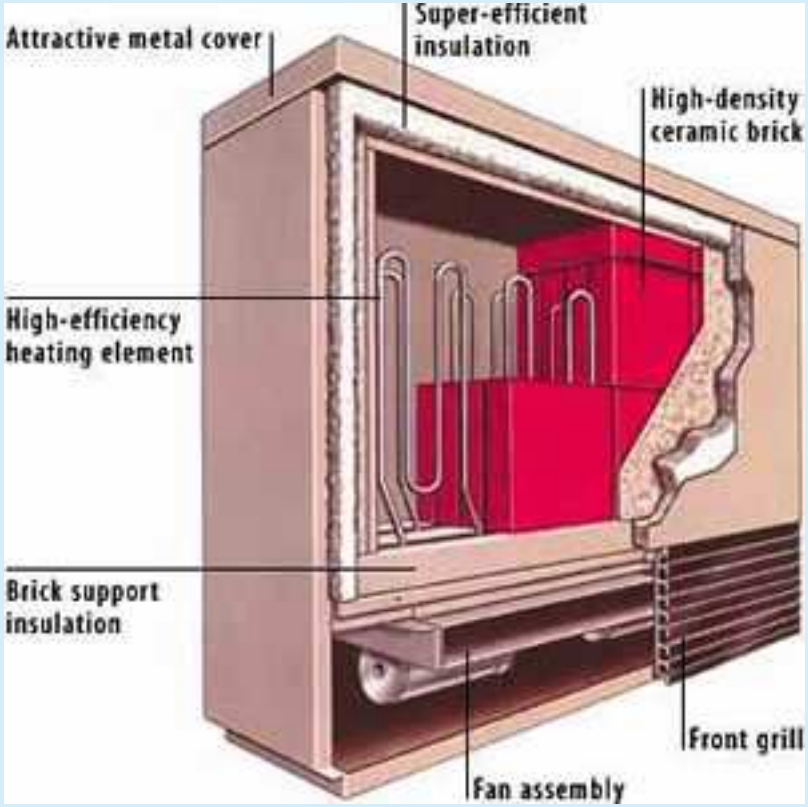
Other Opportunities

- Thermal Energy Storage (TES)
- Electric heat storage
- Pumps
- Spas
- Commercial EMS

Thermal Ice Storage

Source: Ice Energy

Electric Heat Storage



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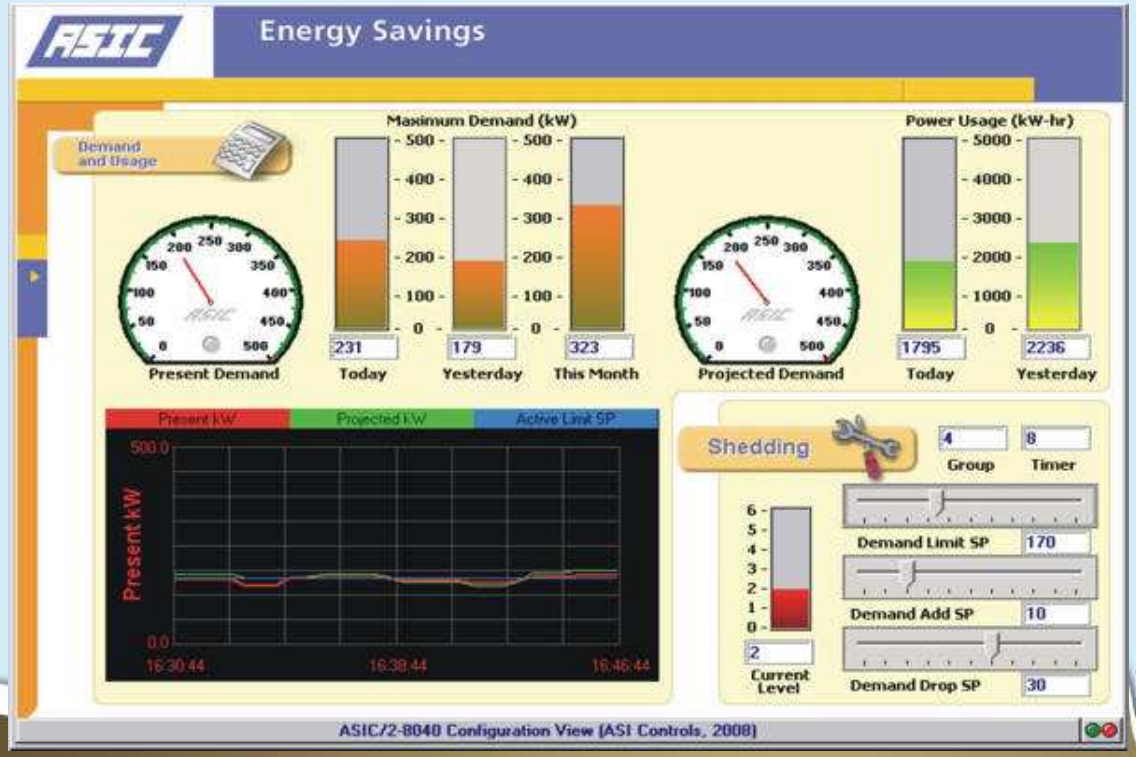
Load Switch

- Water heaters
- Pumps
- Spas

Commercial EMS

- Receive price signals
- Initiate load shedding routines



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Electric vehicles are on the way

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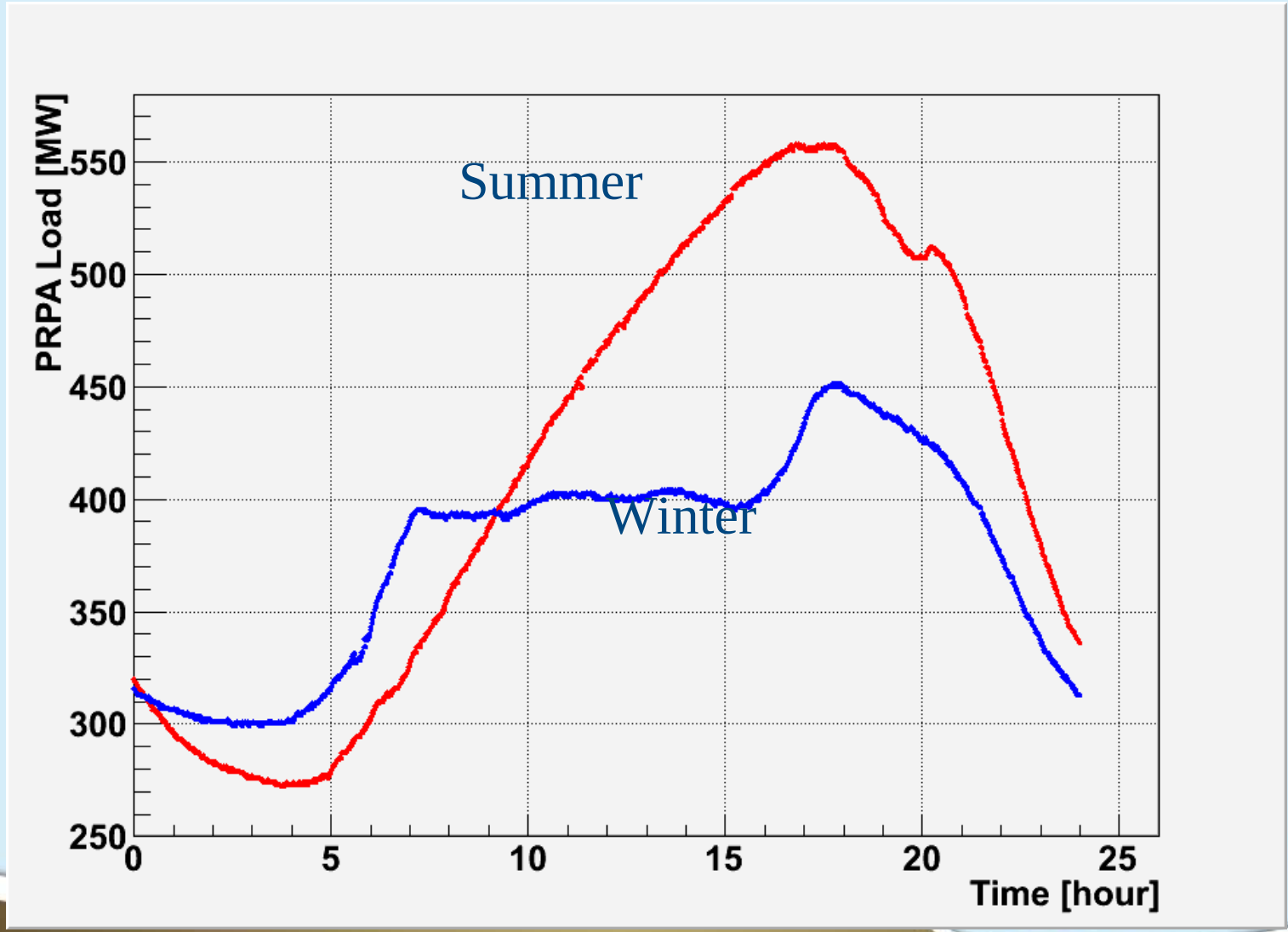
Typical PRPA Daily Load Profiles



Charge times and loads

Charge Level	Voltage	Power Draw	Charge Time	Equivalent to
1	120 V	1.5 kW	24 hours	Space heater Hair dryer
2	240 V	6.5 kW	4 hours	Clothes dryer Electric Range

Renewables Integration

Conclusion

- Smart meters will facilitate customers having more control over their electricity and water use
- Baby steps
  - Web portal
  - In-home display, Programmable Communicating Thermostat
  - Energy Management System with load control
  - Electric vehicle charging
  - Commercial applications

Smart Meter Fort Collins

Questions

Smart Meter Fort Collins

Smart Meter Fort Collins

Presentation Reference Materials

Financial Benefits

Annual operational savings from AMI	
Labor and operation expenses for meter reading	$495,755
Meter accuracy and registration	$347,944
Theft from manipulation of meters	$268,225
Load Control (avoided demand during PRPA peaks	$185,760
Labor dedicated to move-in / move-out and meter changes	$28,410
Purchase of Xcel data for rate design	$35,574
Subtotal	$1,361,668

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Financial Benefits

Annual operation savings through SGIG

Enhanced Demand response program $1,074,240

One time benefit

One time savings related to improved cash flow. Reduced lag between meter reads and billing. $1,600,000

Using a 3.5% interest rate the payback is just over 7 years after grant assistance

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Grid Automation