Smart Grid Implementation at the Sacramento Municipal Utility District

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SMUD's Smart Grid Vision

- A comprehensive regional smart grid solution built upon the installation and operation of an end-to-end smart grid that extends from generation to the smart meters of all SMUD's customers. It will:
  - Link smart meters and home area networks with upstream, automated distribution operations
  - Optimize distribution system operations to improve system reliability and efficiency
  - Enable our customers to fully participate in the electricity marketplace through dynamic pricing and demand response programs






What is Smart Grid?

- Smart grid is all about optimizing and managing the electricity grid to maximize operational efficiencies and reduce the need for additional infrastructure (transmission lines and power plants).
  - Provide control down to the customer level
  - Increase the capacity of the grid
  - Levelize loads
- There are several elements of smart grid that will make it a reality.






SMUD's Smart Grid Grant

- SMUD received a $127.5M Smart Grid Investment Grant from DOE to implement $308 M worth of projects:
  - Advanced Metering Infrastructure/Smart Meters
  - Consumer Behavior Study (Dynamic Pricing)
  - Demand Response
  - Distribution Automation
  - PHEV/EV Infrastructure
  - Customer Applications (Partner Projects)
  - Cyber Security






Other Grants and Direction

- Received several other smart grid-related grants
  - Accelerate renewables & waste biomass ($6.9 M)
  - High Penetration PV ($3.0 M)
  - PV and Energy Storage ($4.3 M)
  - CHP for Food Processing ($1.5 M)
  - Micro Grid ($1.6 M)
  - Other as partner, not prime ($9.2 M)
- Hired Smart Grid manager to oversee SMUD's efforts
- Focus for next three years will be on Stimulus projects
- Strategic plan will be developed to define direction beyond 3 years

SMUD's Smart Grid Partners

SMUD has partnered with three public agencies to implement the Smart Grid grant.

Partners

- SMUD – Sacramento Municipal Utility District
- LRCCD – Los Rios Community College District
- DGS – CA, Department of General Services
- CSUS – California State University, Sacramento

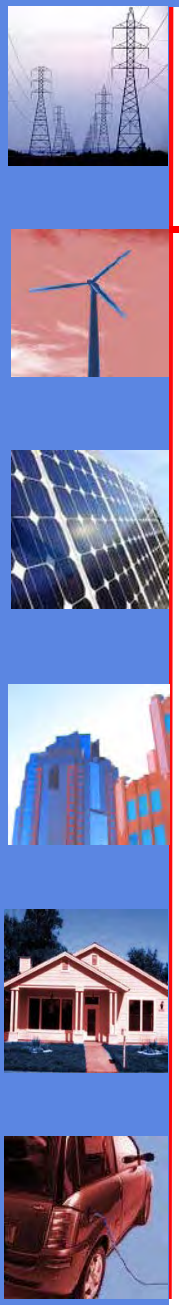





SMUD's FOA 58 Submittal

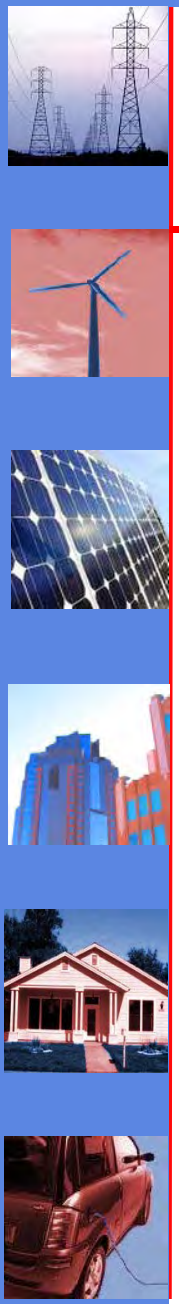
Table 1. Costs of SmartSacramento Project by Task (in millions)

Project Tasks	2009 (Pre-Award)	2010 (Year One)	2011 (Year Two)	2012 (Year Three)	Total Project Costs
Task 1: AMI/Smart Meters	$15.6	$84.5	$26.2	$0.0	$126.3
Task 2: Dynamic Pricing	$0.0	$8.0	$4.0	$4.0	$16.0
Task 3: Demand Response	$0.0	$8.4	$16.3	$23.0	$47.7
Task 4: Customer Applications					
CA DGS	$0.0	$8.3	$8.3	$8.3	$24.9
CSUS	$0.0	$2.8	$2.8	$2.8	$8.4
LRCCD	$0.0	$3.1	$3.1	$3.1	$9.3
Task 5: Distribution Automation	$0.0	$20.5	$25.5	$23.0	$69.0
Cyber Security	$0.0	$3.0	$1.5	$1.6	$6.1
Total Project Costs	$15.6	$138.6	$87.7	$65.8	$307.7



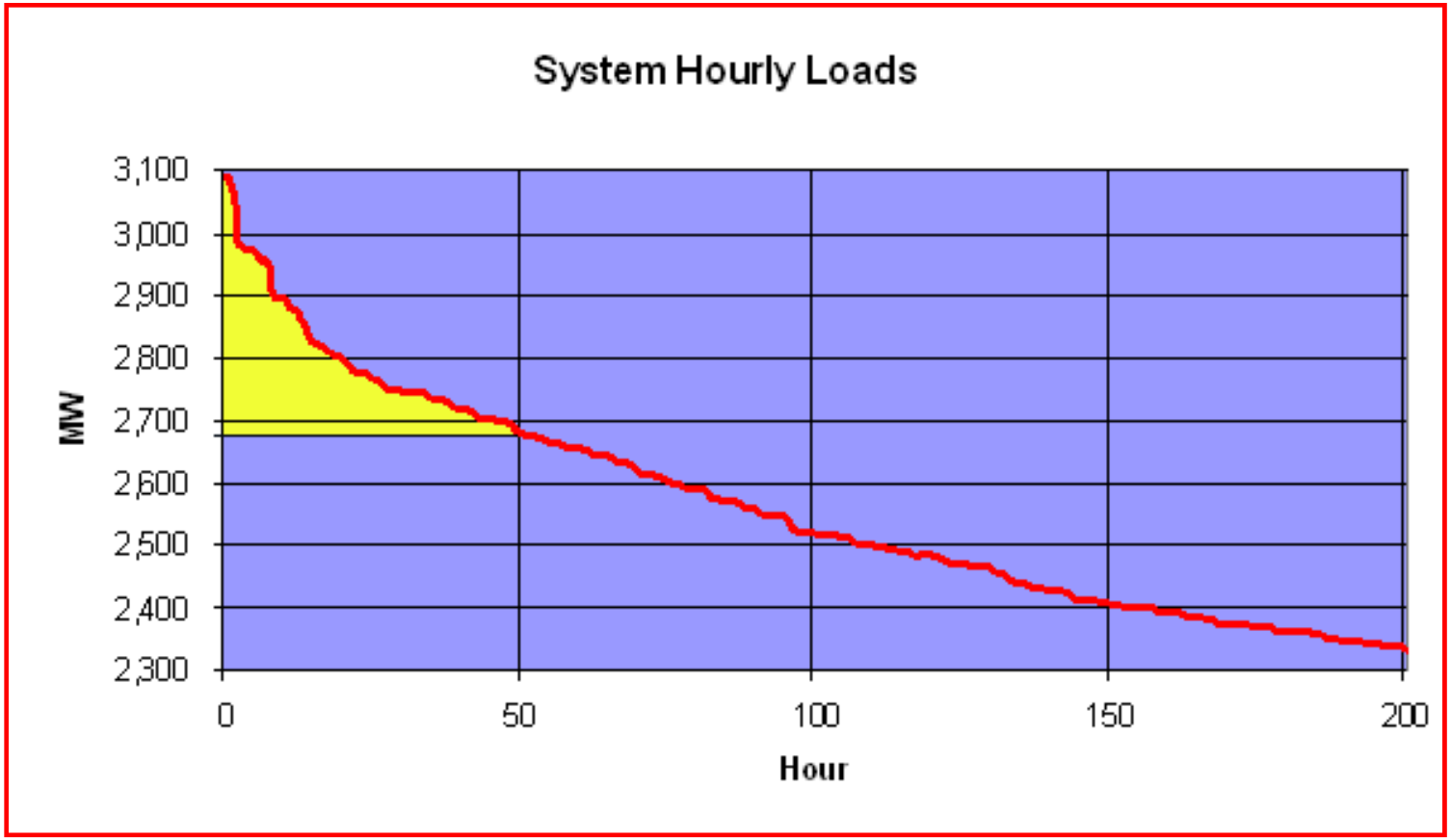
Partner Projects

- At each partner campus energy management systems will be installed or updated to save energy and reduce peak loads
- The CSUS distribution system will be upgraded to increase grid reliability
- PHEV/EV charging stations will be installed at all three partner campuses
- Smart meters will be installed on all 57 buildings on the CSUS campus



Why Smart Grid?

Load Duration Curve



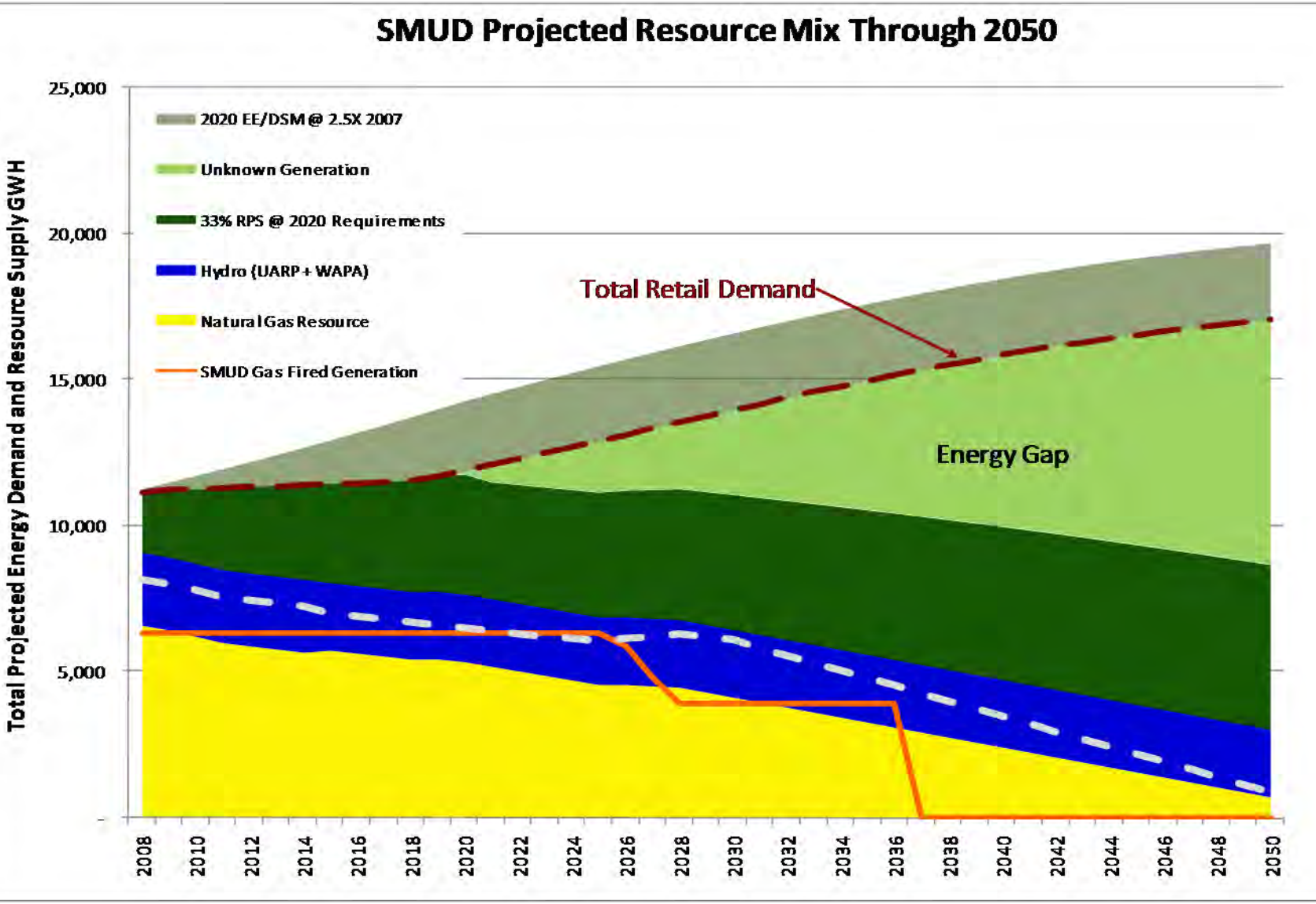





SMUD Strategic Directive 9

- Reduce Greenhouse Gas Emissions 90% below 1990 levels by 2050
- <350,000 metric tonnes/year
- Assure reliable power supply

Why Smart Grid?



Smart Grid Vision



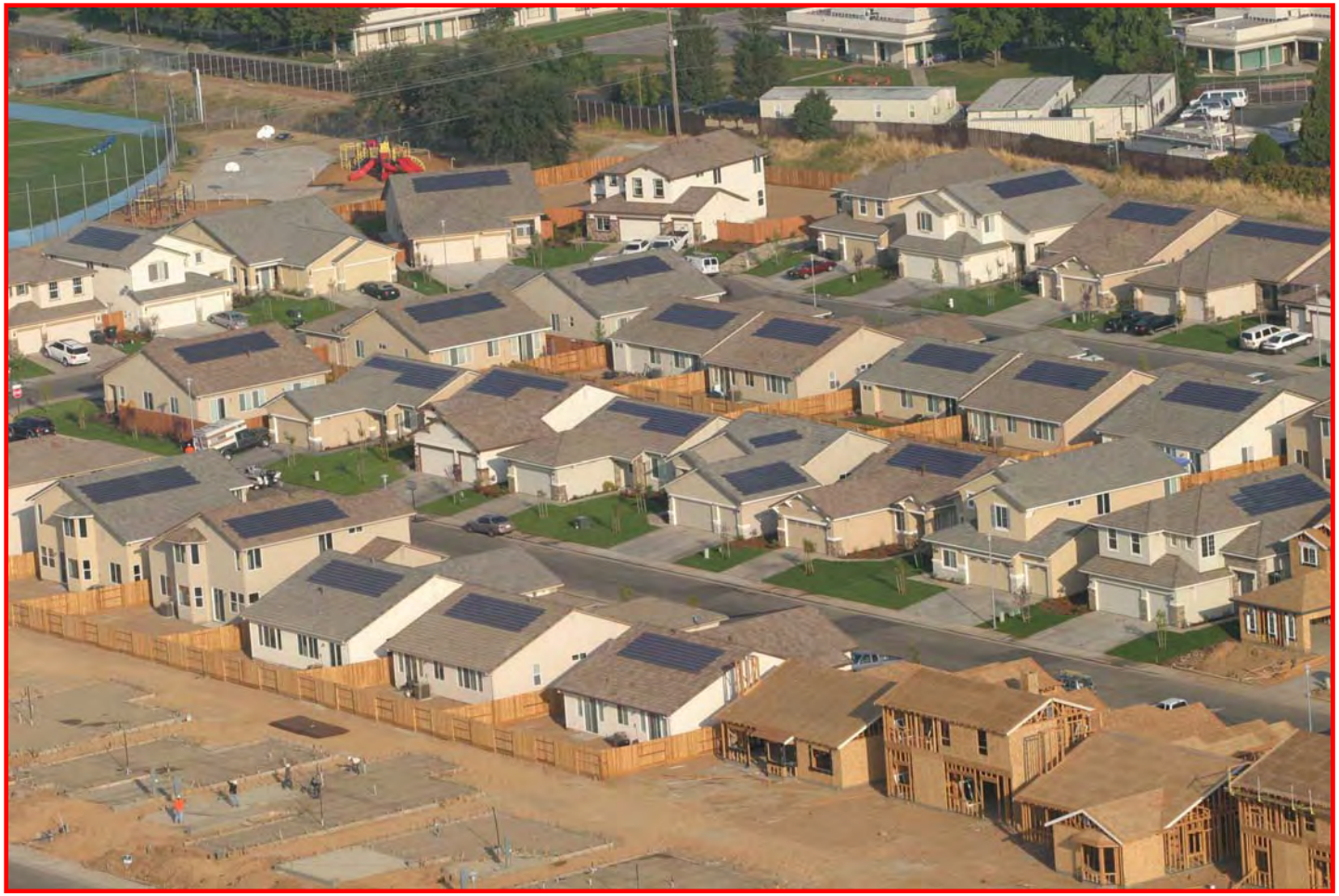



Smart Grid Elements

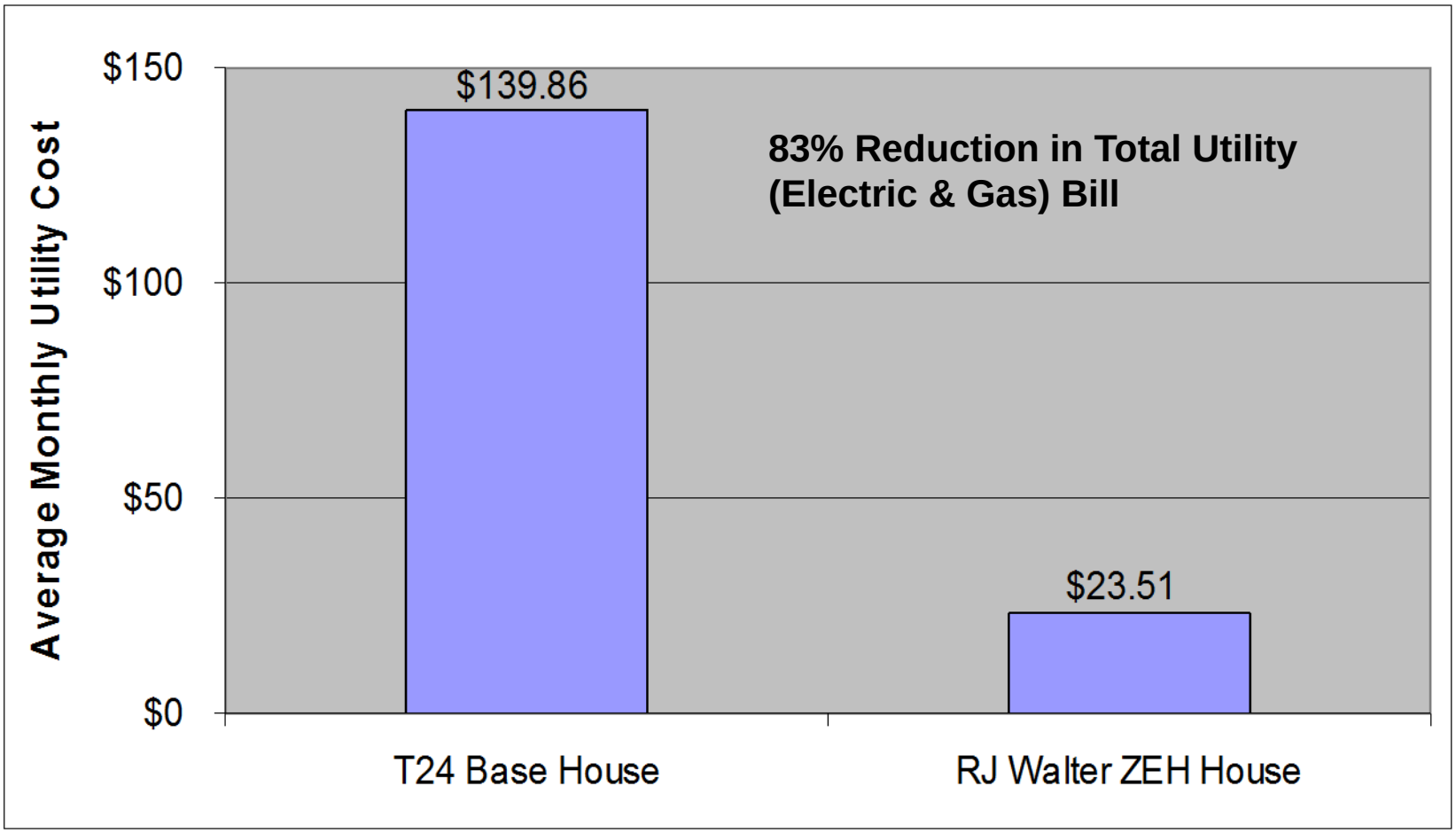
1. Energy Efficiency
2. Renewables/Distributed Generation
3. Energy Storage
4. Demand Response
5. Advanced Metering Infrastructure
6. Dynamic Pricing
7. Distribution System Improvements
8. Generation Efficiency

Deep Energy Efficiency Retrofits

Net Zero Energy Homes by 2020



Total Estimated Energy Bill Savings



$116 monthly savings at $50k incremental cost

Net Zero Energy Commercial Buildings by 2030






Energy Storage

- Develop infrastructure standards for plug in hybrid vehicles that charge off-peak and generate during peak periods
- Test the effectiveness of battery storage and power management products
- Consider 400 MW pumped storage facility


Tree Clear Radius: 500ft
Height Above Ground: 652.6ft
1
2
3
4
5
6
7
8
9
10
11
12
13

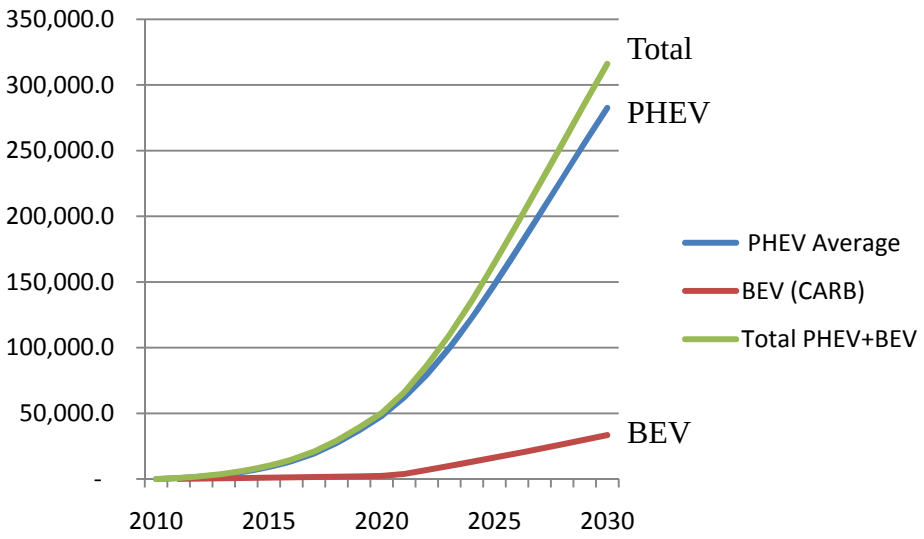





Plug In Hybrids and Battery Electric Vehicles

- Install 250 Battery Electric Vehicle charging stations
- Automate the entire process – customer sets parameters
  - Charge the batteries during off-peak periods based on price signals
  - Sell energy based on a high price or for grid reliability
  - Never let the charge fall below a pre-specified level
- Future – V2G electricity sales and home energy storage
- Automakers not supportive of using batteries for grid stabilization – 10-year warranty on smog equipment

PEV Market forecast for Sacramento



- Load becomes significant around 2025
- Local distribution impacts will be felt sooner
  - UCLA cluster analysis
- Need to manage load and meter for LCFS value

PHEV Average Projection
- Adjusted EPRI Model
- CARB Model (Oct. 2009)
- Charles River Associates

Load Calculation Assume
50% of PHEV's at 1.5 kW charge level
25% of PHEV's at 3.3 kW charge level
25% of PHEV's at 6.6 kW charge level
100% of BEV's at 6.6 kW charge level

Energy Calculation Assume
365 days a year of charging (worst case)
PHEV require 7.5 kWh of charging/day
BEV's require 15 kWh of charging/day

Year	PHEV	BEV	% Sac	Load	Energy
2015	9,225	1,045	0.3	35MW	53 GWh
2020	47,940	2,357	1.4	164MW	144 GWh
2025	148,108	16,322	12.2	566MW	495 GWh
2030	282,524	33,481	30.3	1,097MW	956 GWh






Demand Response

- Automate DR
- SMUD will provide 50,000 residential and small commercial customers with enabling technologies (such as home energy management systems) that allow them to participate in direct load control and pricing programs
- SMUD will work with medium and large commercial customers to provide technical assistance and enabling technology that allows them to automatically respond to peak prices by reducing load
- Benefits
  - Provides customers with tools to manage their bills
  - Reduces system peak
  - Enables dynamic pricing options

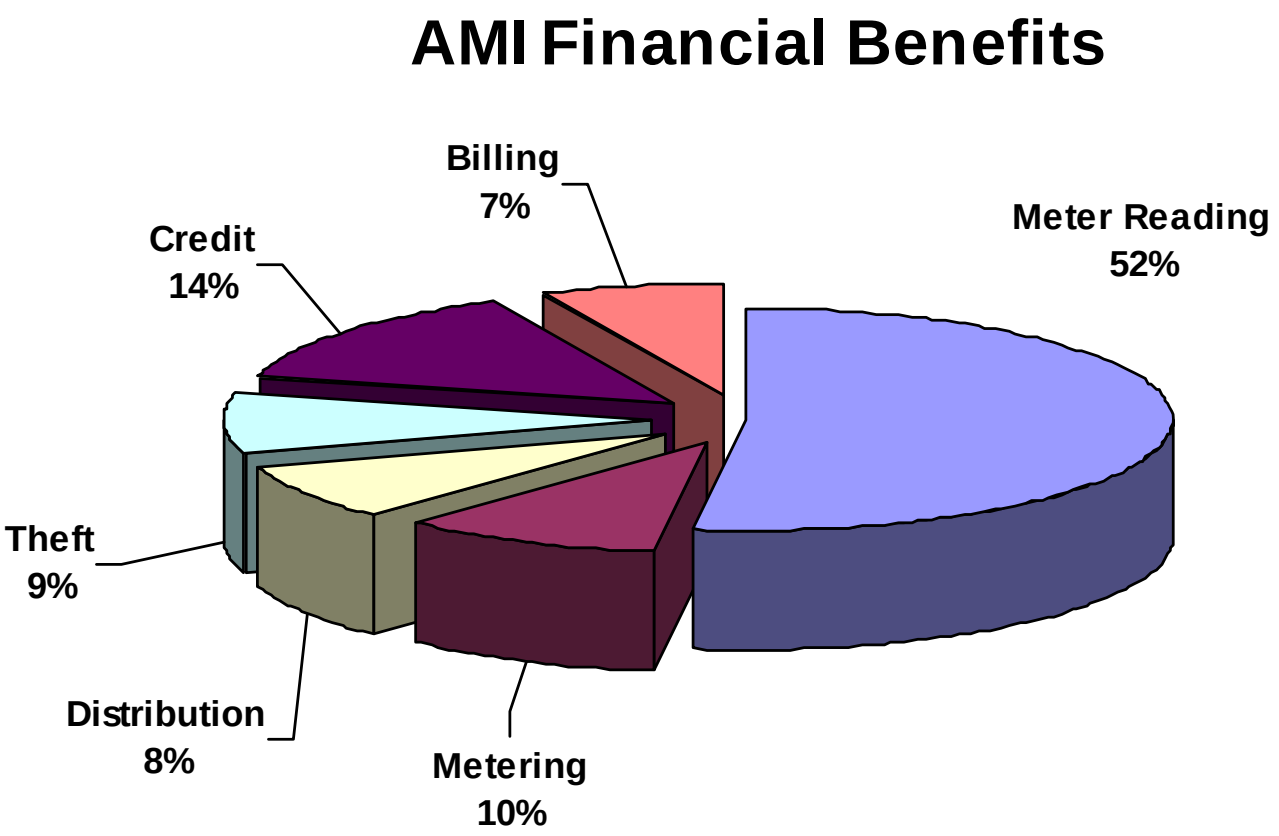





Advanced Metering Infrastructure/Rates

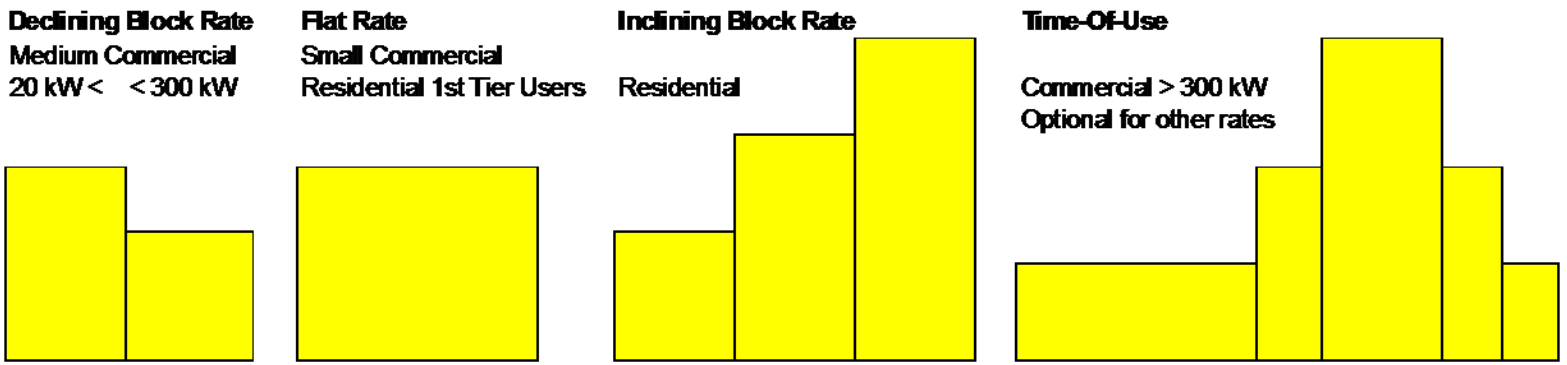
- Enables time differentiated rates and critical peak pricing opportunities
- Enables communication with appliances and equipment for demand response
- Enables loading information and automation all along the supply chain
- Selected Silver Spring Network and Landis + Gyr meters
- 50k pilot installation under way

AMI Business Case



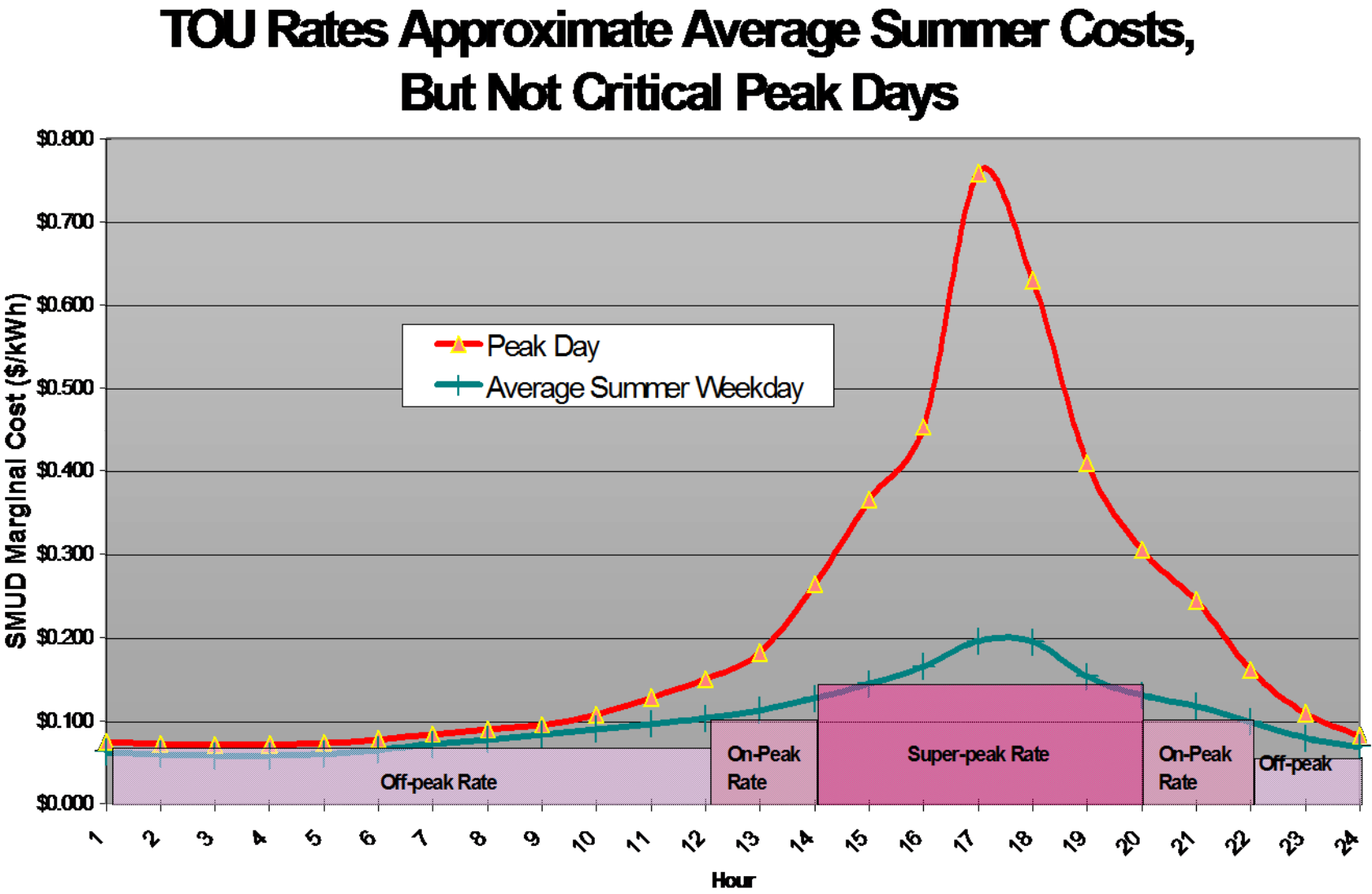
Rates Discussion

- Current rates range in how efficiently they signal underlying costs



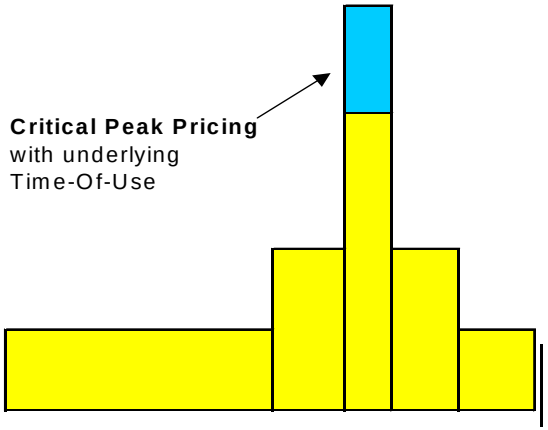
Worst → *Bad* → *Fair* → *Good*

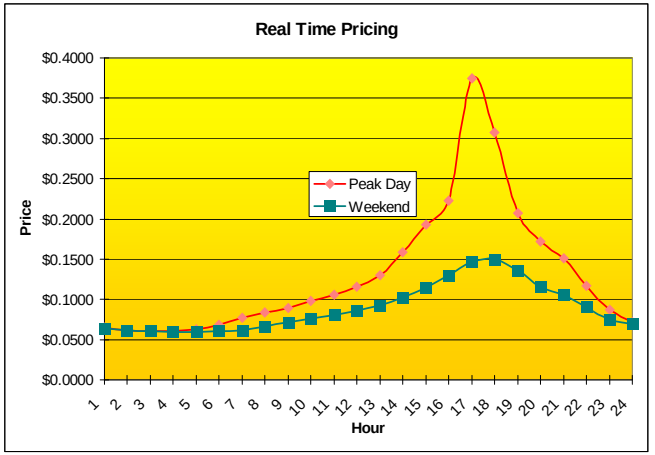
TOU Rates Compared to Peak Profile



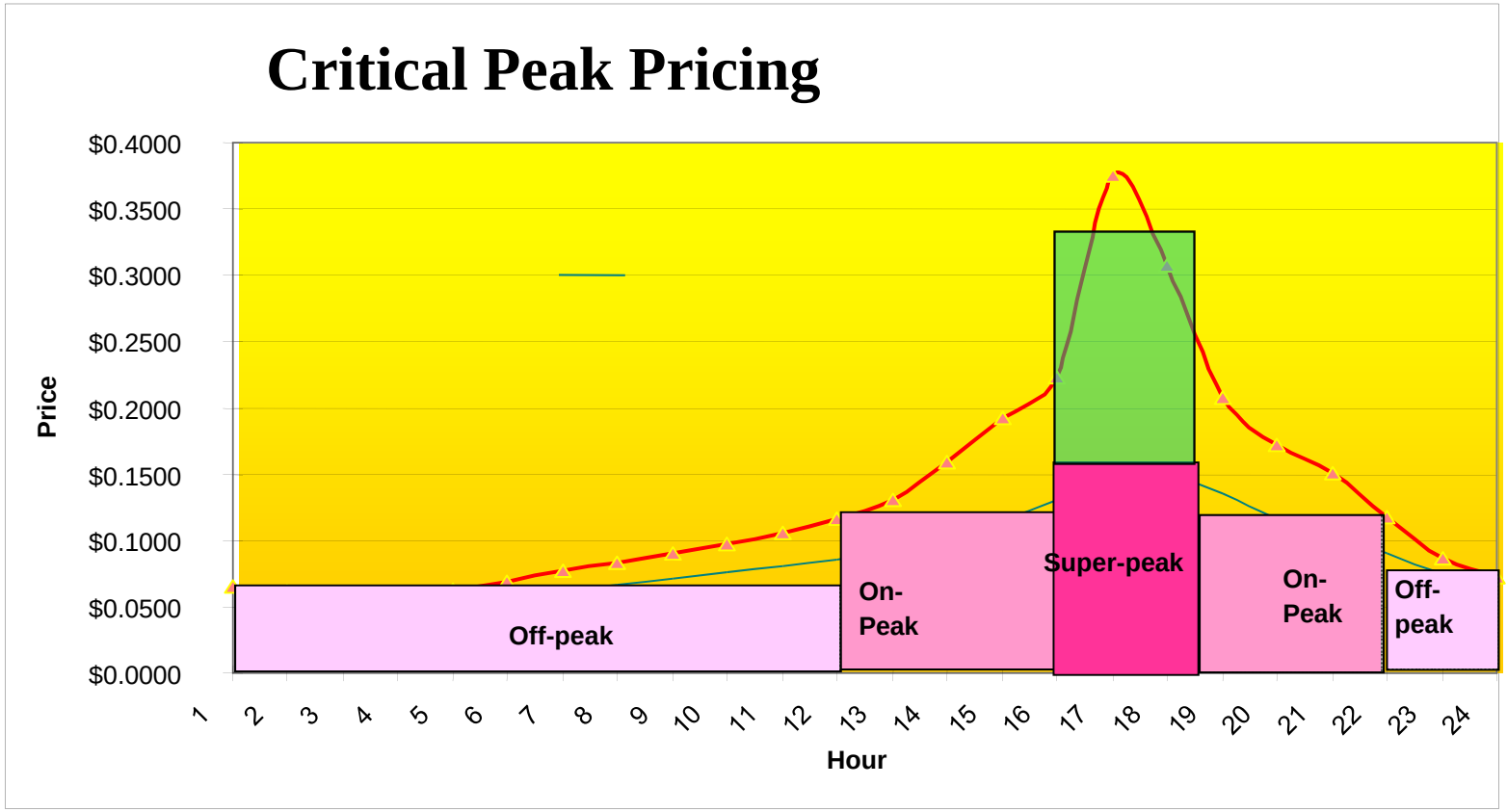
Pricing Potential

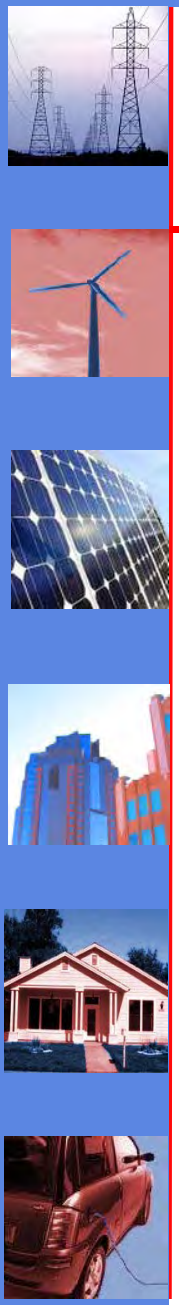
- Alternative rate structures are better at matching costs





Pricing Potential





Consumer Behavior Study

- SMUD will conduct a large-scale dynamic pricing study to test:
  - Customer response to Critical Peak Pricing
  - Customer preferences for information and messaging
  - Ability of customers to reduce peak demand and energy using enabling technologies (such as programmable communicating thermostats)
  - Customer acceptance and response to new technologies and pricing options






Distribution Automation

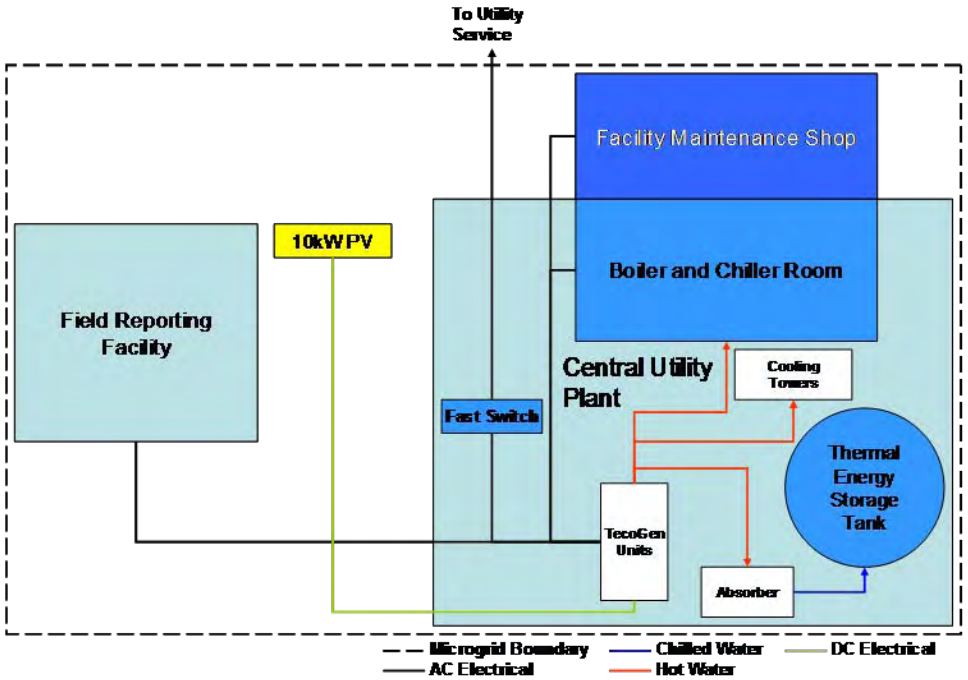
- SMUD will implement a comprehensive package of distribution system automation controls and systems to:
  - Expand SMUD's supervisory control and data acquisition (SCADA) system
  - Install intelligent switching and monitoring equipment
  - Implement an advanced Distribution Management System (DMS)
    - Demonstrate the interoperability between the energy management system (EMS), outage management system (OMS), the DMS and AMI
- Benefits
  - Improved system efficiency
  - Reduced operations and maintenance costs
  - Improved reliability






310 kW field demonstration of CEC/CERTS Microgrid for central utility plant to demonstrate:

- Real world performance
- Allow our central plant and Field Reporting Facility to operate independently of the grid
- 3-100 kW natural gas-fired engines + 10 kW PV system
- Waste heat from engines will provide additional energy efficiency by reducing the need for boilers and providing chilled water for air conditioning (absorption chiller)
- Autonomous local control for fast events (No central controller)
- Economic value to customers and utility
- Numerous technical challenges will be evaluated
- Construction in 2009, operational in 2010








Cyber Security

- SMUD's smart grid will enact security programs and procedures that meet or exceed government mandated standards
- This is a continuation of SMUD's current best practices with increased resources to support smart grid initiatives






Where We Are Today

- Moving forward with the Smart Meters project:
  - Communication network 96% complete
  - 50,000 meters installed
  - 95% customers satisfied with installation
- Working with DOE to negotiate a final grant contract
- Meeting with equipment and software vendors to determine technology landscape
- Purchasing and testing equipment to determine what will be deployed

Smart Grid Customer Benefits

1. More CHOICES and OPTIONS for customers through new smart grid enabled programs and applications
2. Customers work in PARTNERSHIP with SMUD to shift load and reduce energy usage, lowering operating, infrastructure and environmental costs
3. More detailed energy INFORMATION will allow customers to better manage their energy usage






Conclusions

- SMUD is committed to implementing Smart Grid and is working with EPRI on the statewide smart grid roadmap sponsored by PIER
- Smart Grid will improve the grid through:
  - Better load management through demand response and energy storage
  - Improved customer participation through Home Area Networks and utility programs
  - Reduced loads due to innovative rate structures
  - Automation of the distribution system
  - Improved home and commercial building performance by moving towards net zero energy
  - Improved reliability through implementation of distributed generation and micro grids
- There is no silver bullet. Smart Grid promotes the silver buckshot approach—working on multiple strategies simultaneously—energy efficiency, renewables and DG, distribution automation, energy storage, demand response, generation efficiency, AMI and rates to maximize benefits