# SmartSacramento ®
# SMUD's Smart Grid Initiatives

**Jim Parks**

October 2014

Powering forward. Together.

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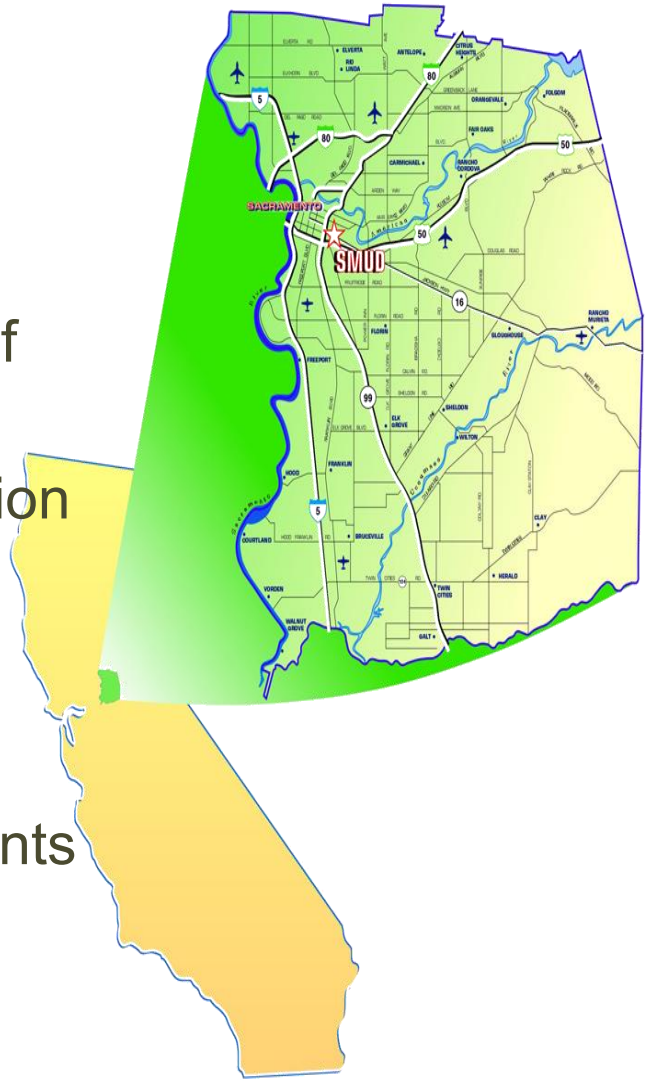
# SMUD – Owned By Customers

- Not-for-profit, publicly owned utility (POU)
- Voter approved in 1923, began service in 1946
- Serves Sacramento County, small parts of Placer and Yolo counties
- 604,000 customers; population of 1.4 million
- Peak load: 3,299 MW (July 2006)
- Sixth-largest POU in U.S.
- Seven-member Board of Directors
- Independent of city and county governments
- Low rates, reliable, innovative and green

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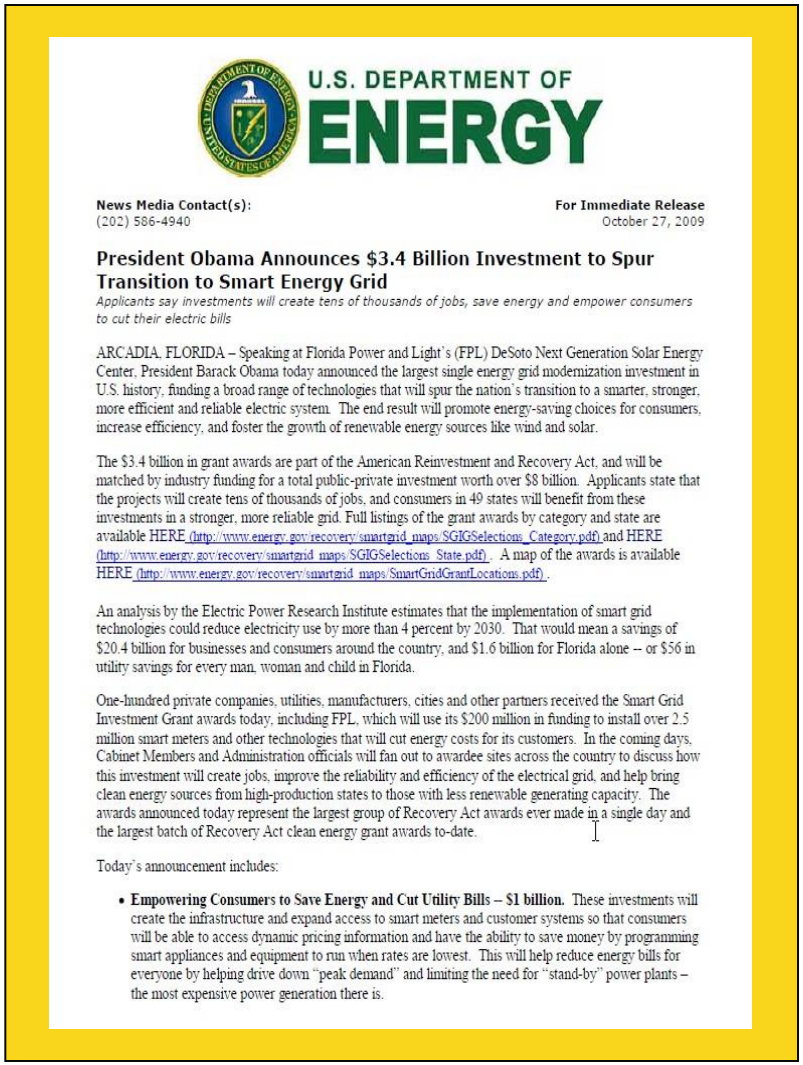
# Smart Grid Investment Grant (SGIG)

- October 2009 DOE Announcement
  - SGIG grants to 100 entities
  - $203 million to California
  - $127.5 award to SMUD for a $308 million project
  - SMUD received 63% of the SGIG funds that went to California



U.S. DEPARTMENT OF ENERGY

**News Media Contact(s):**
(202) 586-4940

**For Immediate Release**
October 27, 2009

**President Obama Announces $3.4 Billion Investment to Spur Transition to Smart Energy Grid**

*Applicants say investments will create tens of thousands of jobs, save energy and empower consumers to cut their electric bills*

ARCADIA, FLORIDA – Speaking at Florida Power and Light's (FPL) DeSoto Next Generation Solar Energy Center, President Barack Obama today announced the largest single energy grid modernization investment in U.S. history, funding a broad range of technologies that will spur the nation's transition to a smarter, stronger, more efficient and reliable electric system. The end result will promote energy-saving choices for consumers, increase efficiency, and foster the growth of renewable energy sources like wind and solar.

The $3.4 billion in grant awards are part of the American Reinvestment and Recovery Act, and will be matched by industry funding for a total public-private investment worth over $8 billion. Applicants state that the projects will create tens of thousands of jobs, and consumers in 49 states will benefit from these investments in a stronger, more reliable grid. Full listings of the grant awards by category and state are available HERE (http://www.energy.gov/recovery/smartgrid_maps/SGIGSelections_Category.pdf) and HERE (http://www.energy.gov/recovery/smartgrid_maps/SGIGSelections_State.pdf) . A map of the awards is available HERE (http://www.energy.gov/recovery/smartgrid_maps/SmartGridGrantLocations.pdf) .

An analysis by the Electric Power Research Institute estimates that the implementation of smart grid technologies could reduce electricity use by more than 4 percent by 2030. That would mean a savings of $20.4 billion for businesses and consumers around the country, and $1.6 billion for Florida alone -- or $56 in utility savings for every man, woman and child in Florida.

One-hundred private companies, utilities, manufacturers, cities and other partners received the Smart Grid Investment Grant awards today, including FPL, which will use its $200 million in funding to install over 2.5 million smart meters and other technologies that will cut energy costs for its customers. In the coming days, Cabinet Members and Administration officials will fan out to awardee sites across the country to discuss how this investment will create jobs, improve the reliability and efficiency of the electrical grid, and help bring clean energy sources from high-production states to those with less renewable generating capacity. The awards announced today represent the largest group of Recovery Act awards ever made in a single day and the largest batch of Recovery Act clean energy grant awards to-date.

Today's announcement includes:

- **Empowering Consumers to Save Energy and Cut Utility Bills -- $1 billion.** These investments will create the infrastructure and expand access to smart meters and customer systems so that consumers will be able to access dynamic pricing information and have the ability to save money by programming smart appliances and equipment to run when rates are lowest. This will help reduce energy bills for everyone by helping drive down "peak demand" and limiting the need for "stand-by" power plants – the most expensive power generation there is.

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# Acknowledgement/Disclaimer

**Acknowledgement:** This material is based upon work supported by the Department of Energy under Award Number OE000214.



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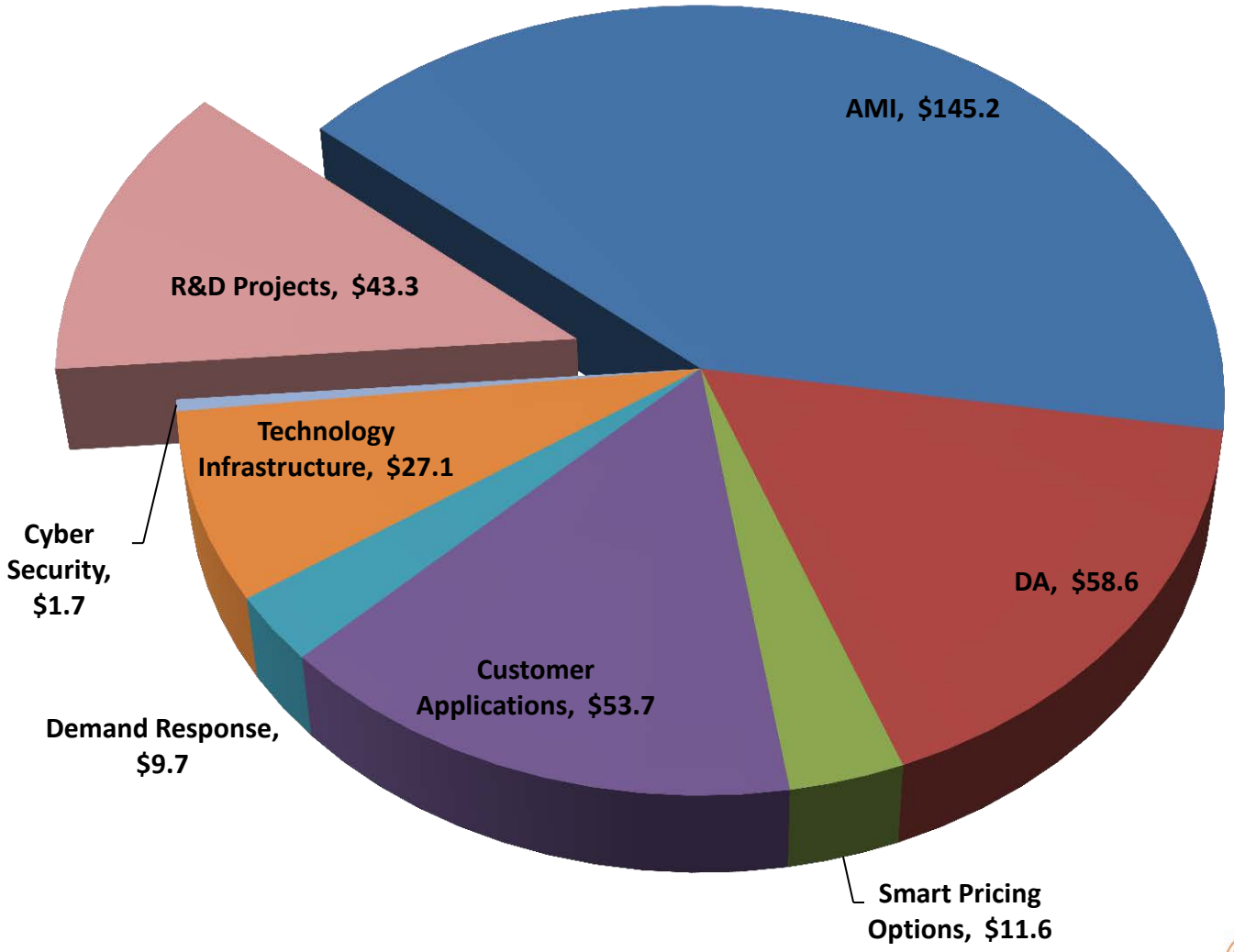
# What SMUD has Done

1. Smart meter installation
2. Consumer behavior study
3. Demand response
4. Distribution automation
5. Customer applications
6. Technology infrastructure
7. Cyber security
8. R&D Projects


# Smart Grid Projects & Budgets

**Smart Grid Budget $351M ($307.7M SGIG + $43.3M R&D)**

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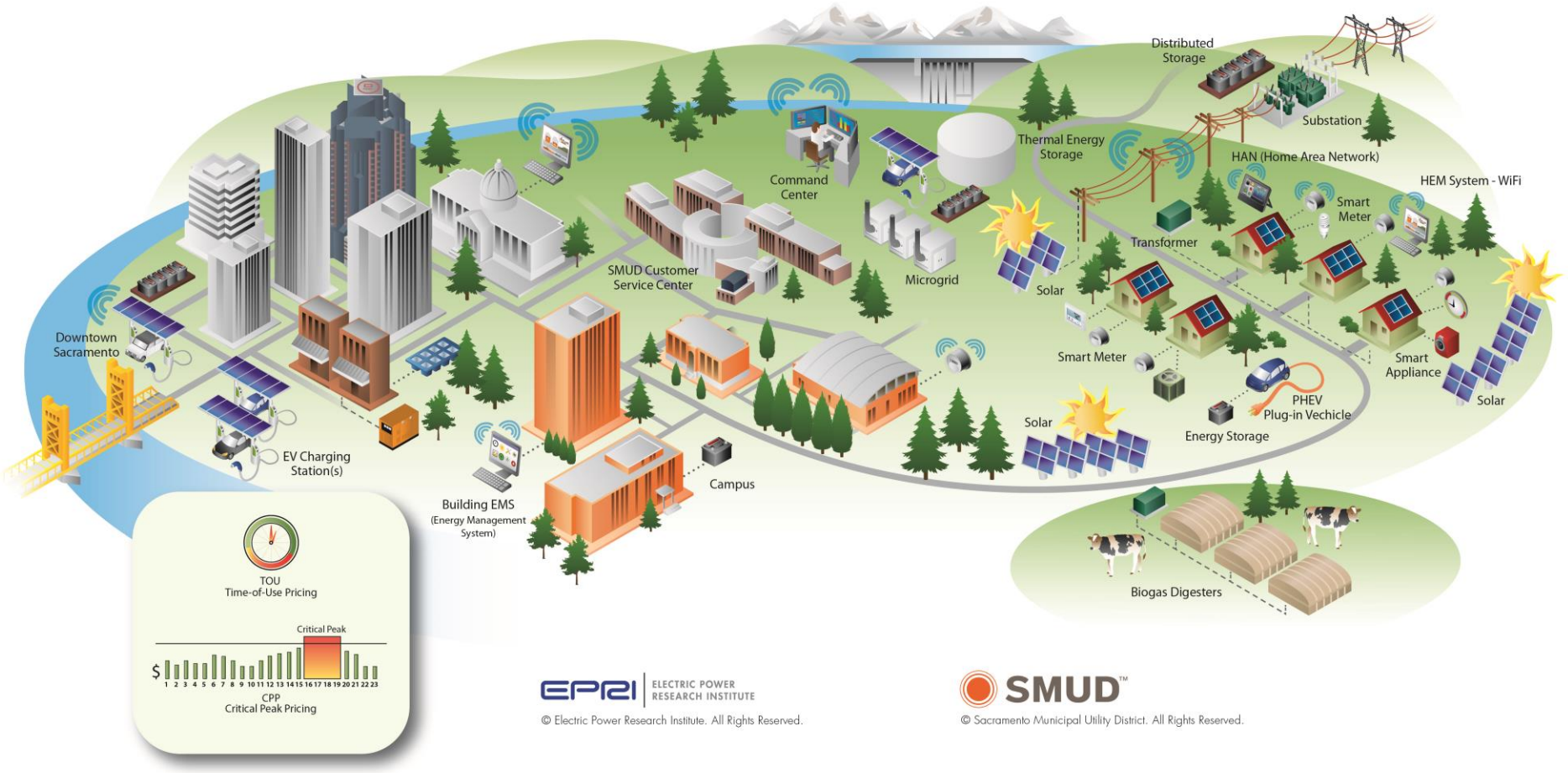
# Smart Grid Vision




EPRI ELECTRIC POWER RESEARCH INSTITUTE



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# Smart Meters

- Installed over 620,000 meters
- Completed installation of telecommunication network
- Allow customers to opt out of smart meters
- Remote connect/disconnect switch activated April 2011 reducing truck rolls by over 400,000 per year

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# Smart Meters

- Other utilities encountered publicity problems with AMI deployments
- Deployed 80k meters in hard-to-read areas and temporarily stopped deployment
- Tested system to ensure accuracy, data transfer capability, storage and communication
- Trained 40 staff plus executives and board members to present information in community

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# Smart Meter Benefits

- Yesterday's data today
- TOU/CPP capable
- Communicate with HANs for demand response
- Meter tamper detection
- Automatic connect/disconnect
- 'Ping' meters after outage restoration to verify there are no imbedded outages
- System voltage reads


**Potential Future Functionality Additions**

- System/DER monitoring and optimization
- Transformer loading characteristics (future)
- Enable 'Last Gasp' functionality for outage notification

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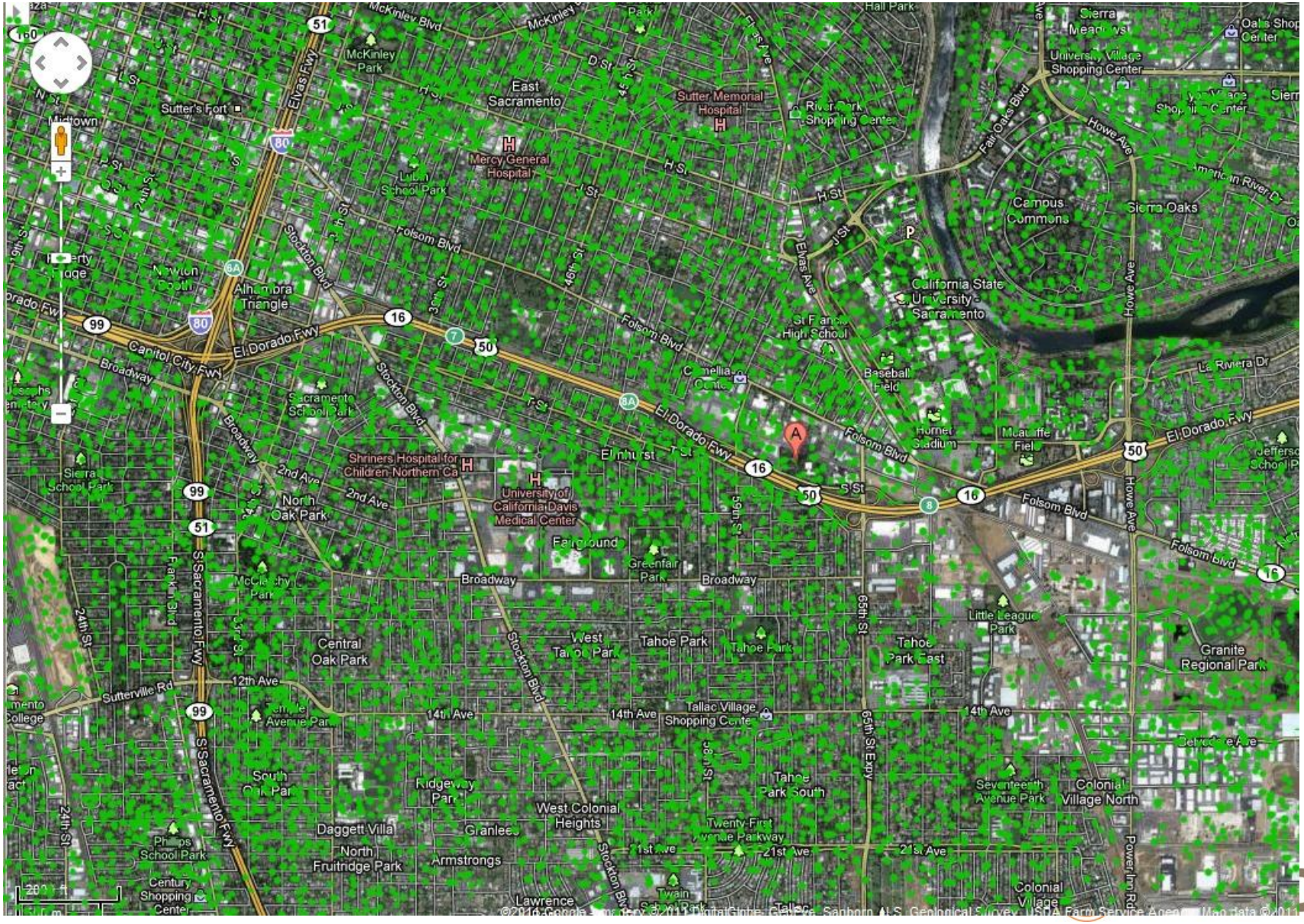
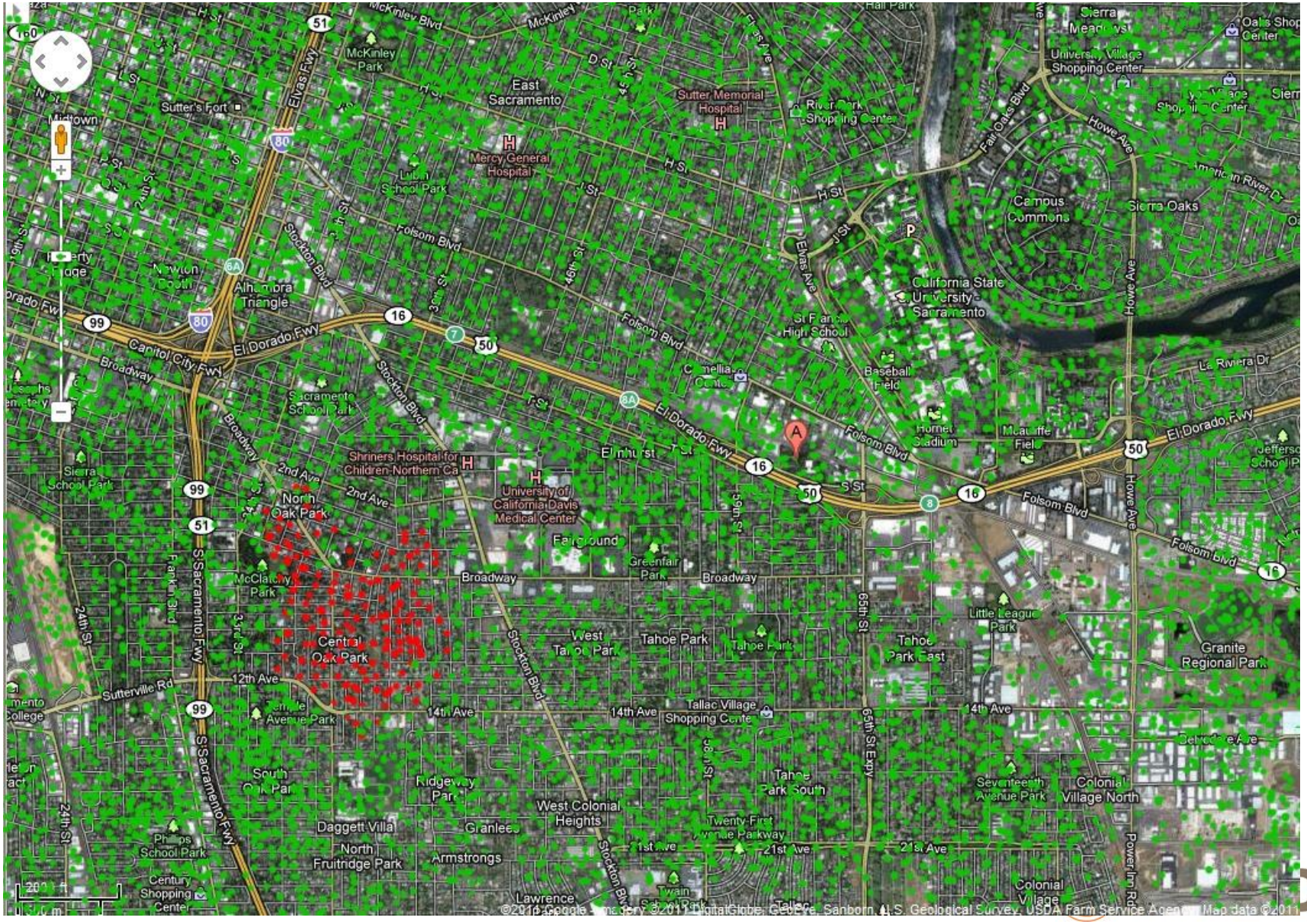
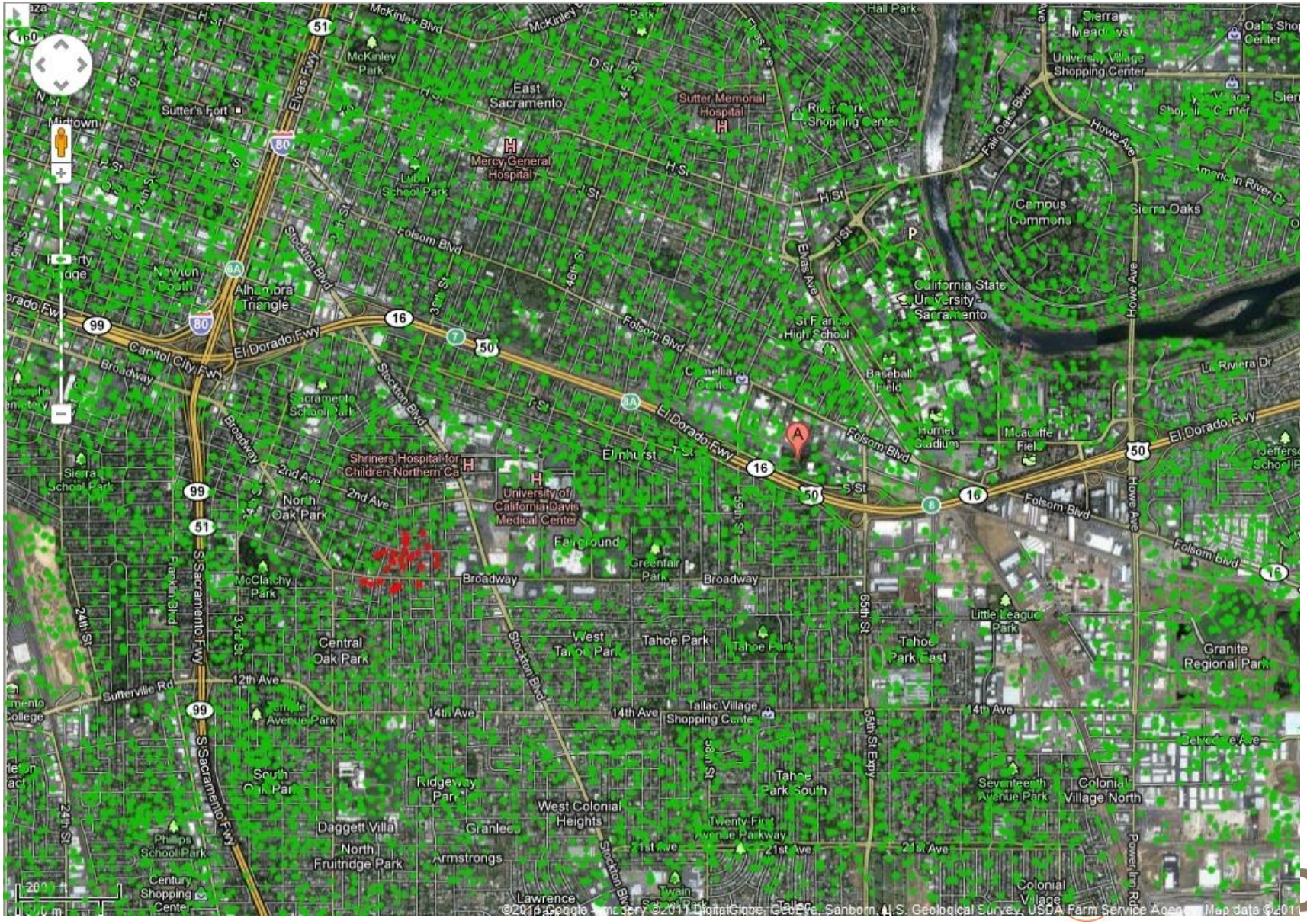
# Outage Detection



# Outage Detection



# Imbedded Outages



# Smart Pricing Options

## Scope

- Dynamic pricing pilot offering opt-in and opt-out Time of Use (TOU), Critical Peak Price (CPP), and Time of Use with a Critical Peak Price (TOU-CPP) rates to residential customers to determine the impacts of various offers on peak load reduction & customer satisfaction

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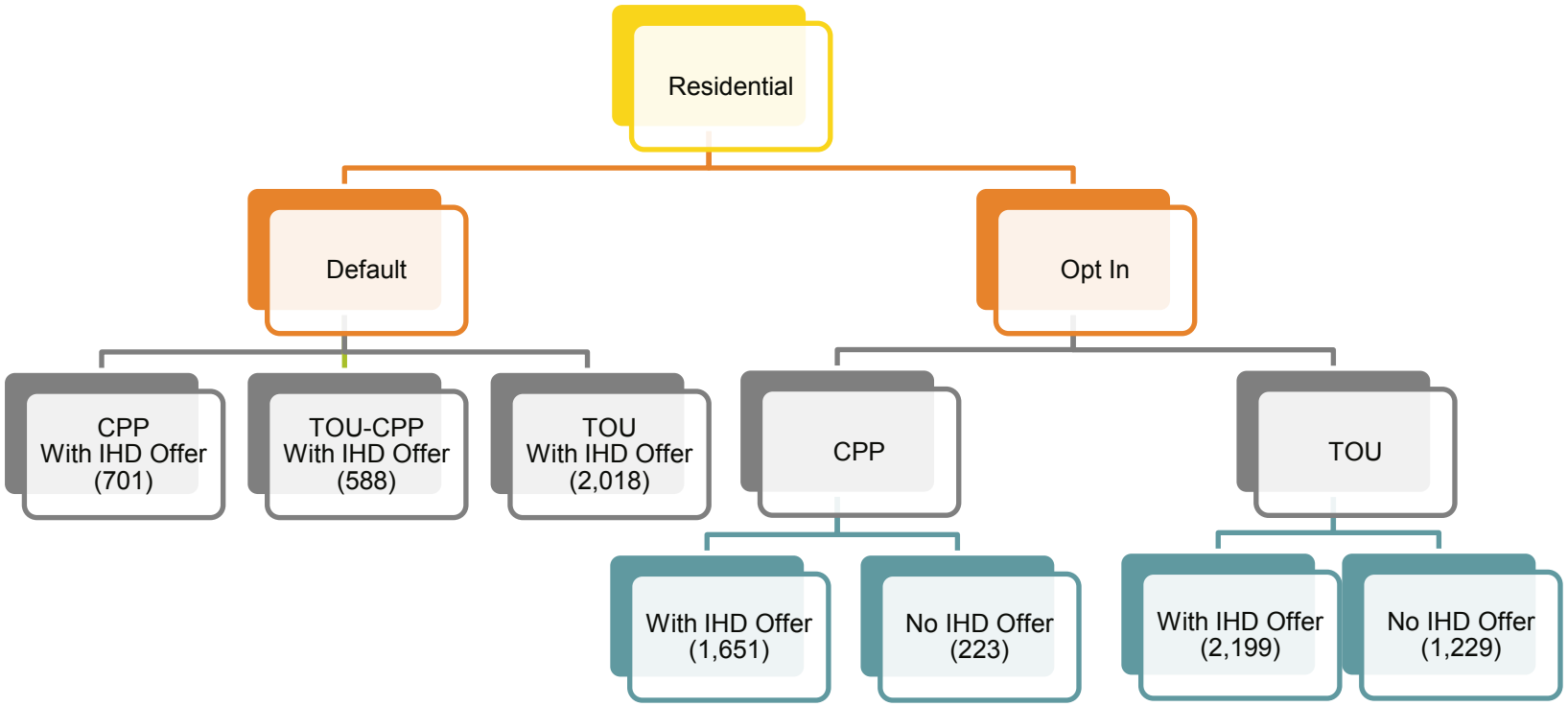
# Key features of SPO pilot & enrollment




Total enrollment including deferred groups = 12,027; Total # of customers receiving offers (including deferred groups) = 53,798;
Total # of customers in SPO including controls = 99,661

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# SmartPricing Options

| Standard Residential CBS Rate | On-Peak Prices Weekdays: 4-7 PM | | Off-Peak Prices (All Other Hours) | | Monthly Service Charge |
|---|---|---|---|---|---|
| | Peak Price | Critical Peak Price | Tier 1 | Tier 2 | |
| Time-Of-Use Peak Rate | $0.27 | $0.00 | $0.0846 | $0.1660 | $10.00 |
| Time-Of-Use with Critical Peak Pricing | $0.27 | **$0.75** | **$0.072** | $0.1411 | $10.00 |
| Critical Peak Pricing (Stand-Alone) | $0.00 | **$0.75** | $0.0851 | $0.1665 | $10.00 |

| Low Income Residential CBS Rate | On-Peak Prices Weekdays: 4-7 PM | | Off-Peak Prices (All Other Hours) | | | Monthly Service Charge |
|---|---|---|---|---|---|---|
| | Peak Price | Critical Peak Price | Tier 1 | Tier 2 | Tier 3 | |
| Time-Of-Use Peak Rate | $0.20 | $0.00 | $0.0550 | $0.1162 | $0.1660 | $3.50 |
| Time-Of-Use with Critical Peak Pricing | $0.20 | $0.50 | $0.0468 | $0.0987 | $0.1411 | $3.50 |
| Critical Peak Pricing (Stand-Alone) | $0.00 | $0.50 | $0.0553 | $0.1165 | $0.1665 | $3.50 |

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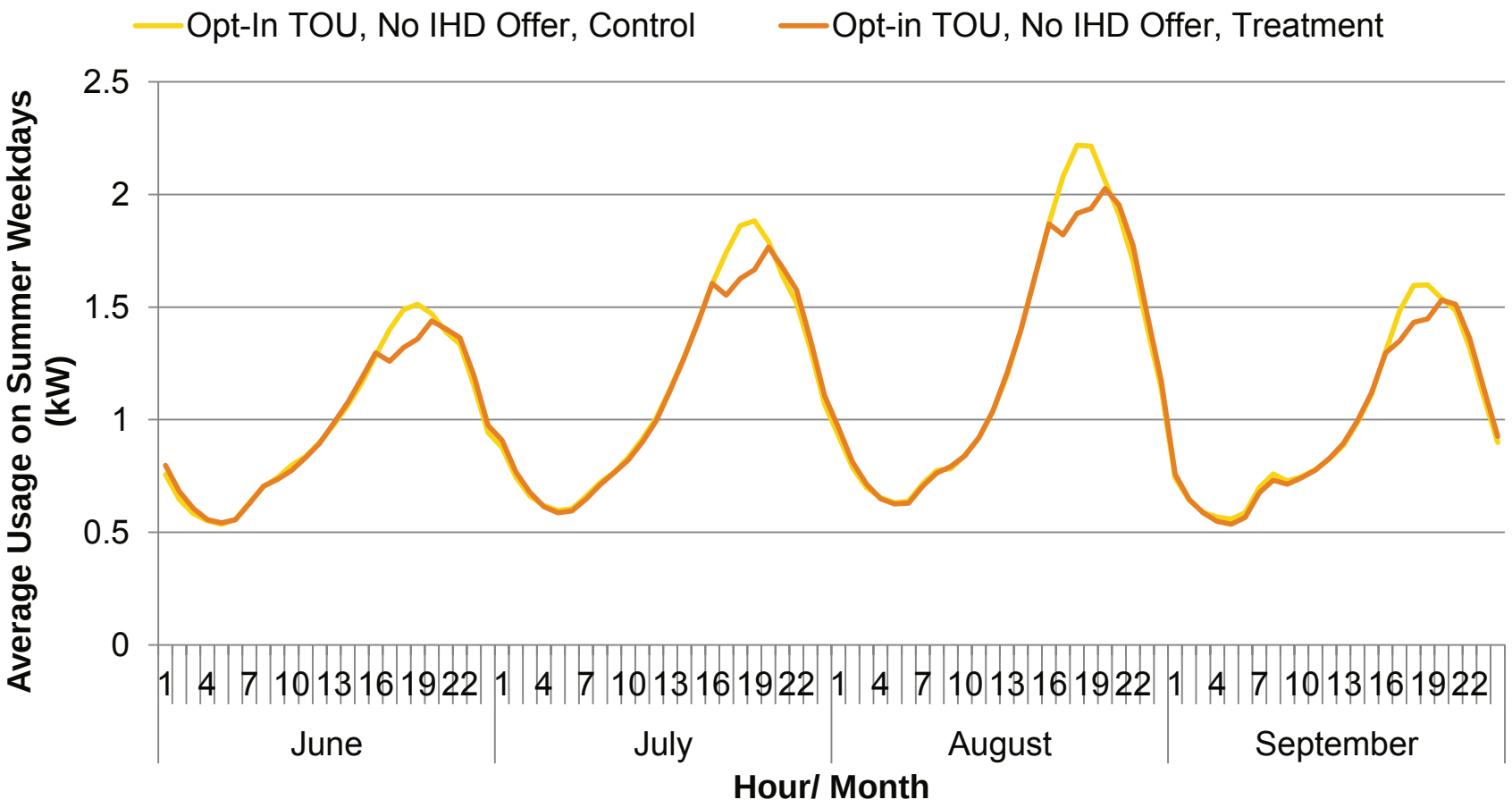
# Impacts For Opt-In TOU




*Results are quite similar for TOU with IHD offer treatment group

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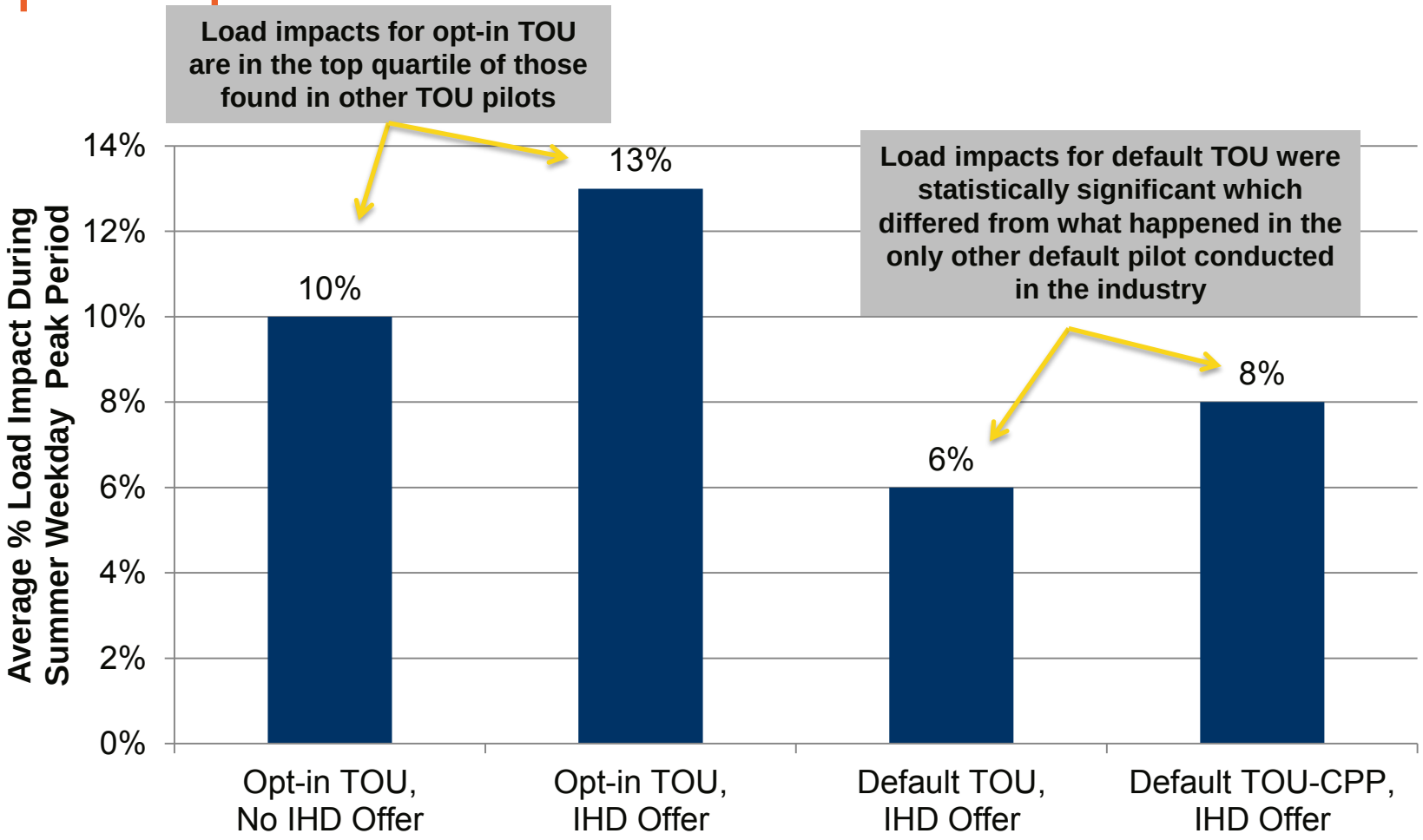
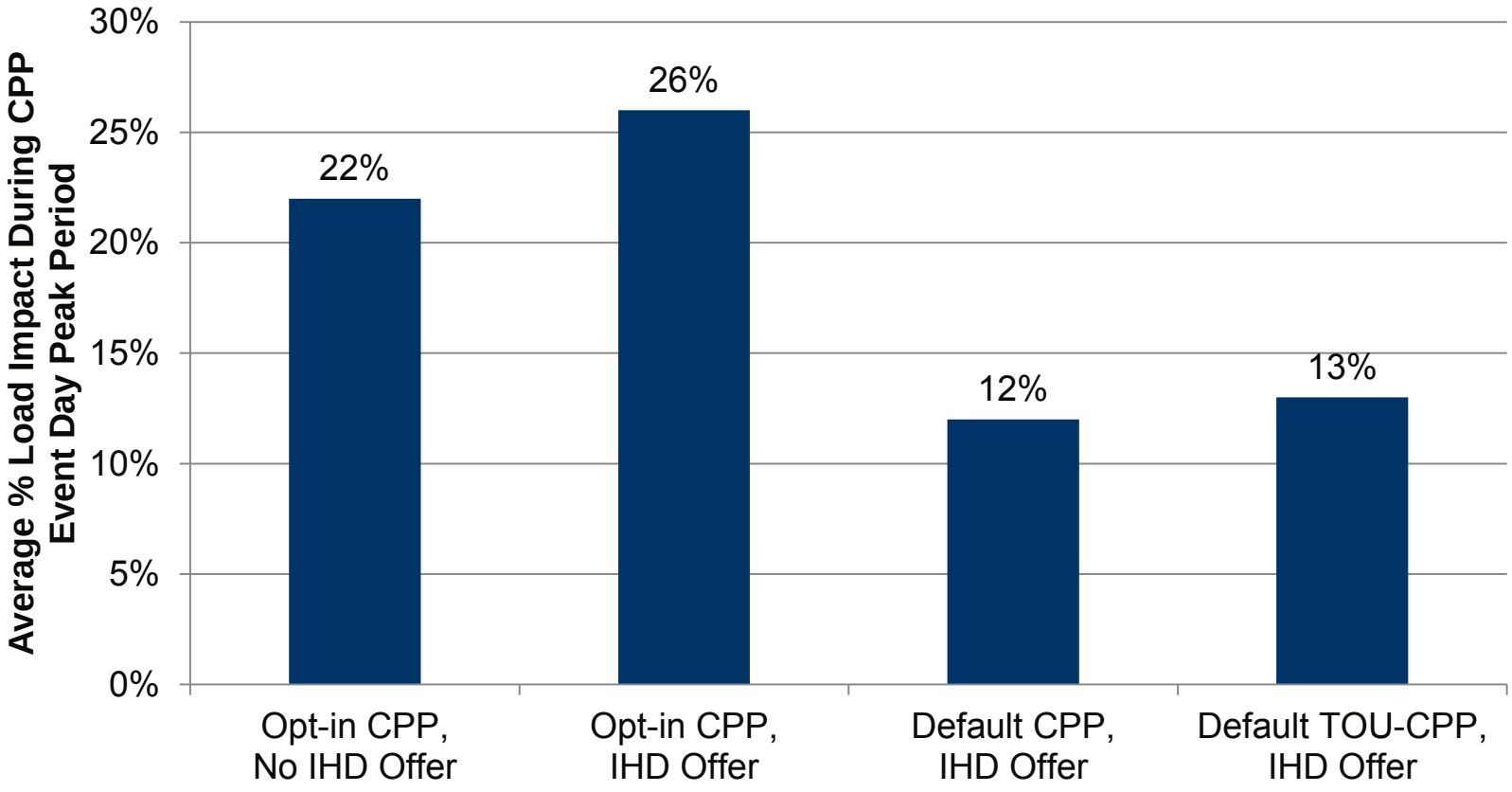
# % load reductions for TOU pricing plans were significant for both opt-in and default participants



# Peak load reductions for CPP pricing plans were significant for both opt-in and default participants



# Demand Response

- Procured and install a demand response management system (DRMS) software platform (Lockheed Martin SeeLoad)
- Implemented demand response pilots for residential customers-
  - 2012 PowerStat pilot (180 homes, pre-cooling strategy)
  - 2013 PowerStat pilot (825 homes, TOU-CPP rate, incentives paid per event, customer control or SMUD control)
- Developed and implemented an Automated Demand Response (AutoDR) program for medium and large commercial
  - 3.5 MW signed up
  - Program expanding in 2014

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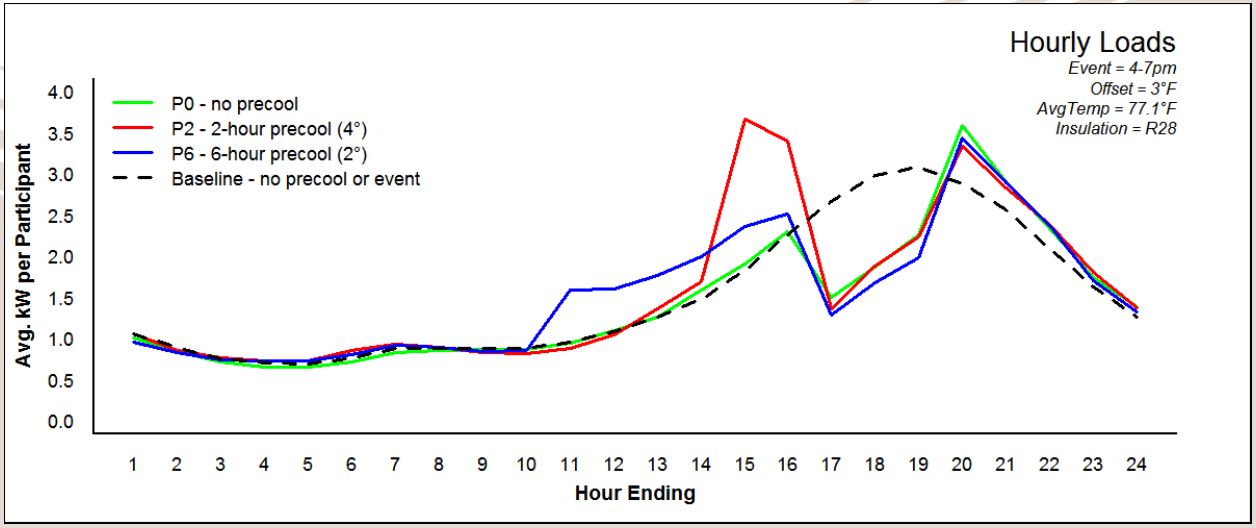
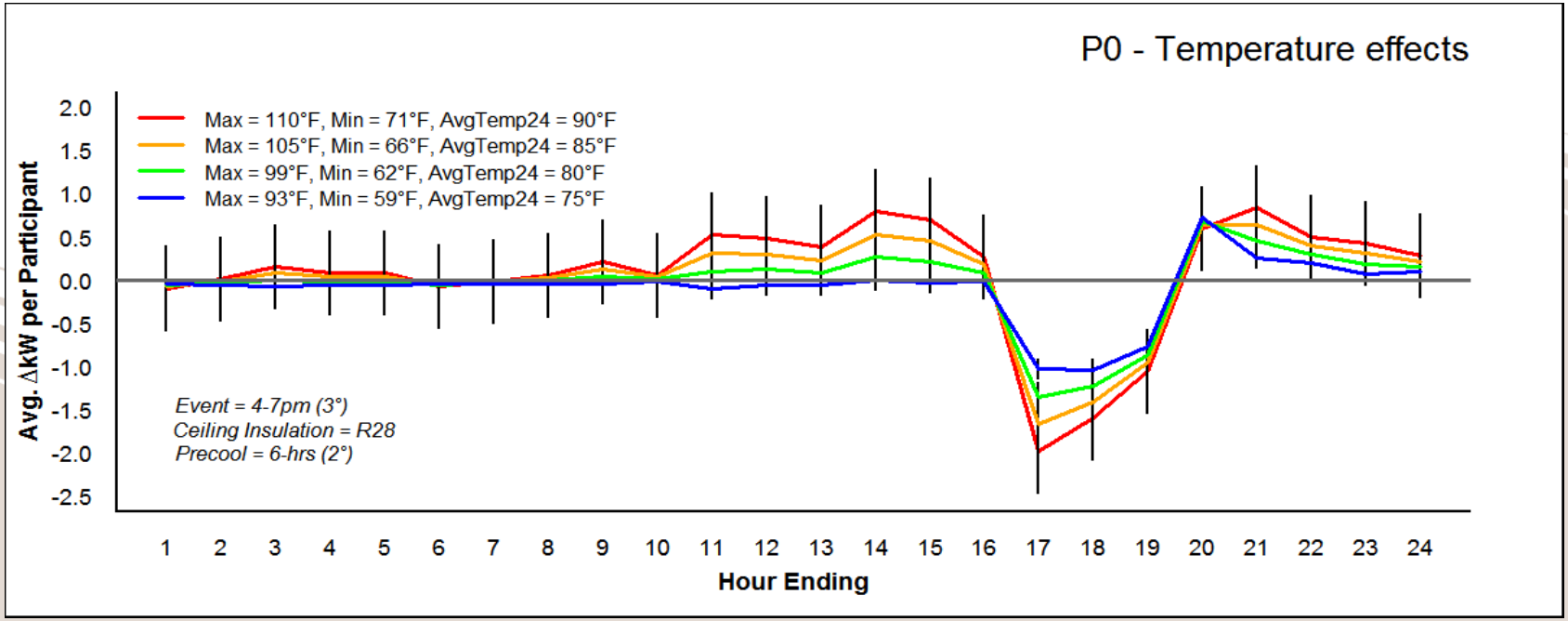
# PowerStat 2012

- Before the event, the 6 hour precool used significantly more energy
  - The 2 hour precool used the highest
- During the event, the 6 hour precool reduced the most
  - The 2 hour and no precool was similar
- After the event, no significant differences
- Total daily energy use was lowest under the no precool
  - The 2 hour and 6 hour precool was not statistically different



# How did the load impacts change with the outdoor temperature

- In all cases, results show that higher temperatures increase pre-peak and post peak loads and lower peak loads

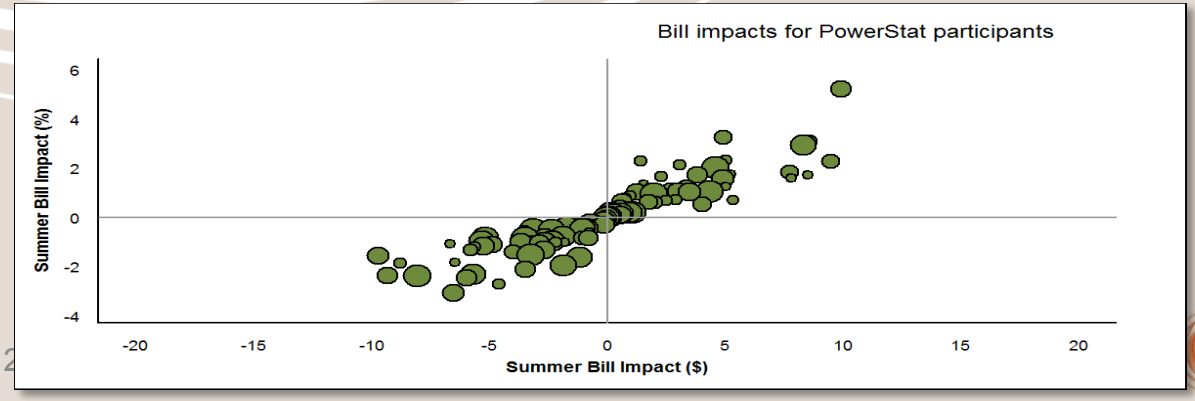


# Electric Bill Impacts

- Average monthly bill impacts for PowerStat® participants ranged from a $2 monthly bill savings (-1.2%) to a $0.55 monthly bill increase (+0.5%)

| Treatment | Average Monthly Bill Impact ($) | % Bill Impact |
|---|---|---|
| No Precool | - $2.03 | - 1.2 % |
| 2 hr precool | + $0.55 | + 0.5 % |
| 6 hr precool | - $0.20 | - 0.1 % |

- Bill impact estimates ranged from -$10 to $10 for the summer, representing between -3% and +5% of the August-September bills.



# Distribution Automation

- Automated 118 distribution feeders
- Implemented SCADA (supervisory control and data acquisition) at 40 existing substations
- Implemented VVO/CVR at two substations in 2011 and 14 subs in 2013-14
- Field tested Automatic Sectionalizing & Restoration control logic
- Upgraded Outage Management System - Integraph's OMS 8.2 and Mobile Thin Client
- Situational Awareness and Visualization Intelligence (SAVI) -- Distribution Dashboard
- Implemented an electronic wall map
- Outage Communication - designed and developed automated process for customer notification of outages

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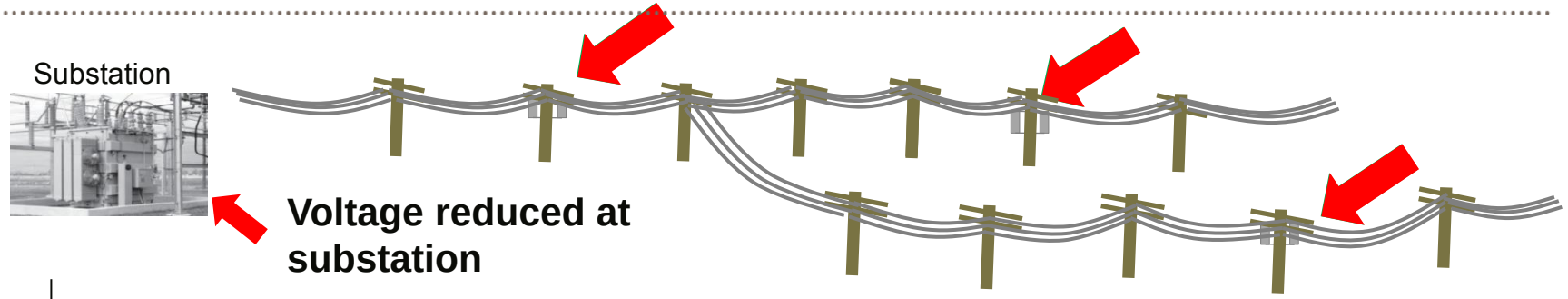
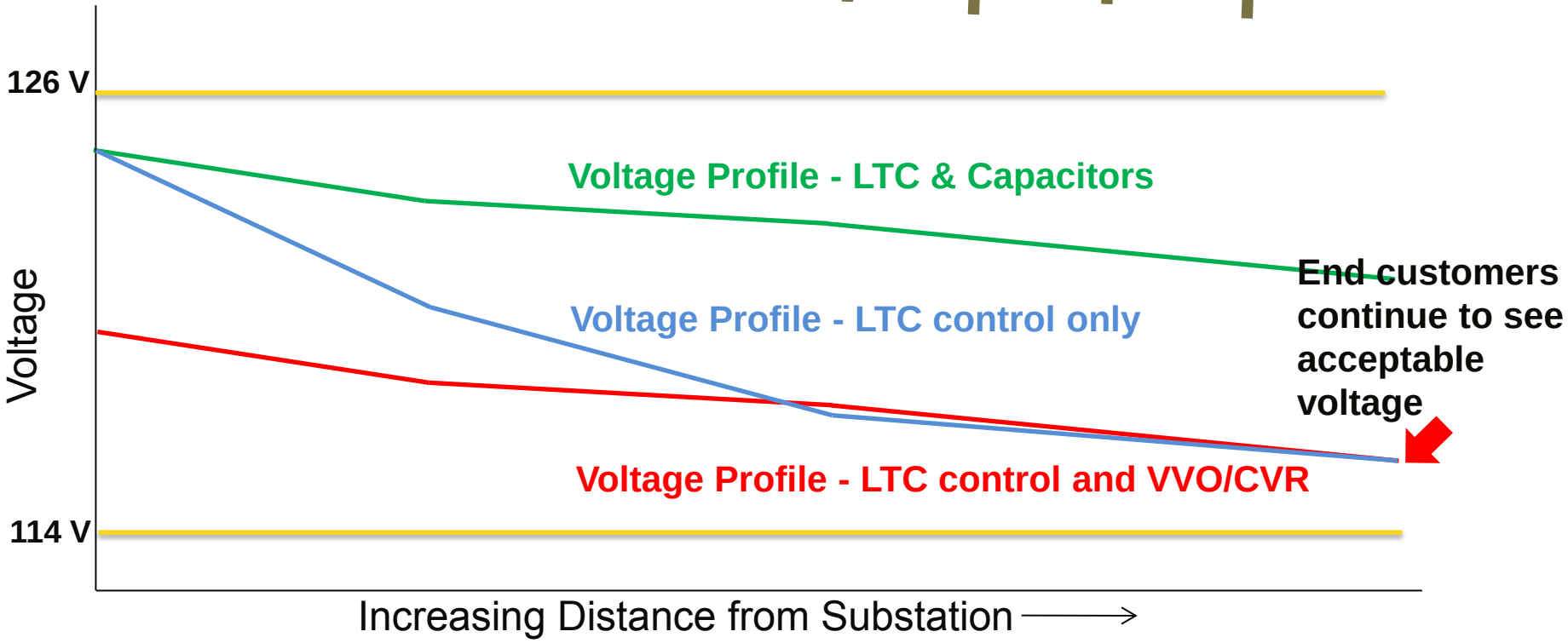
# VVO / CVR


Substation
Voltage reduced at substation


126 V
Voltage Profile - LTC & Capacitors
Voltage Profile - LTC control only
End customers continue to see acceptable voltage
Voltage Profile - LTC control and VVO/CVR
114 V
Voltage
Increasing Distance from Substation



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# CVR Impact Variation

- Impact of CVR varies depending on a variety of factors including load mix, load level, weather and season.

**Approx. Load Impacts (for 3% Voltage Reduction)**

| Load Type | Approx. Demand Reduction Range |
|---|---|
| Lighting - Incandescent | 5% |
| Lighting - Fluorescent Tube / CFL | 2-8% |
| Lighting - LED | 0-6% |
| LCD TV | 0% |
| Plasma TV | 0% |
| Air Conditioning - Conventional | 0.5-1.0% |
| SOURCE: PACIFIC NORTHWEST NATIONAL LABORATORY | |



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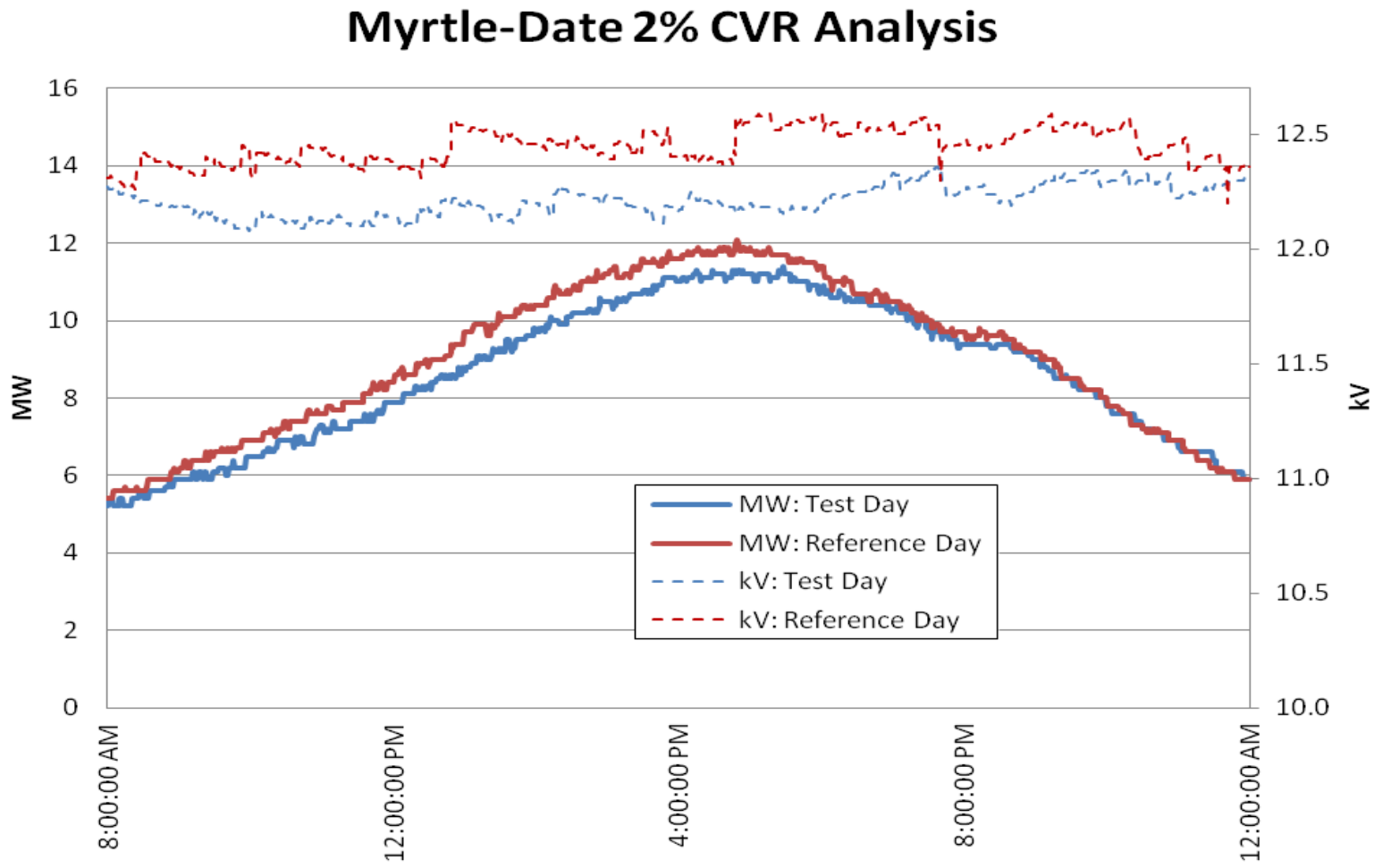
# 2011 Pilot Deployment - CVR Results



# Pilot Test Findings

- Pilot test results illustrated a range of potential impacts depending on individual feeder load response to a voltage reduction.

**Pilot Test Results for 2% Voltage Reduction**

| | Madison-Kenneth | Myrtle-Date |
|---|---|---|
| Ave Peak Demand | 15.0 MW | 12.4 MW |
| Avg Peak Demand Reduction | 150 kW (~1%) | 310 kW (~2.5%) |
| Avg Energy Impact* | 0.5 MWh | 4 MWh |

* Over 16 hour period



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# Situational Awareness and Visual Intelligence (SAVI)

- Provide a tool that would make data actionable
  - Implement a Dashboard for Distribution System Operators
    - Tool to geospatially display information from multiple source systems and allow for geospatial analysis
    - Ability to trend current and historical information

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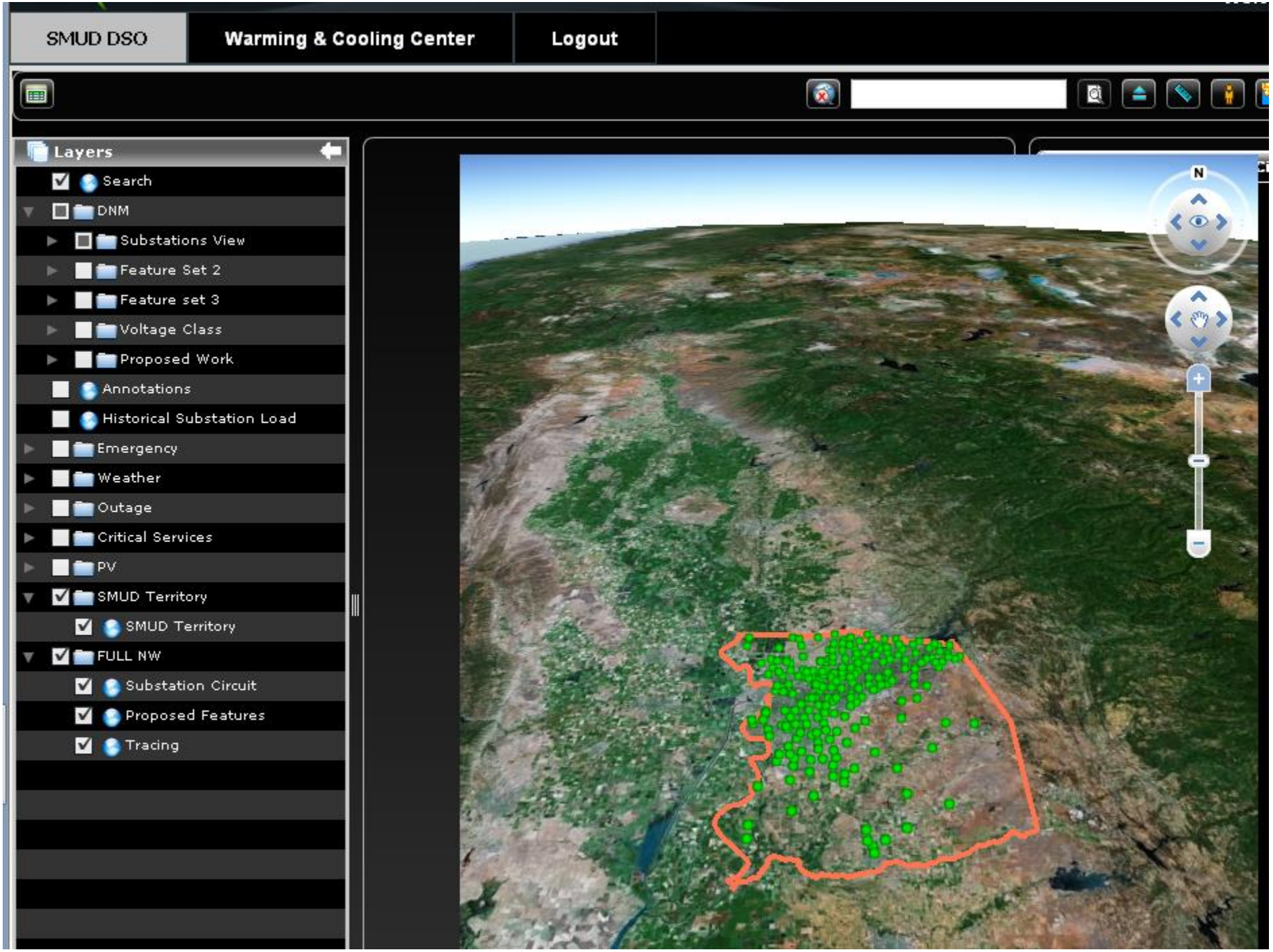
SMUD DSO
Warming & Cooling Center
Logout
Layers
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Substations View
Feature Set 2
Feature set 3
Voltage Class
Proposed Work
Annotations
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SMUD Territory
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FULL NW
Substation Circuit
Proposed Features
Tracing
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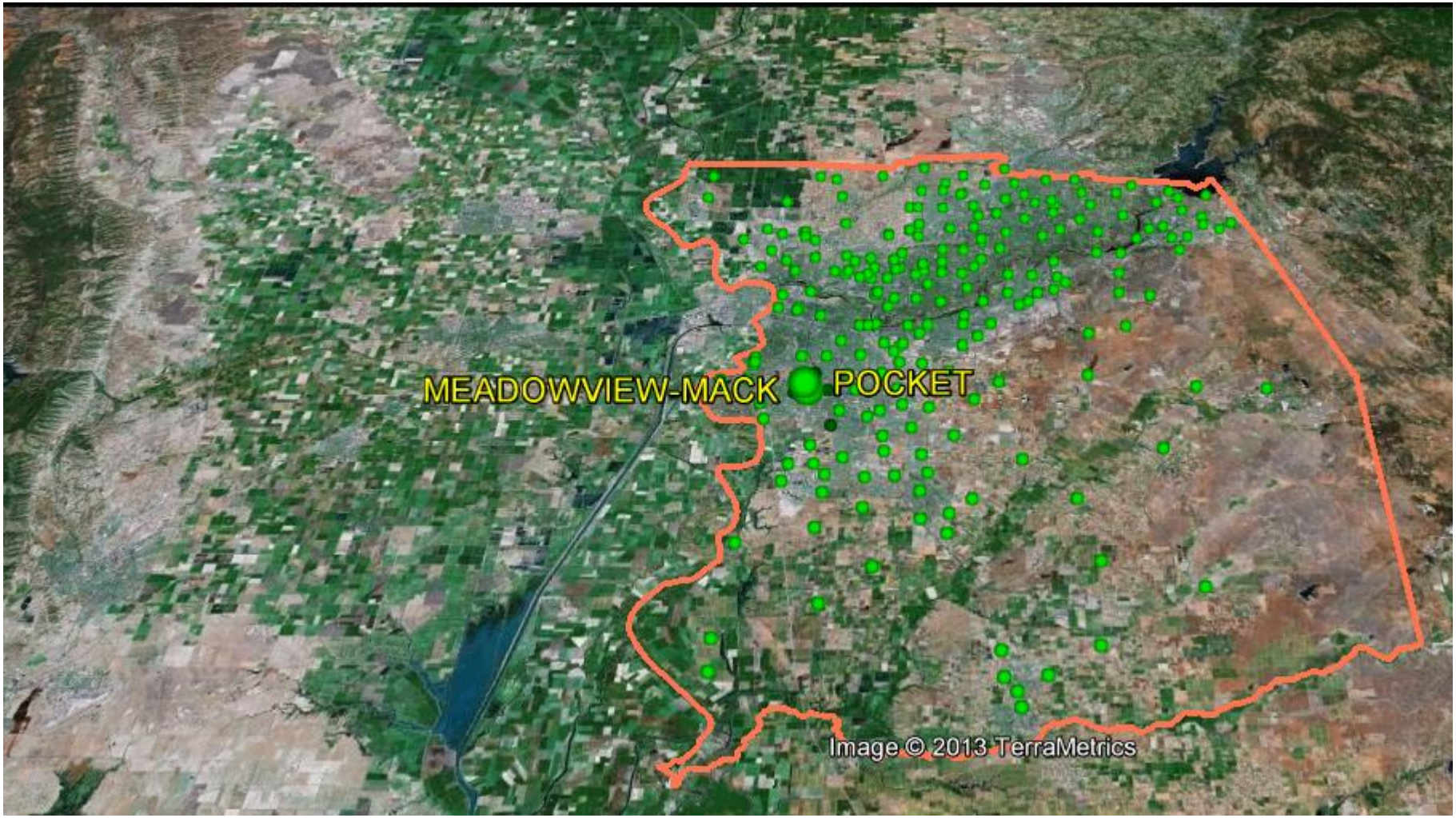


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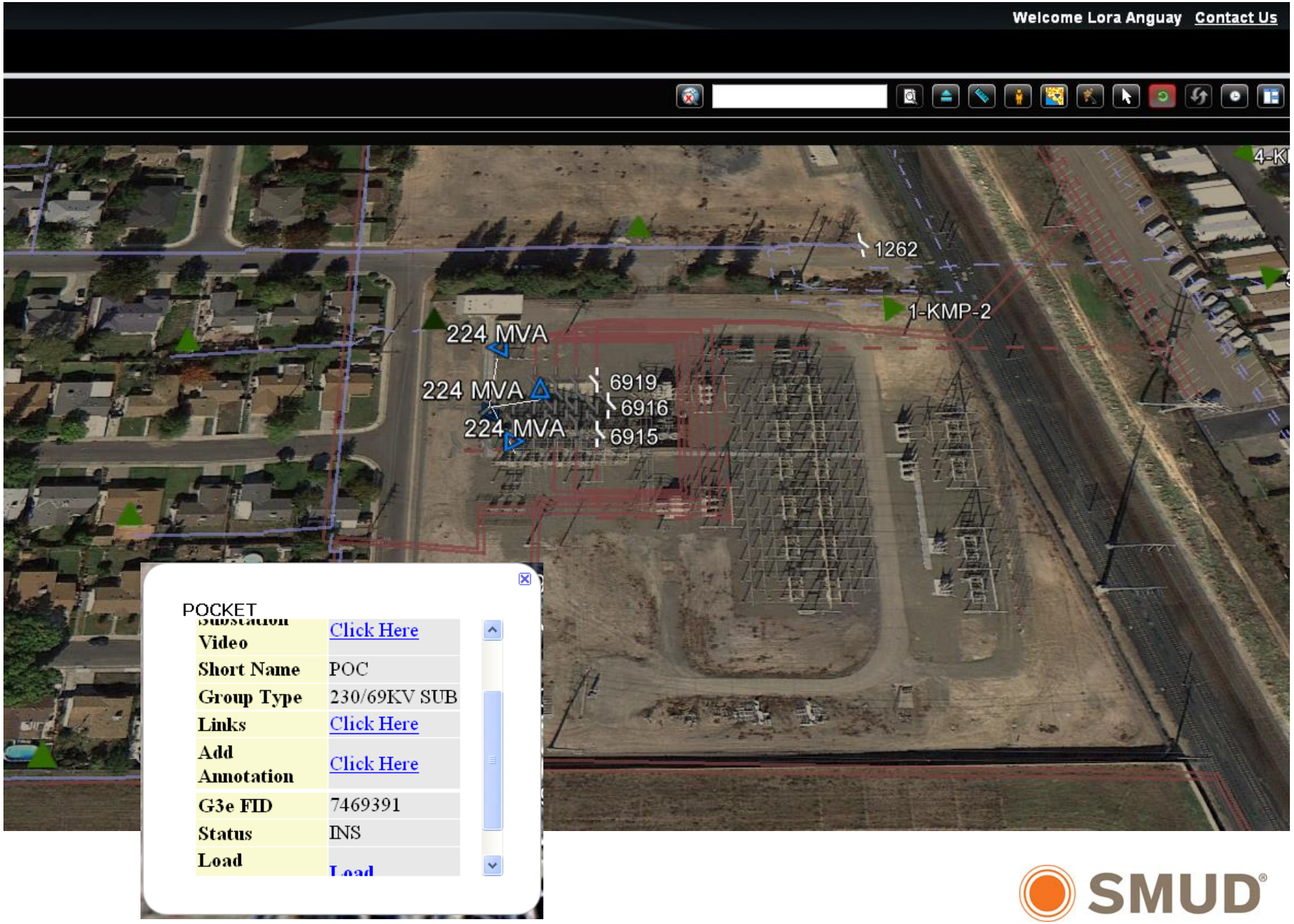
Welcome Lora Anguay
Contact Us
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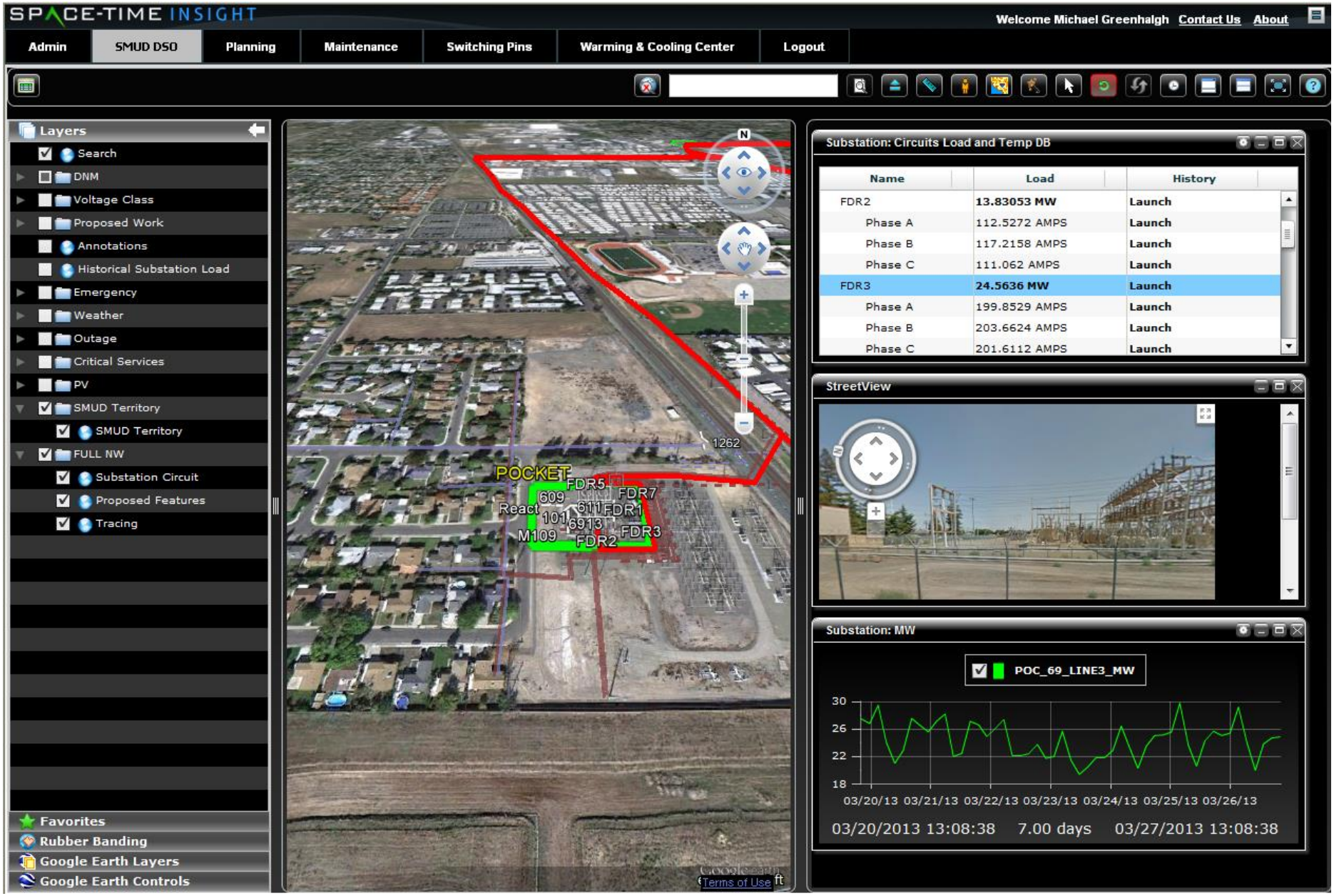
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Substation Circuit
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Tracing
Favorites
Rubber Banding
Google Earth Layers
Google Earth Controls
POCKET
FDR5
FDR7
609
React
611
FDR1
101
6913
FDR3
M109
FDR2
1262
Terms of Use
Substation: Circuits Load and Temp DB
Name
Load
History
FDR2
13.83053 MW
Launch
Phase A
112.5272 AMPS
Launch
Phase B
117.2158 AMPS
Launch
Phase C
111.062 AMPS
Launch
FDR3
24.5636 MW
Launch
Phase A
199.8529 AMPS
Launch
Phase B
203.6624 AMPS
Launch
Phase C
201.6112 AMPS
Launch
StreetView
Substation: MW
POC_69_LINE3_MW
30
26
22
18
03/20/13 03/21/13 03/22/13 03/23/13 03/24/13 03/25/13 03/26/13
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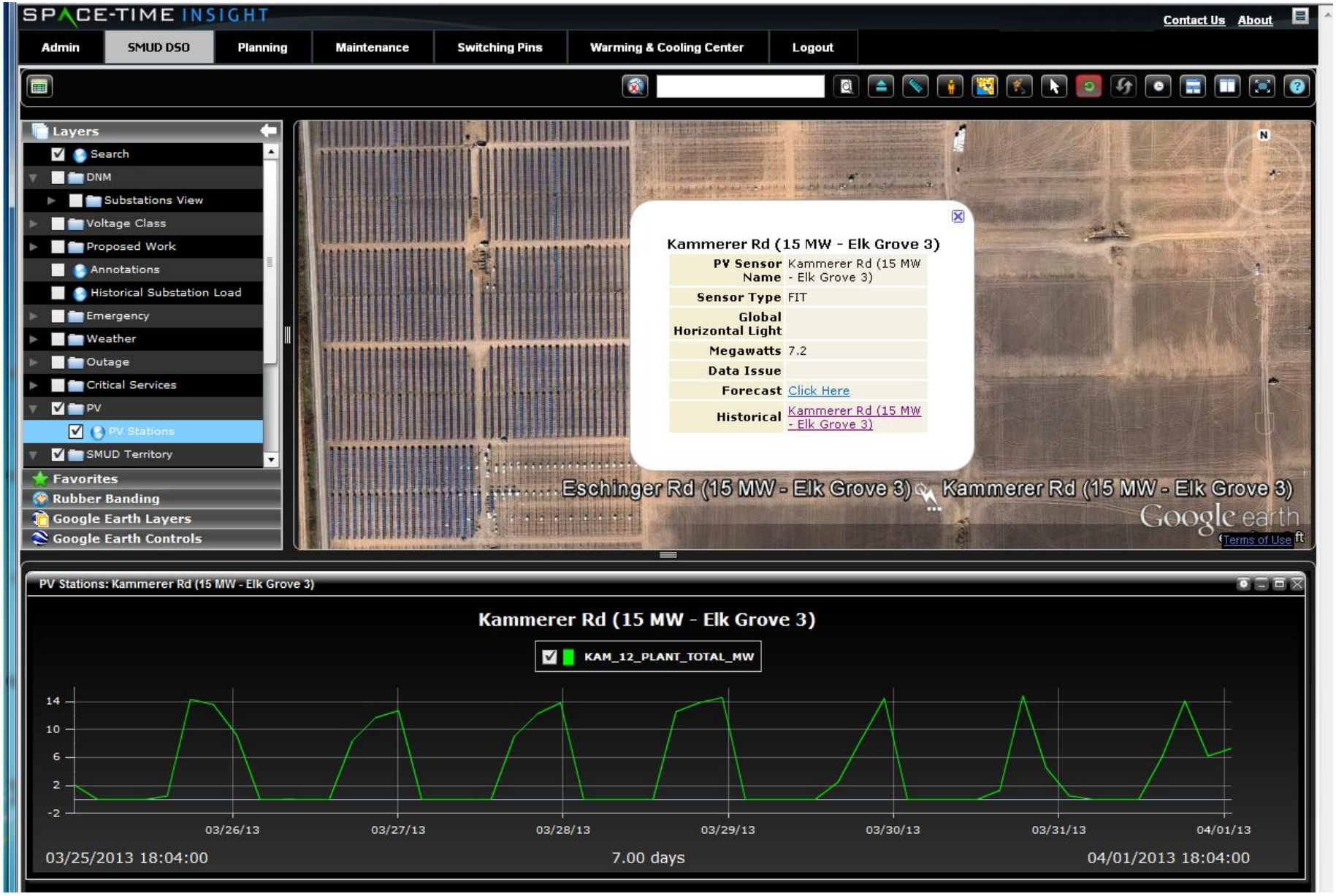
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Favorites
Rubber Banding
Google Earth Layers
Google Earth Controls
Kammerer Rd (15 MW - Elk Grove 3)
PV Sensor Name
Kammerer Rd (15 MW - Elk Grove 3)
Sensor Type
FIT
Global Horizontal Light
Megawatts
7.2
Data Issue
Forecast
Click Here
Historical
Kammerer Rd (15 MW - Elk Grove 3)
Eschinger Rd (15 MW - Elk Grove 3)
Kammerer Rd (15 MW - Elk Grove 3)
Google earth
Terms of Use
PV Stations: Kammerer Rd (15 MW - Elk Grove 3)
Kammerer Rd (15 MW - Elk Grove 3)
KAM_12_PLANT_TOTAL_MW
14
10
6
2
-2
03/26/13
03/27/13
03/28/13
03/29/13
03/30/13
03/31/13
04/01/13
03/25/2013 18:04:00
7.00 days
04/01/2013 18:04:00

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# Customer Services & Solutions

**Scope**

- Developed expanded energy information and education toolset to help customers manage their energy use
- Provided technology solutions allowing customers to control and automate their electric use
- Deployed six residential and small commercial pilots to assess effectiveness of various levels of technology, automation, control and education enabled by the smart grid in comparison to more traditional methods

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# Customer Services & Solutions

- Projects completed for residential and small commercial pilots: Smart Thermostats, Low Income Energy Management and IHD Check-Out Pilot
- Vendor selected for med-large C/I Energy Information & Tools (Energy Profiler Online by Schneider Electric), working on real-time pilot
- Rebate programs developed for C/I EMS and Advanced Lighting—EMS program finished, Lighting program still active
- Some projects cancelled due to timing or lack of available products—Residential Energy Management Systems, Controllable Appliances, HAN Usability Study

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# Advanced Lighting Program

- Provided rebates for the installation of advanced, controllable lighting systems
- Combined efficient lighting technologies (technology neutral—LED, fluorescent, HID, etc.) with control strategies
- Energy savings in the 50% to 90% range

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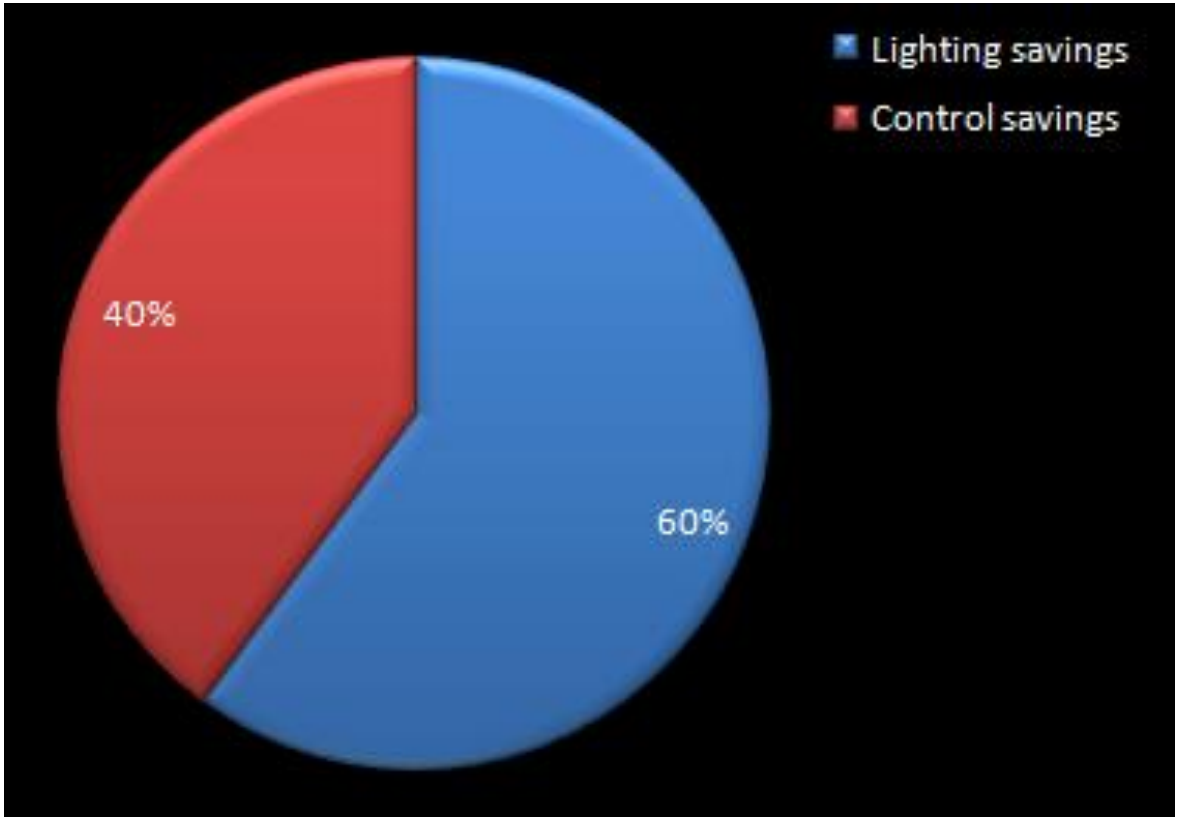
# A Glance at the Savings




| | |
|---|---|
| Savings from lighting upgrades: | 2,505,672 kWh / year |
| Savings from controls: | 1,661,322 kWh / year |
| Total estimated savings: | 4,166,994 kWh / year |

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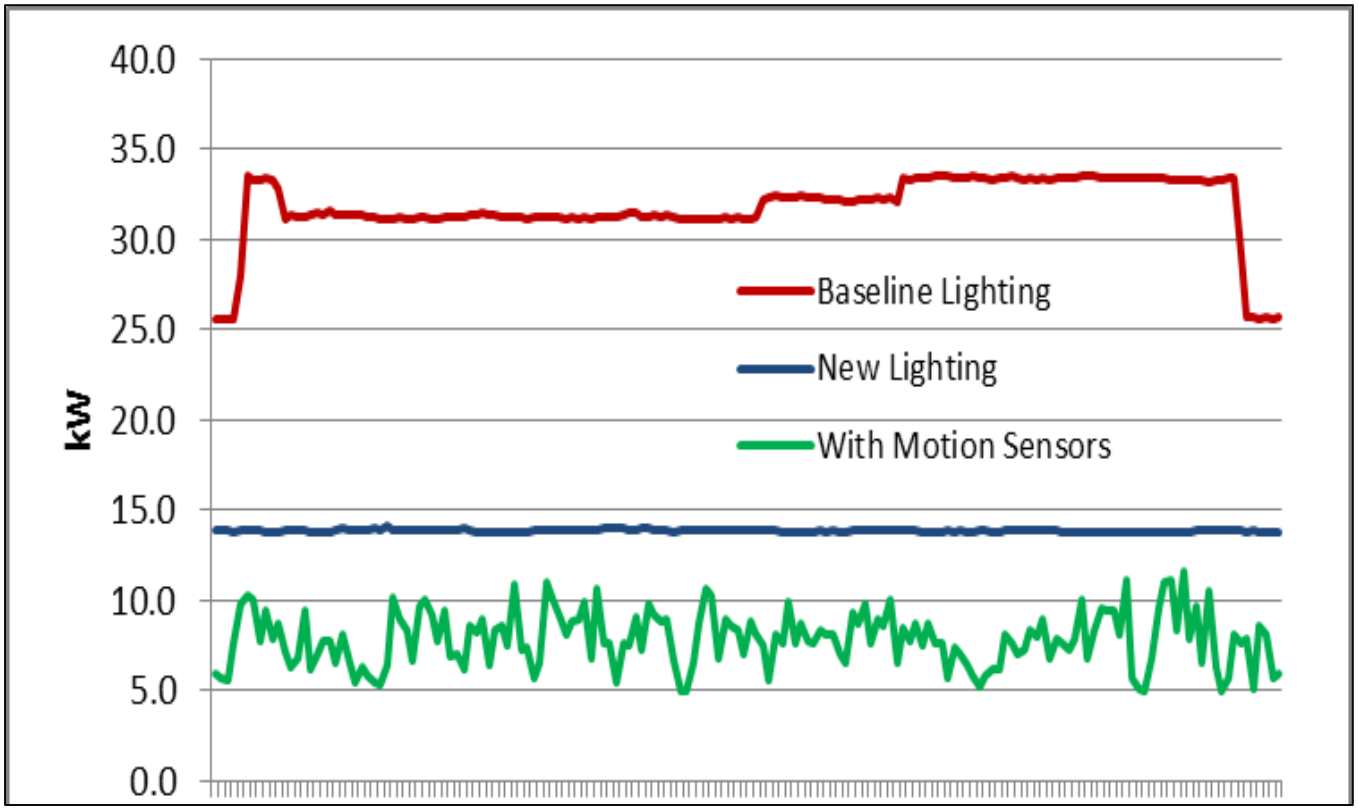
# Case Study Results




Lighting load profiles for pre-retrofit baseline, new baseline, and with motion sensors.

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# Technology Infrastructure


## Enterprise Service Bus

- Installed Enterprise Service Bus software platform to simplify integration of new smart grid systems and legacy systems
- Reduced the number, size, and complexity of integration interfaces between systems in order to reduce cost and improve speed of service to the customer

## Customer Relationship Management (CRM)

- Installed Customer Relationship Management System software that integrates customer service call center with back office billing system

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# Cyber Security

Scope

- Procure and install cyber security hardware and software to prevent attack, monitor attempted attacks, and continuously check for vulnerabilities
- Incorporate cyber security at all levels of upgraded/new systems

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# Lessons Learned

- Executive support is essential for large-scale projects
- Customer communication is critical
- Flexible scope and schedule is important
  - Some of our scope was hard and fast
  - Other parts were flexible
  - Flexibility allowed us to move things around when projects didn't work out as planned

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# Lessons Learned

- Data accuracy and timeliness is important
  - New applications allow highly detailed view of system
  - If data is bad, capabilities of advanced tools and applications cannot be fully realized
  - Results will not be reliable or timely

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# Lessons Learned

- Immature technologies--some of the smart grid products were not quite ready for broad-scale deployment:
  - Smart appliances were pulled from the market in the middle of our project
  - Certain software products were not as fully developed as expected (they are improving over time)
  - Early version products tend to be expensive and costs exceed benefits (some home controls/technologies)
- Products have come a long way, but there are still many early-stage products that need additional testing before being ready for prime time

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# Lessons Learned

- Heavily technology-dependent assets should be procured as close to implementation as possible
  - Product functionalities and capabilities are improving rapidly
  - Prices tend to come down over time
- Vendors sometimes overpromised and under-delivered

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# Next Steps

- Still a lot of work to do.  Some projects implemented at 100% level (smart meters), others at a much lower level (automated feeders at 18%).
- Complete SmartSacramento project (over 99% complete, wraps up by 12/23/14)
- Develop Smart Grid Roadmap to guide future smart grid deployments

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# Next Steps - Roadmap

- Issued an RFP 8-Oct 2014 to hire a consultant to 1) evaluate SmartSacramento and 2) develop a smart grid roadmap
- Evaluation summary
  - Summarize existing evaluations (12)
  - Evaluate additional projects (11)
  - Summarize all evaluations into a single SmartSacramento evaluation

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# SGIG Evaluations - Completed and Proposed

| Project Name | Evaluation Performed? | Evaluation Required? | Level of Effort |
|---|---|---|---|
| AMI | Yes | No | Already evaluated. Incorporate findings in final report. |
| SCADA | No | Yes | High-level evaluation of benefits compared to costs. |
| Line Automation | No | Yes | Already evaluated. Incorporate findings in final report. |
| CVR | Yes | No | Already evaluated. Incorporate findings in final report. |
| ASR | No | Yes | Evaluate benefits compared to costs and future potential. |
| SAVI | No | Yes | Identify benefits and potential value. |
| OMS Upgrade | No | Yes | Evaluate benefits vs cost. |
| PI | No | Yes | Evaluate benefits vs cost. |
| Outage Communication Tool | No | Yes | Look at benefits and future needs/potential. |
| Integrated T&D Modeling | No | Yes | Look at benefits compared to current modeling tool. |
| Mobile Data Terminal Replacement | No | No | No need to evaluate under this contract. |
| SmartPricing Options | Yes | No | Already evaluated. Incorporate findings in final report. |
| DRMS | No | Yes | High level look at benefits and long-term capabilities. |
| PowerStat 2012 | Yes | No | Already evaluated. Incorporate findings in final report. |
| PowerStat 2013 | Yes | No | Already evaluated. Incorporate findings in final report. |
| Auto DR | Yes | No | Already evaluated. Incorporate findings in final report. |
| Partner Projects | No | No | No need to evaluate under this contract. |
| Smart Charging Pilot | Yes | No | Already evaluated. Incorporate findings in final report. |
| Smart Thermostats | Yes | No | Already evaluated. Incorporate findings in final report. |
| Low-Income Weatherization | Yes | No | Already evaluated. Incorporate findings in final report. |
| In-Home Display Checkout | Yes | No | Already evaluated. Incorporate findings in final report. |
| Commercial EMS | No | No | No need to evaluate under this contract. |
| Res Smart Community | Yes | No | Evaluation underway. |
| Advanced Controllable Lighting | Yes | No | Already evaluated. Incorporate findings in final report. |
| Commercial Energy Information and Tools | No | Yes | High level look at what will be needed in the future as we progress with smart grid projects. |
| Enterprise Service Bus | No | No | No need to evaluate under this contract. |
| CRM | No | No | No need to evaluate under this contract. |
| Revenue Protection Detection Software | No | Yes | Look at the benefits compared to costs. |
| Cyber Security | No | No | No need to evaluate under this contract. |

| |
|---|
| 11 potential new evaluations |
| 12 Completed evaluations that need to be reviewed and results incorporated into the Roadmap/Evaluation report |
| 6 projects without evaluations and no plans to complete evaluations under this contract |

# Next Steps - Roadmap

- Develop a smart grid roadmap that incorporates SmartSacramento lessons learned and current best practices
- The plan will include:
  - Evaluation results
  - Proposed new project descriptions, benefits, risks, budgets, staffing impacts
  - Relative project priority
  - Gap analysis
- Roadmap completion expected in June 2015

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# After the Roadmap

- Review project recommendations
- Develop business cases as needed
- Look for projects with positive ROI or where there is a compelling business need
- Request budget and resources to implement viable projects

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# Smart Grid Vision


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# Discussion and Questions

Jim Parks
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# Smart Grid R&D




| SMUD Smart Grid Projects | | | | | | |
|---|---|---|---|---|---|---|
| # | Project Name | Budget | DOE | CEC | 3rd Party | SMUD $ |
| 1 | AMI | $ 145.2 | | | | $ 85.7 |
| 2 | DA | $ 58.6 | | | | $ 34.6 |
| 3 | Smart Pricing Options | $ 11.6 | | | | $ 6.9 |
| 4 | Customer Applications | $ 53.7 | | | $ 18.3 | $ 10.1 |
| 5 | Demand Response | $ 9.7 | | | | $ 5.7 |
| 6 | Technology Infrastructure | $ 27.1 | | | | $ 16.0 |
| 7 | Cyber Security | $ 1.7 | | | | $ 1.0 |
| **Total SGIG Projects** | | **$ 307.7** | **$ 127.5** | **$ 1.0** | **$ 18.3** | **$ 159.9** |
| **R&D Projects** | | | | | | |
| # | Project Name | Budget | DOE | CEC | 3rd Party | SMUD $ |
| 8 | Anatolia PV & Energy Storage Integration | $ 6.0 | $ 4.3 | $ 0.5 | | $ 1.0 |
| 9 | Flow Batteries Distributed Storage | $ 3.9 | $ 6.1 | $ 0.2 | $ 4.8 | $ 1.4 |
| 10 | Microgrid Field Demonstration | $ 3.0 | | $ 1.6 | | $ 1.4 |
| 11 | Electric Transportation Infrastructure GM | $ 4.0 | $ 2.0 | $ 0.6 | $ 0.2 | $ 1.2 |
| 12 | Electric Transportation Infrastructure Chrysler | $ 0.4 | $ 0.2 | $ 0.1 | | $ 0.1 |
| 13 | EV Impact Study | $ 0.5 | | | $ 0.1 | $ 0.4 |
| 14 | Residential Information and Controls Pilot | $ 0.9 | | | $ 0.4 | $ 0.5 |
| 15 | Smart Controls in Multifamily | $ 0.5 | | $ 0.3 | | $ 0.2 |
| 16 | PV System Advanced Inverter & Storage | $ 3.3 | | $ 2.0 | $ 0.2 | $ 1.1 |
| 17 | Simply Solar | $ 9.0 | $ 1.5 | $ 0.1 | $ 6.6 | $ 0.8 |
| 18 | High Penetration PV (CPUC) | $ 3.7 | | | $ 2.1 | $ 1.6 |
| 19 | New Hope Dairy Digester | $ 3.1 | $ 0.5 | $ 0.1 | $ 2.6 | |
| 20 | Warmerdam Dairy Digester | $ 5.0 | $ 0.7 | $ 0.1 | $ 4.2 | |
| **Total R&D Projects** | | **$ 43.3** | **$ 15.3** | **$ 5.5** | **$ 21.2** | **$ 9.8** |
| **Grand Total** | | **$ 351.0** | **$ 142.8** | **$ 6.5** | **$ 39.5** | **$ 169.7** |

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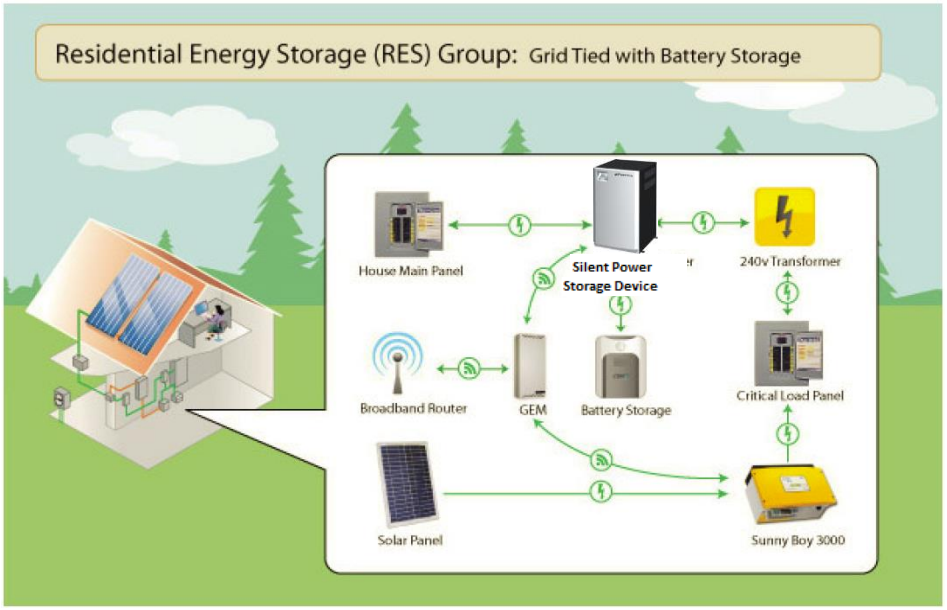
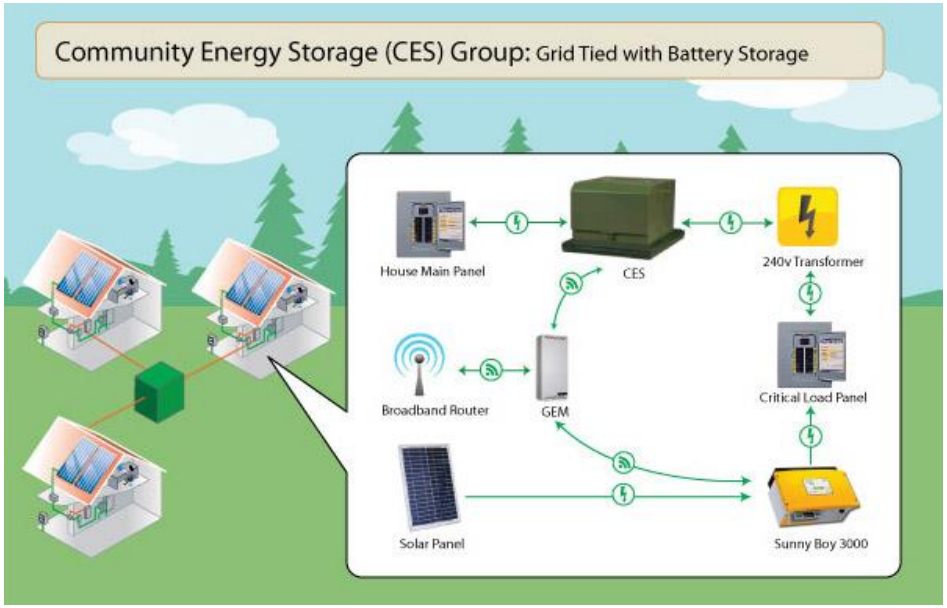
# SMUD PV & Smart Grid Pilot at Anatolia

## High Penetration Solar Development




- **Anatolia SolarSmart$^{SM}$ Homes Community (280 homes)**
  - High building efficiency measures
  - 2kW PV systems
- **Installed 15 RES (10kW/8.8kWh) and 3 CES (30kW/30kWh) units**
- Will firm renewables, reduce peak load and improve reliability
- Installed utility and customer portals to monitor PV, storage, customer load
- Sent price signals to affect changes in customer usage
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

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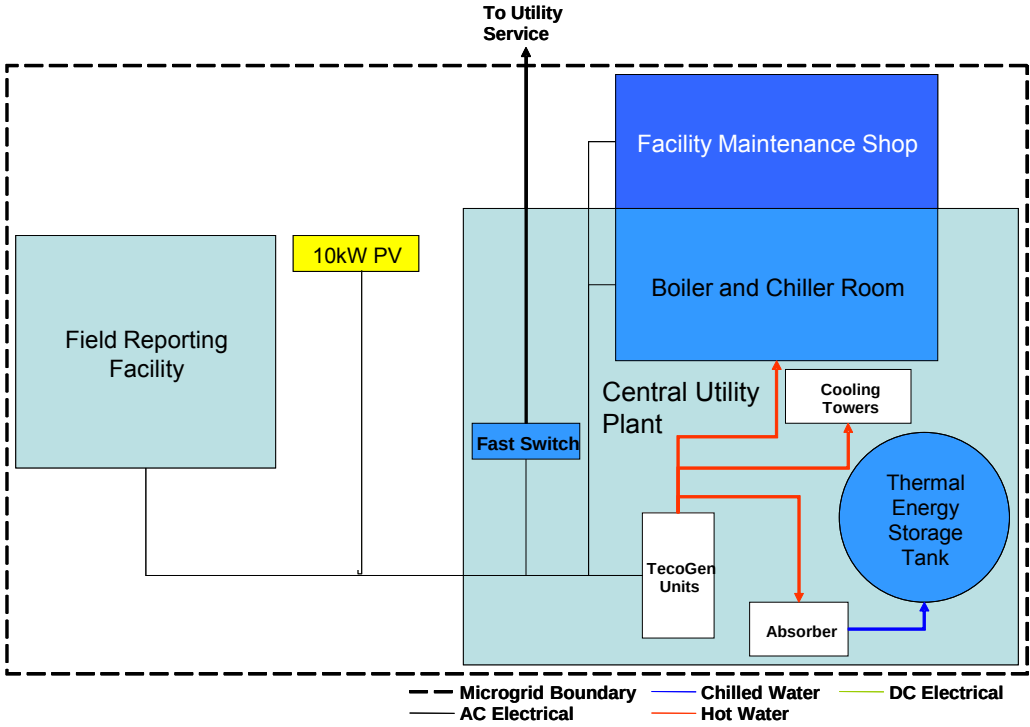
# SMUD Microgrid Project Overview

310kW demo of Microgrid concept
for our central utility plant and Field Reporting Facility

- 3-100kW natural gas engines
- 10kW PV
- Absorption chiller
- Seamless separation and isolation from utility grid and resynchronization


- 2 centrifugal chillers (600 ton and 200 ton)
- 2 boilers
- 15,000 ton-hour chilled water energy storage (760,000 gallons)

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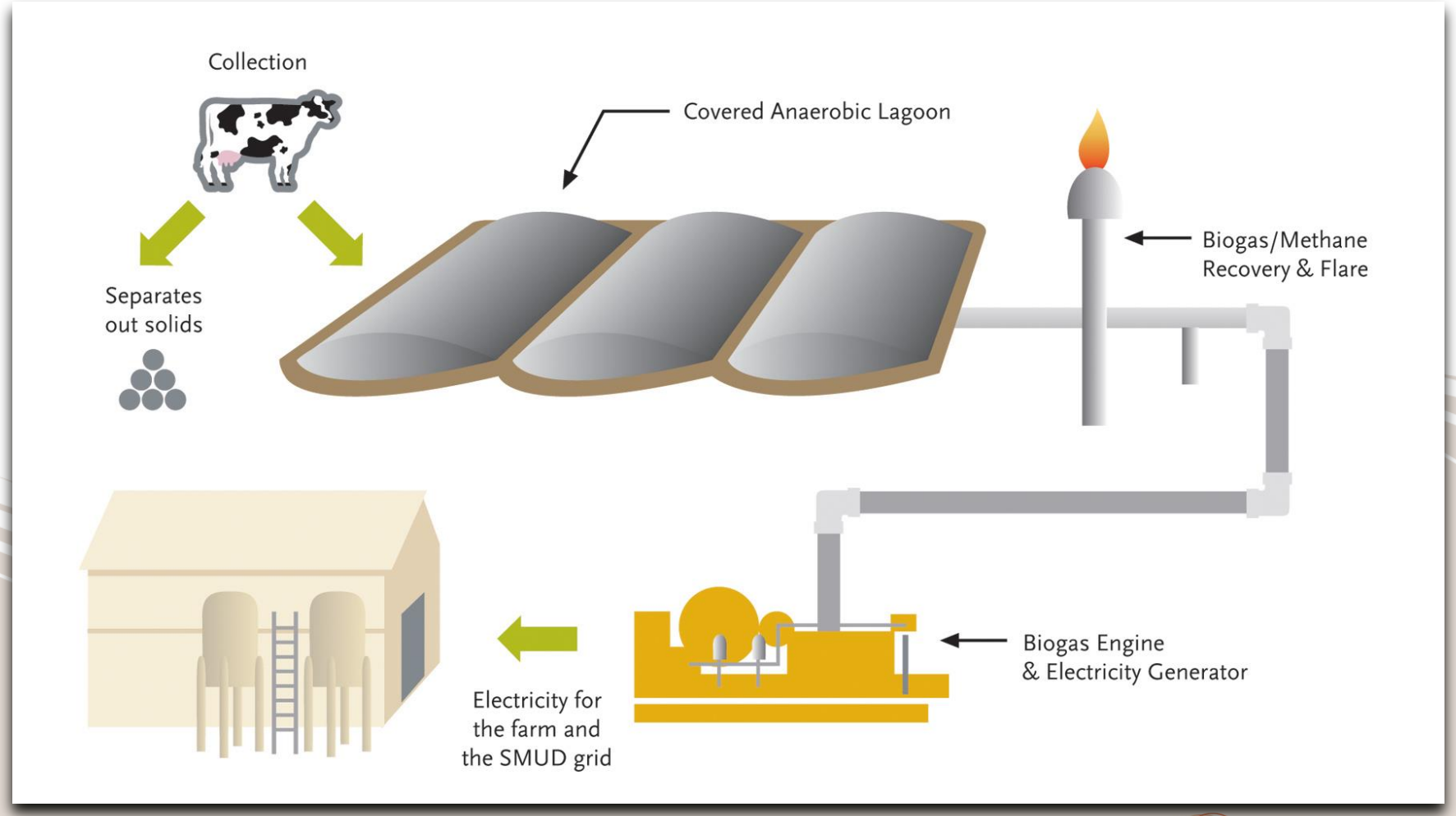
# Dairy Manure Digesters

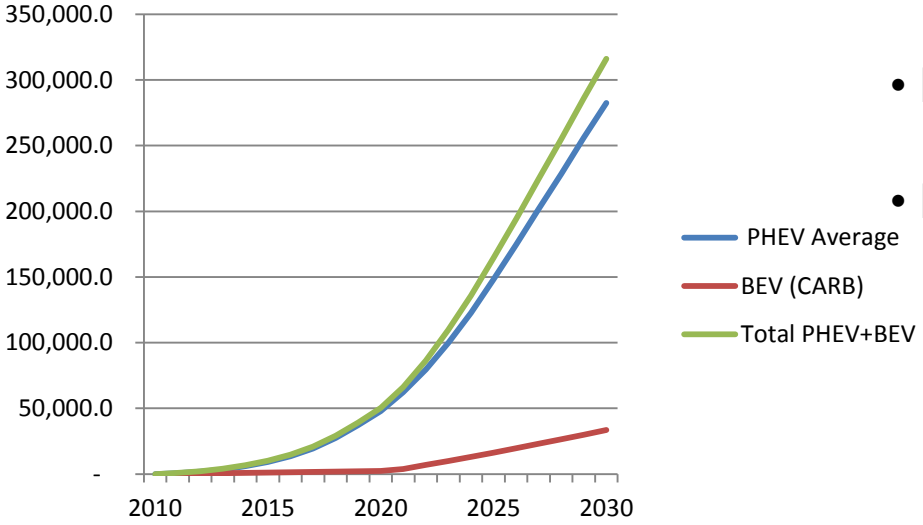


# Dairy Digester Projects

- Warmerdam Dairy
  - 600 kW with Selective Catalyst Reduction (SCR), covered lagoon digester
  - About 1,200 milk cows
  - Completion Q1 2013

- New Hope Dairy
  - 450 kW SCR above ground, high solids tank digesters
  - Complies with strictest NOx and SOx emission limits
  - 1,200 milk cows
  - Completion Q1 2013

# Electric Vehicle Potential Load Impacts




- Load becomes significant around 2025
- Local distribution impacts will be felt sooner
  - Will need to manage load

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 |



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