California Energy Commission
DOCKETED
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TN 71941
AUG 26 2013

SMUD's Preparations For 2030 And Beyond

Tim Tutt

Presented to California Energy Commission
Electricity System Needs Workshop
August 19th, 2013

Powering forward. Together.

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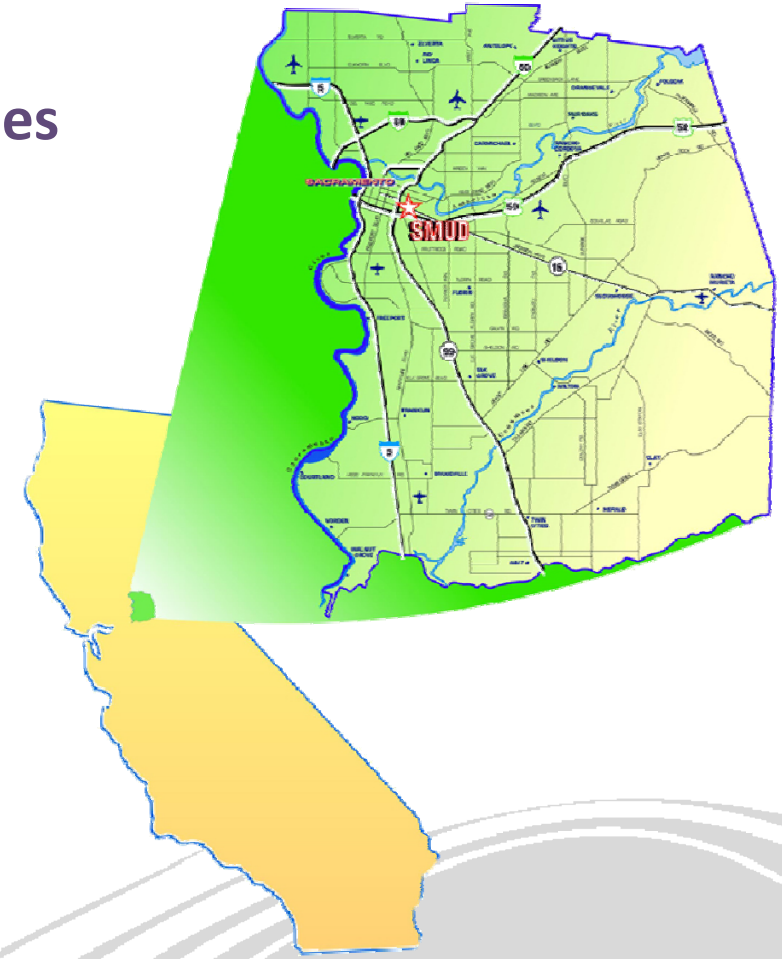
- **Fifth Largest California Utility; 3300 MW Peak, 11,000 GWh Sales**
- **Publicly-Owned; Governed By Seven Member Elected Board**
- **Board Adopted Goals**
  - **33% Renewables By 2020**
  - **15% Efficiency Savings**
  - **90% Reduction In GHG Emissions By 2050**



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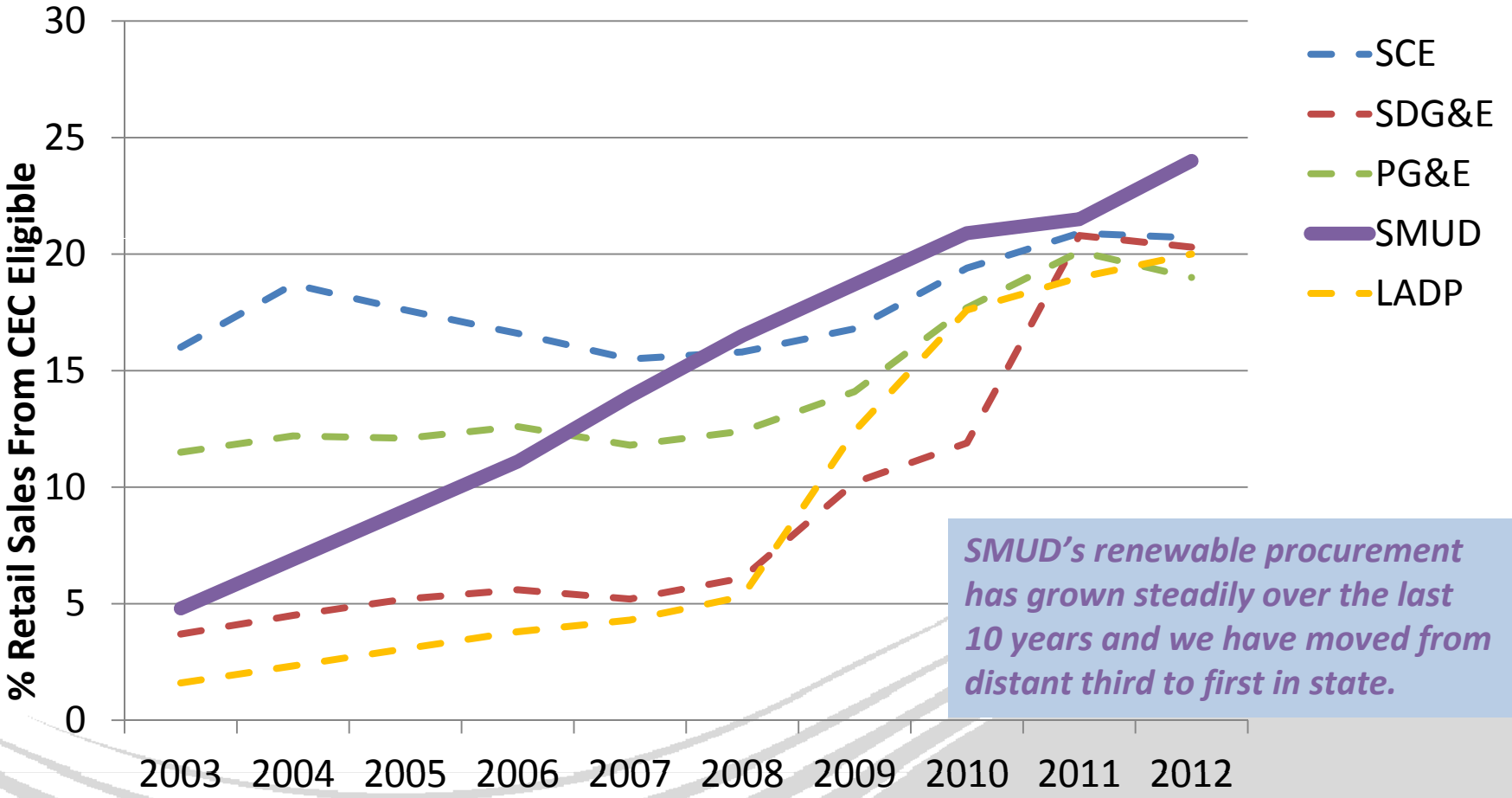
Renewable Procurement As % Retail Sales For the Five Largest Utilities In California



SMUD's renewable procurement has grown steadily over the last 10 years and we have moved from distant third to first in state.

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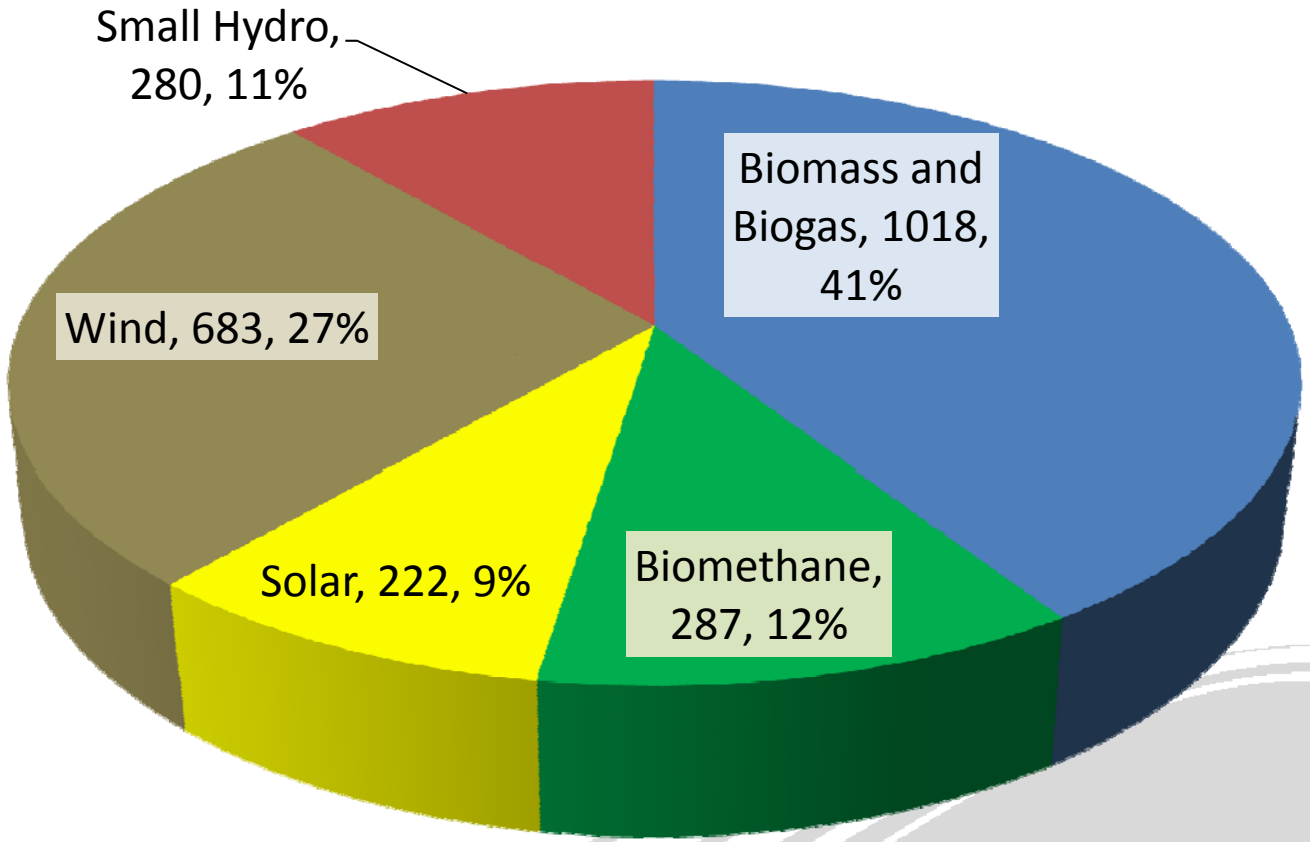
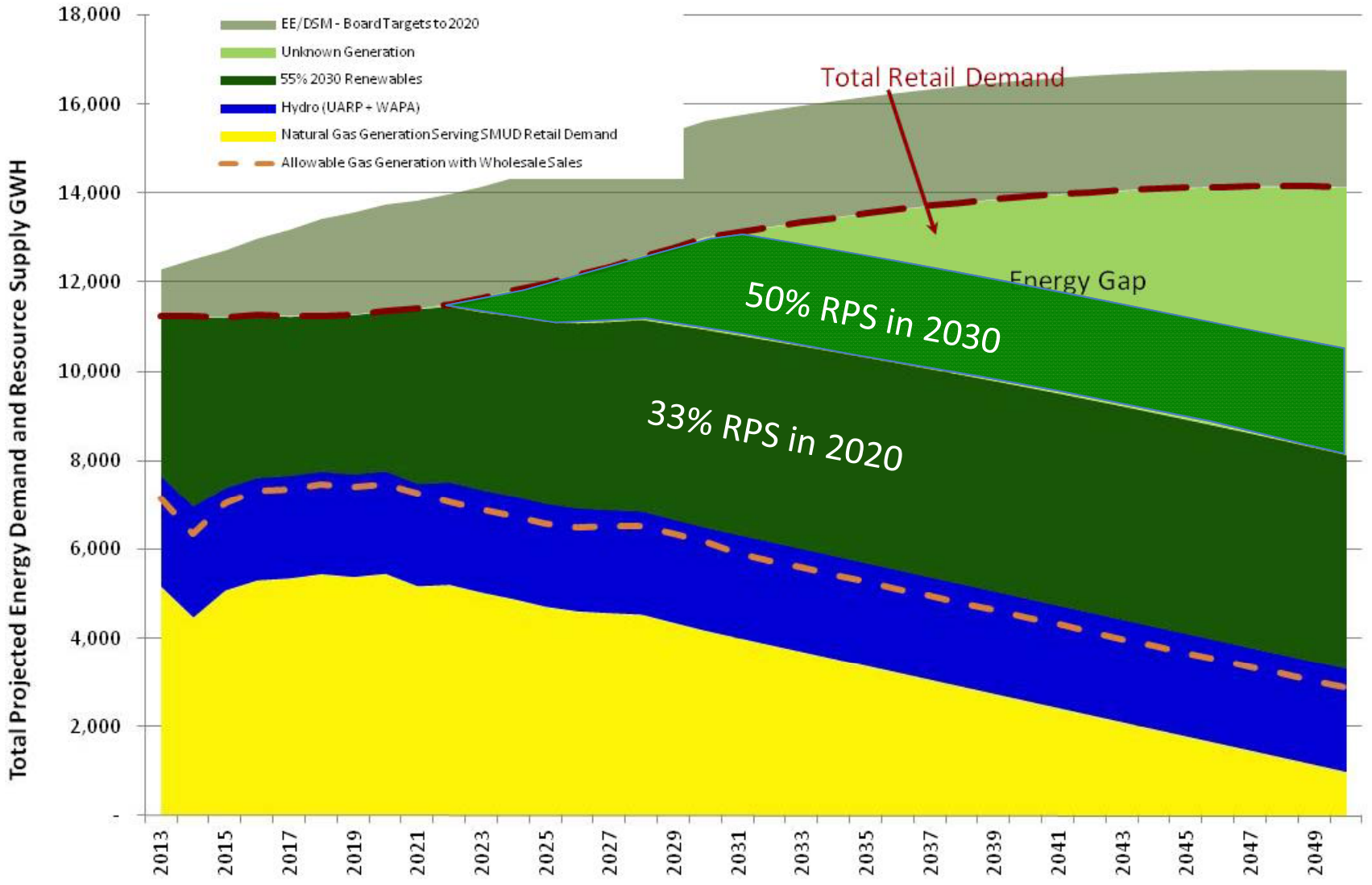
SMUD's Renewable Portfolio: 2012

2490 GWH total, 24%



SMUD Projected Resource Mix Through 2050



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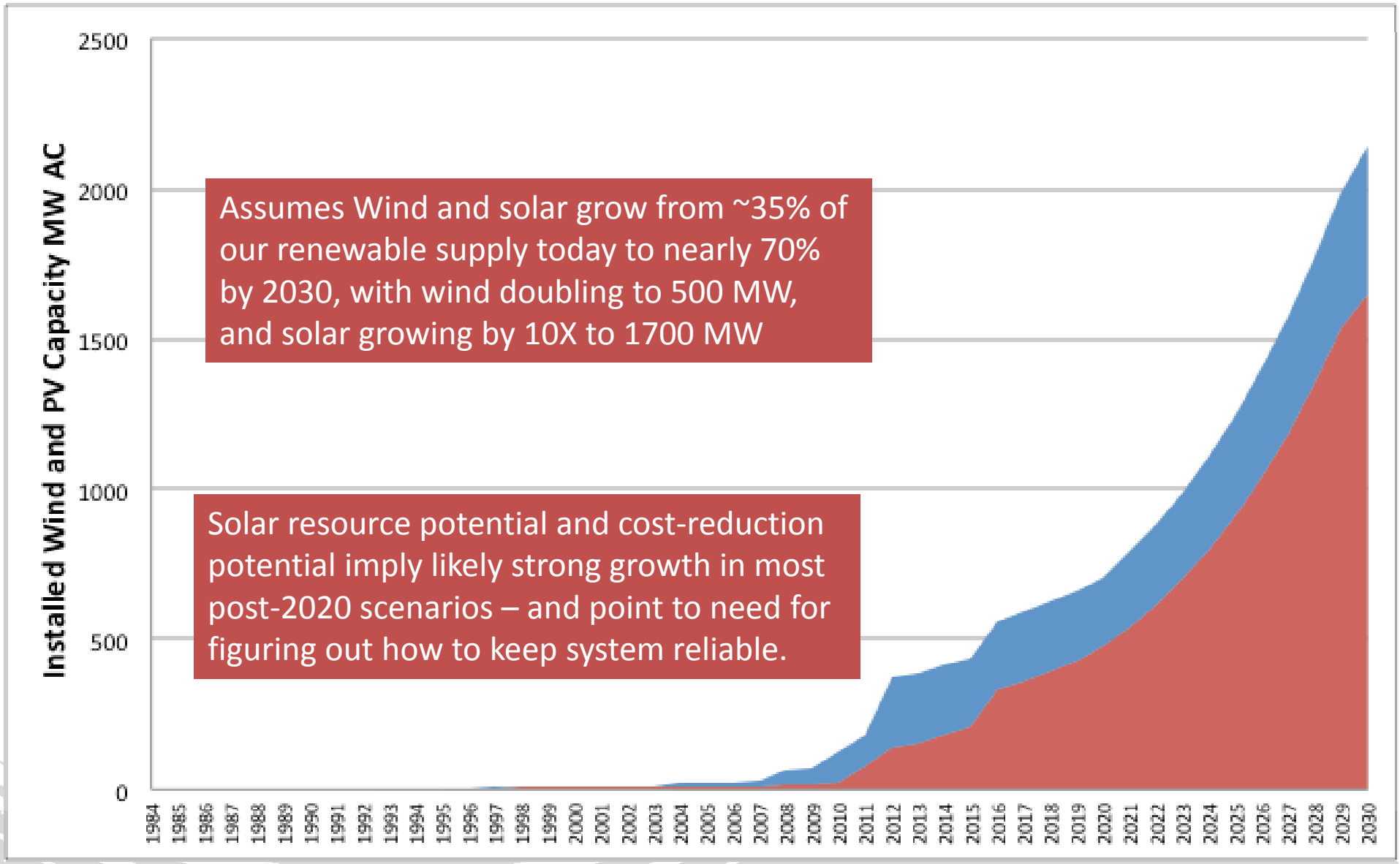
High Variable Renewable Scenario Stress Case for 2030



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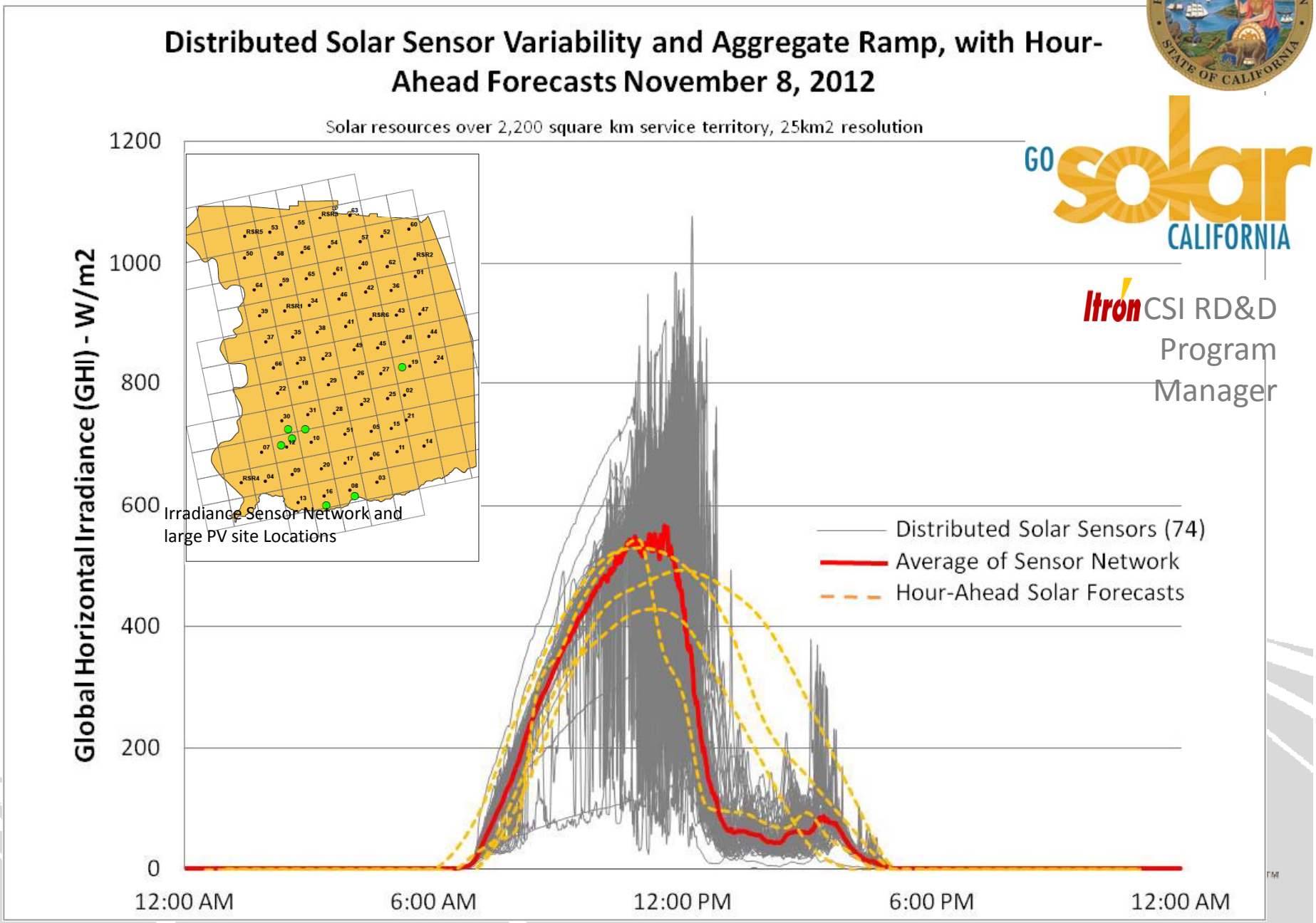
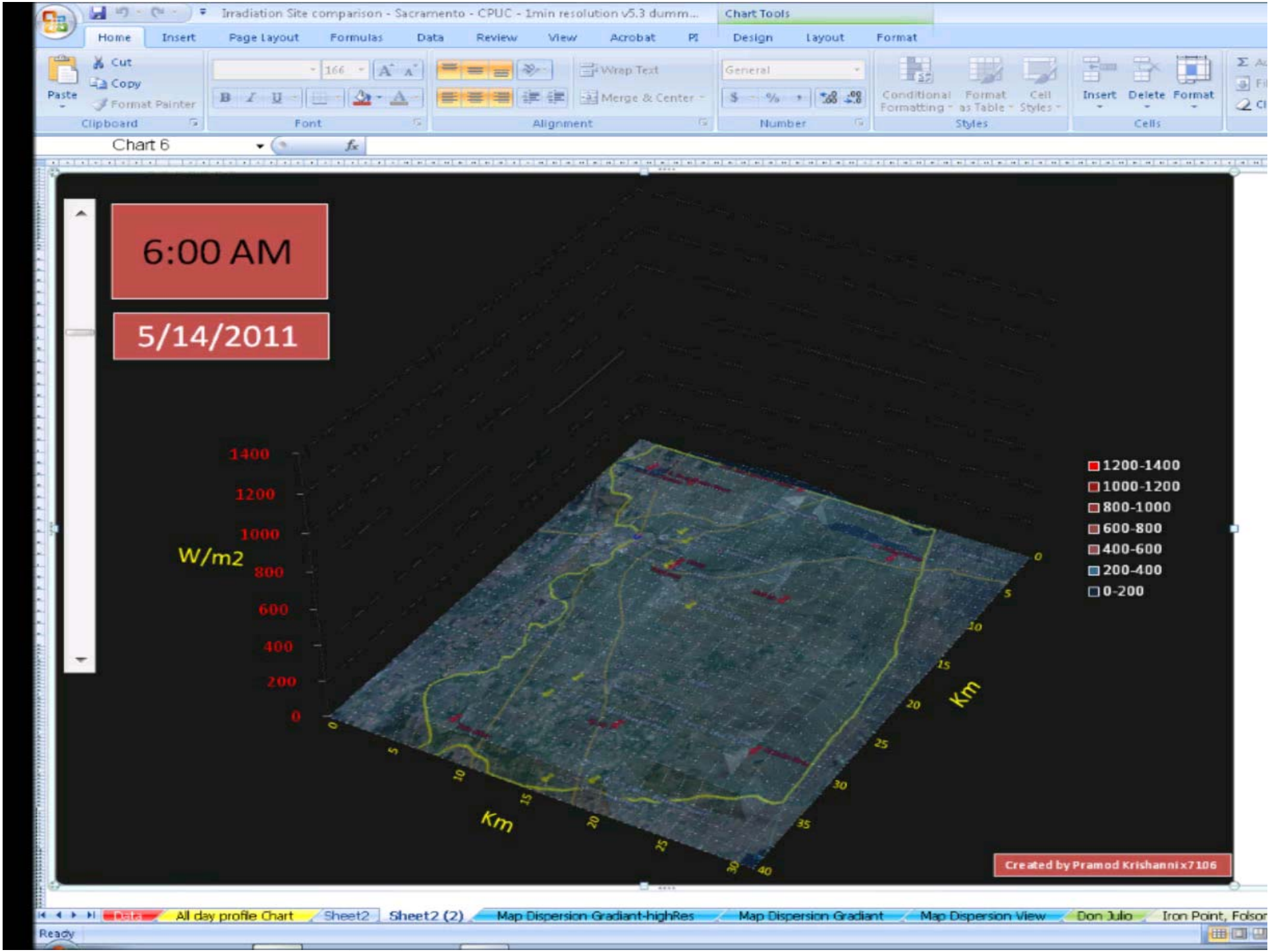
Solar Resource, Variability and Forecasting Assessments



GO solar CALIFORNIA

Itron CSI RD&D Program Manager


Irradiation Site comparison - Sacramento - CPUC - 1min resolution v5.3 dumm...
Chart Tools
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All day profile Chart
Sheet2
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Map Dispersion Gradiant-highRes
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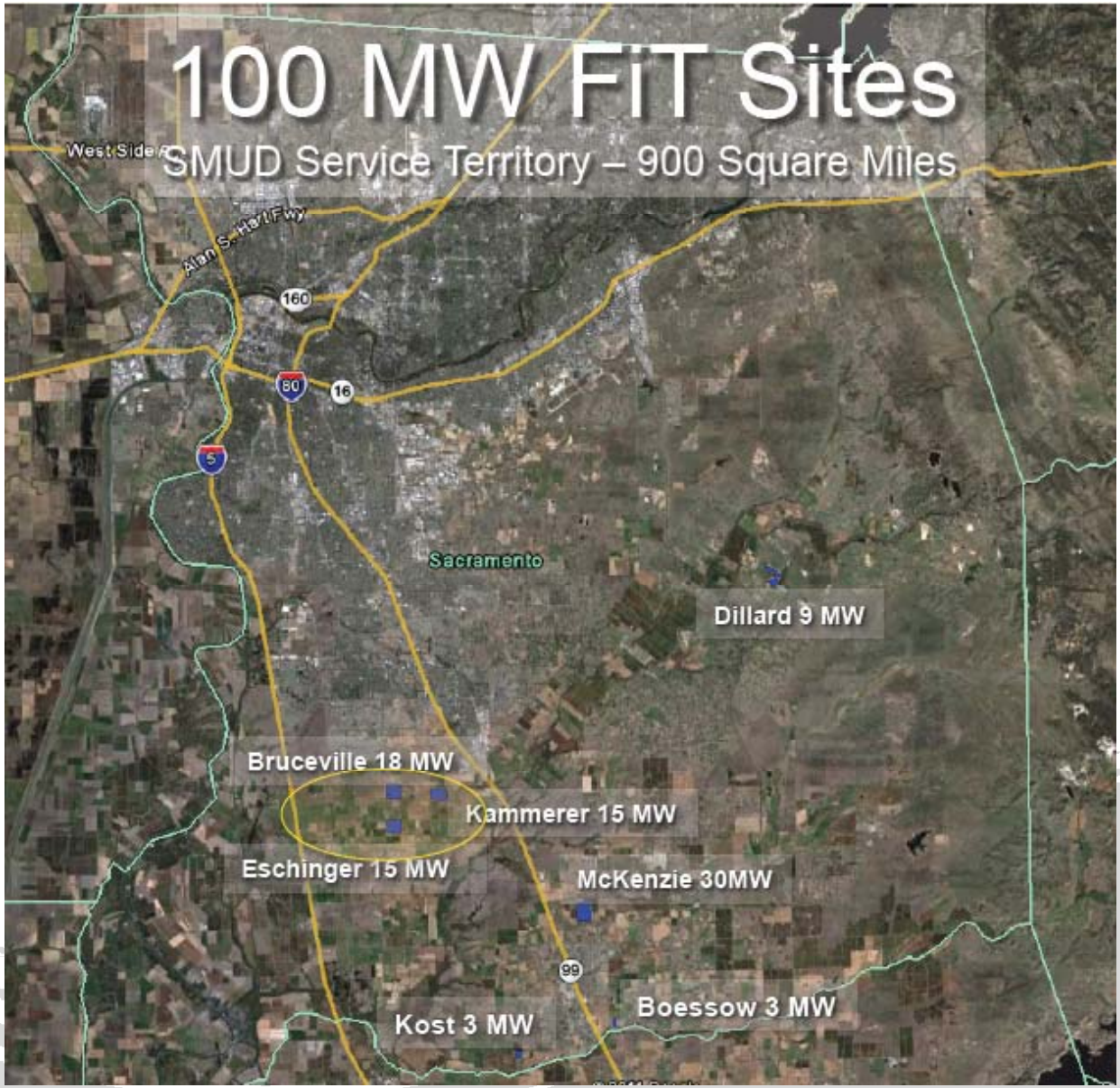
Don Julio
Iron Point, Folsom
Ready

Challenges with PV – System Variability and Balancing



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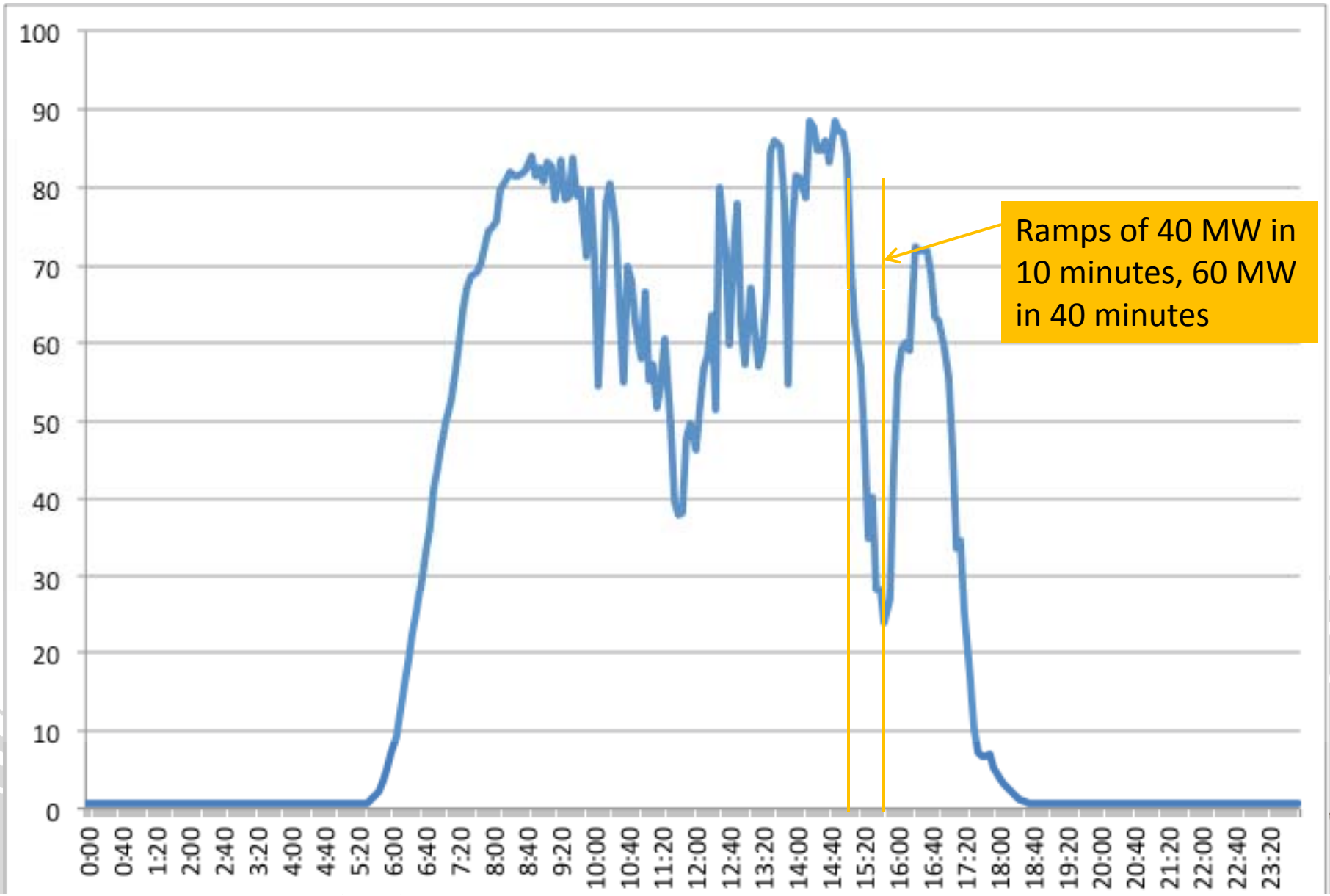
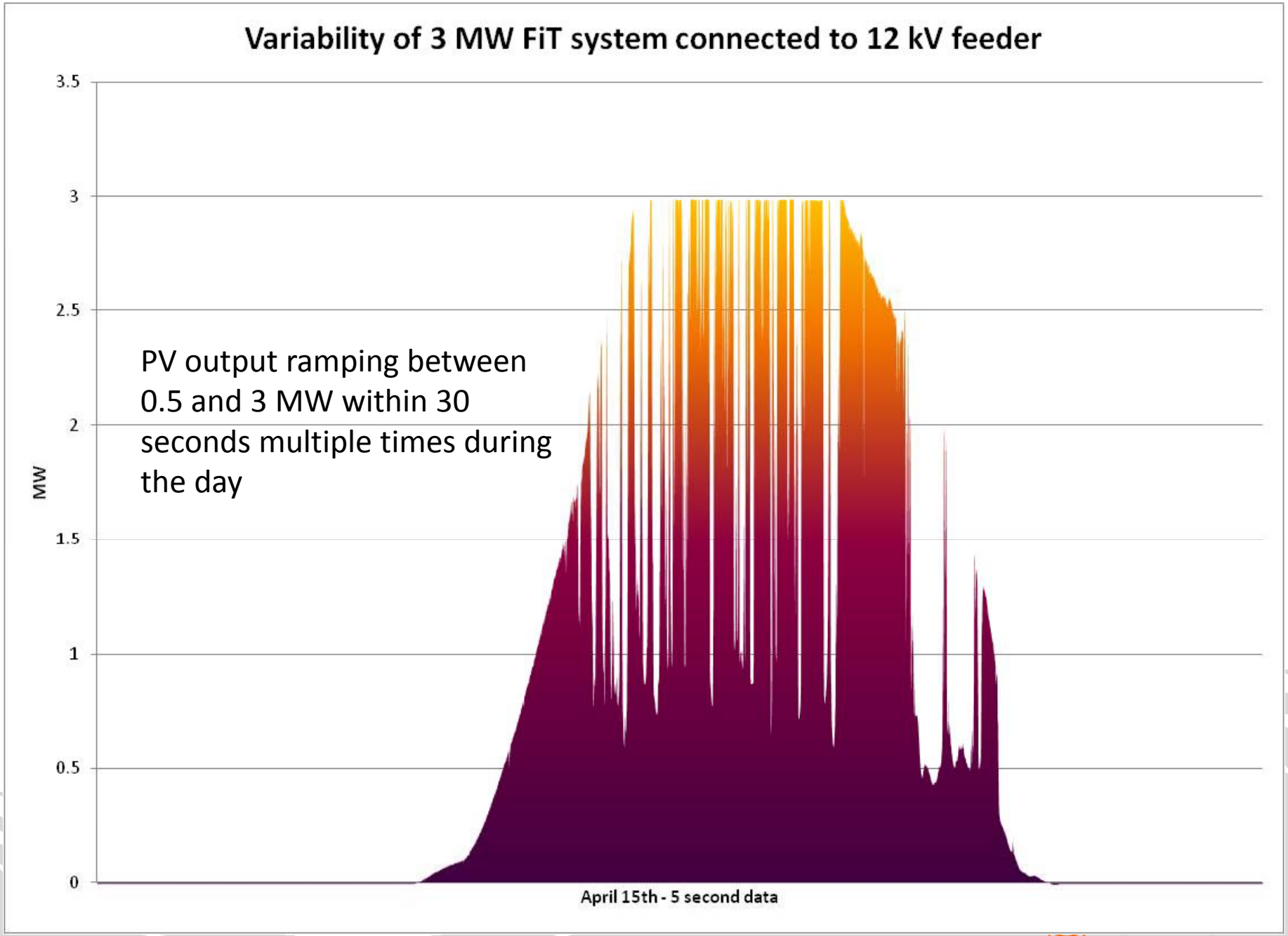
Challenges with PV: Variability of SMUD's 100 MW of FiT Solar

April 15th, 2013



Distribution Feeder Voltage Issues

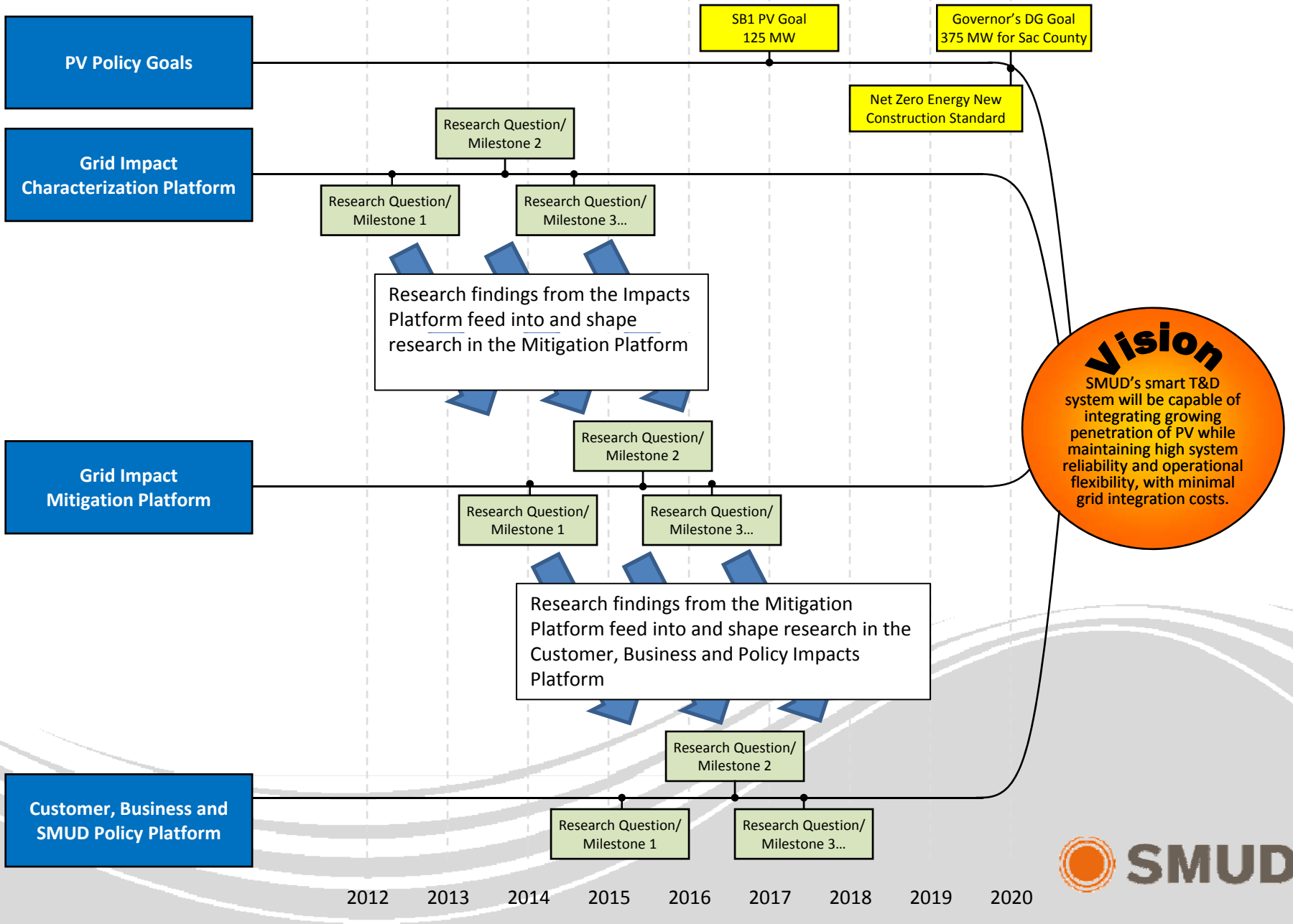
- 3 MW System on 12 kV Feeder, potentially feeding 100% of minimum daytime load on circuit
- Voltage regulated every 60 seconds from substation


Variability of 3 MW FiT system connected to 12 kV feeder
3.5
3
2.5
2
1.5
1
0.5
0
MW
PV output ramping between 0.5 and 3 MW within 30 seconds multiple times during the day
April 15th - 5 second data

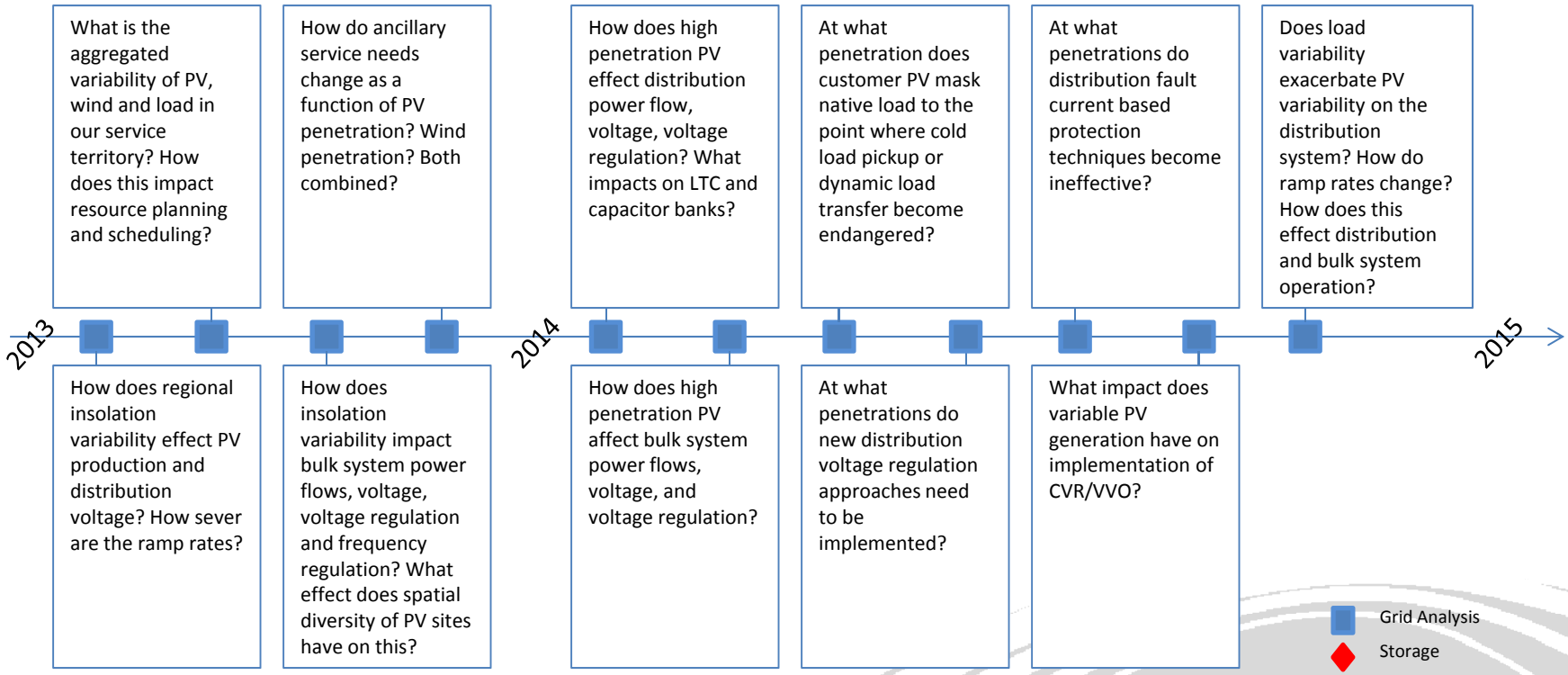
SMUD Research Looking at Grid Impacts, Mitigation Alternatives, System Effects and Policies

- Developing better forecasting models; examining the effect of geographic variation
- Examining communications between PV inverters and system to allow monitoring and possibly control
- Research on storage at the house, neighborhood, and system level, and with Electric Vehicles (managed charging, V2H, V2G)
- Demand Response pilots and goals
- Strategic flexible IC engine pilot for system support

PV Integration Roadmap Structure



Grid Impact Characterization Platform



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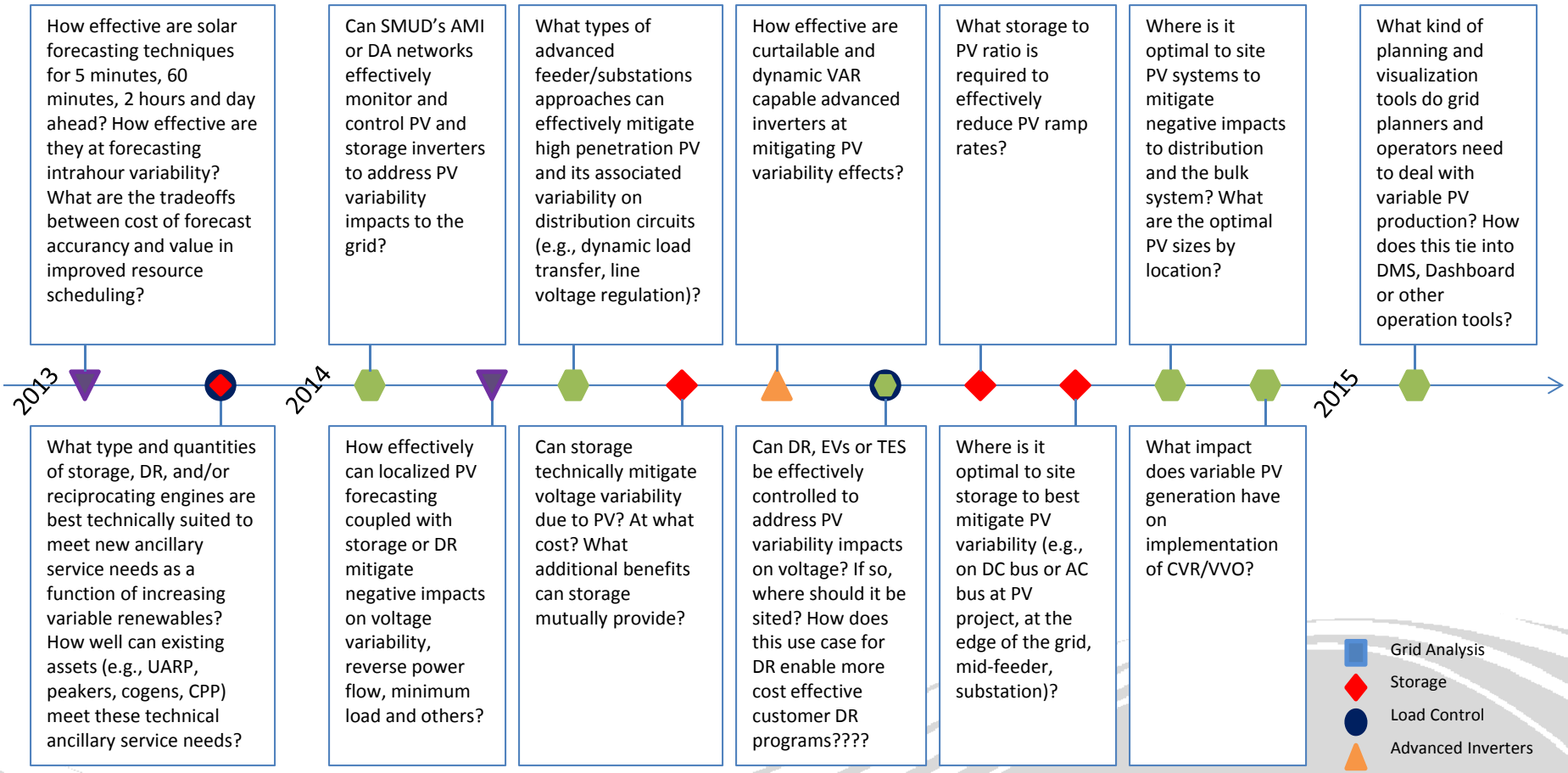
Grid Impact Mitigation Platform



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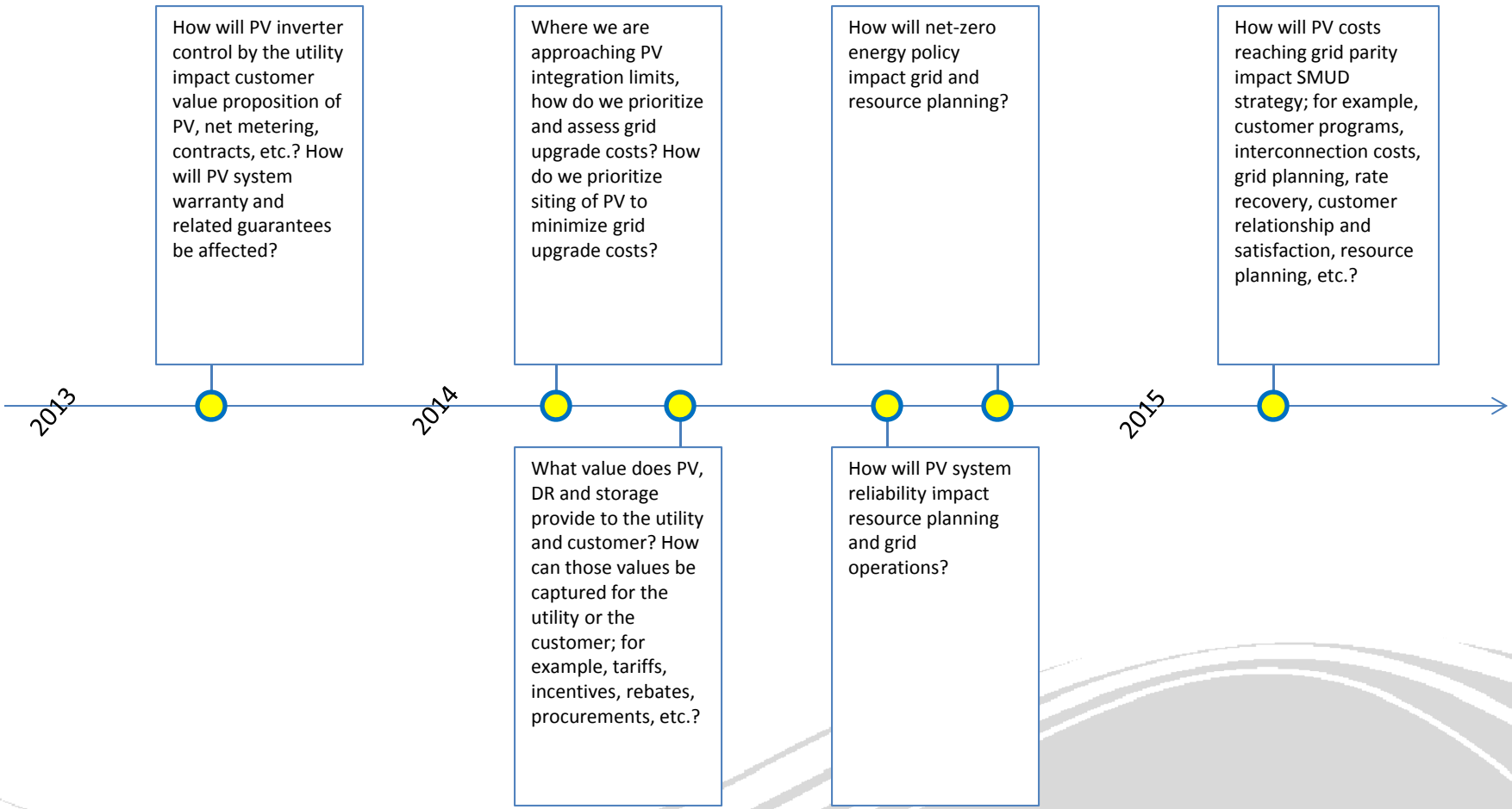
Customer, Business and SMUD Policy Platform



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Integrated T&D Modeling Tool

- Integrates T&D into single model
- Enables systemic evaluation of impacts from:
  - High penetrations of PV
  - High penetrations of EVs
- Allows for optimization analysis – where best to locate PV, Demand Response, EVs, Distribution Automation
- SMUD system online this year for analysis

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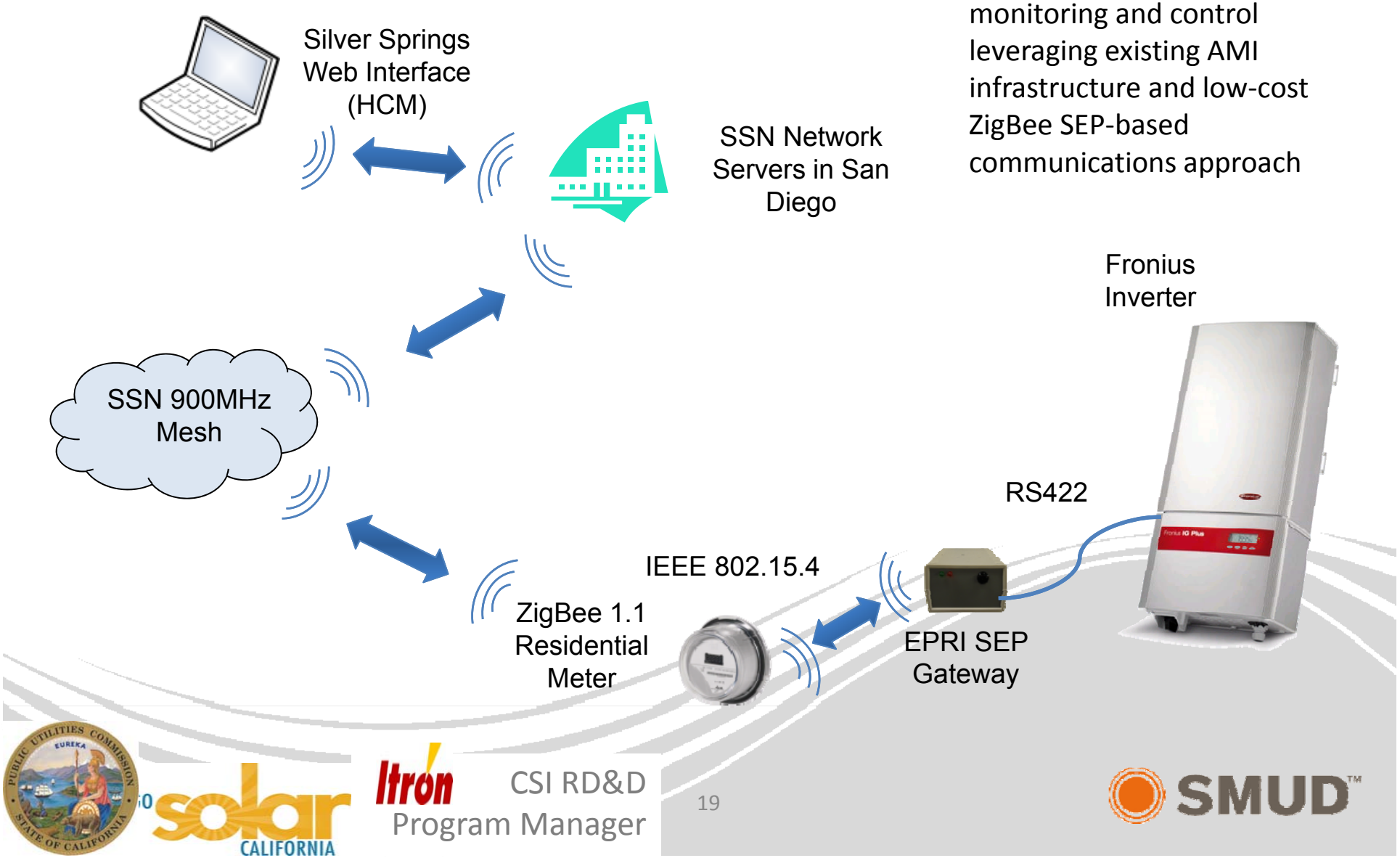
Smart Grid Communications with Advanced Inverter Demo

Demonstrating PV inverter monitoring and control leveraging existing AMI infrastructure and low-cost ZigBee SEP-based communications approach



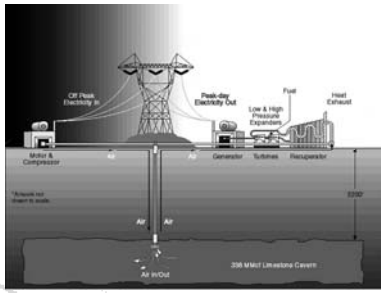
SMUD Storage Portfolio

Transmission

Distribution

Substation

Wind with Compressed Air Energy Storage

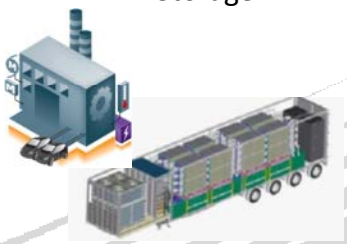


Commercial Scale PV with Li+ Storage

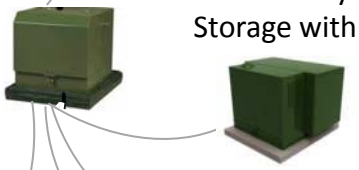
Commercial Scale PV with NaNiCl Storage

Feeder ZnBr Storage for PV Community

Microgrid with ZnBr Storage



Community Li+ Storage with PV



Residential Li+ Storage with PV

Residential Li+ Storage with PV

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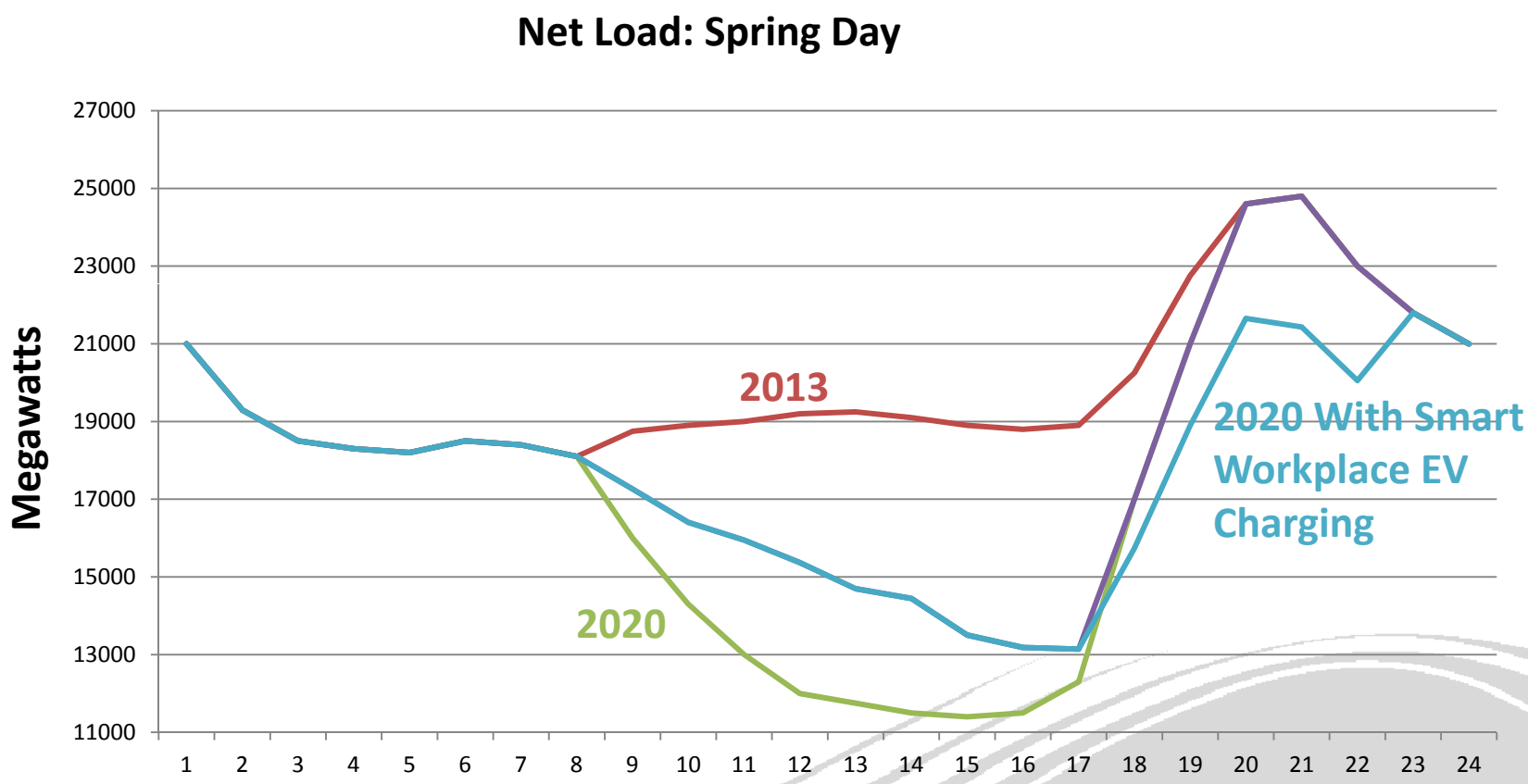
“Duck Curve” revisited



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Thanks for your attention

Contact me at:

ttutt@smud.org

Appendix slides:

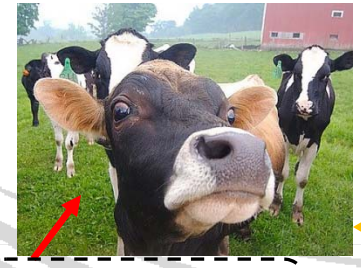
Current SMUD storage project details

Advanced Feeder Demo

3 MW PV Array
480V-12kV
9690 Kost Road
Galt, CA 95632

Energy Storage will monitor output from PV array and firm/smooth generation

500 kW / 125 kWh Energy Storage System
9690 Kost Road
Galt, CA 95632



575 kW Dairy Digester
9501 New Hope Rd
Galt, CA 95632

Galt Substation
Bank #1
6.25 MVA
69-12kV

CB CB

Feeder 1201

Feeder 1202

SCADA Controlled Switch/Recloser:
Enables transfer of all load on 1201 feeder to the 1203 feeder when needed to prevent reverse power flow through Galt Bank #2

N.O.
S-921

N.O.

Galt Substation
Bank #2
6.25 MVA
69-12kV

CB CB

Feeder 1203

Feeder 1204

Voltage Regulator:
If LTC at substation needs to lower bus voltage to allow optimal generation from PV farm, regulator will raise line voltage to ensure customers at end of 1204 will maintain acceptable voltage levels.

R

N.O.

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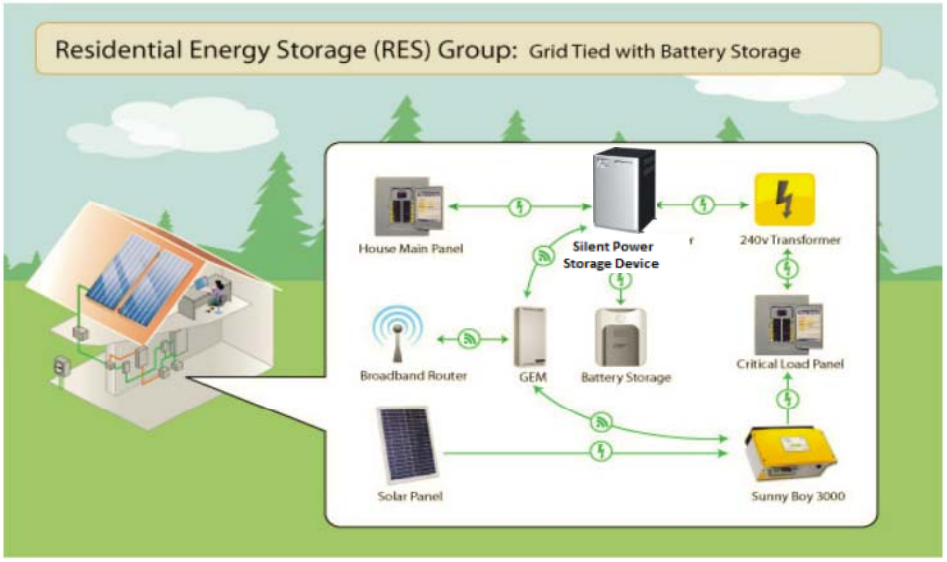
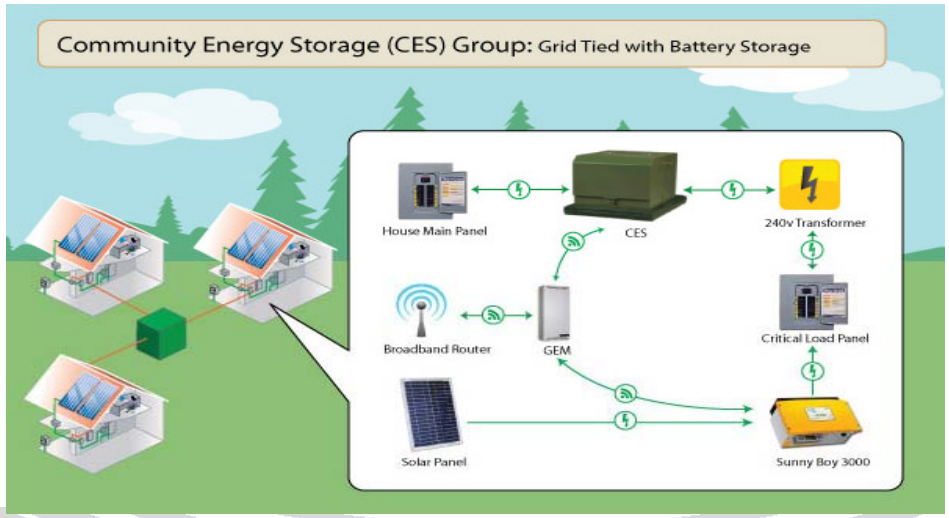
SMUD PV & Smart Grid Pilot at Anatolia

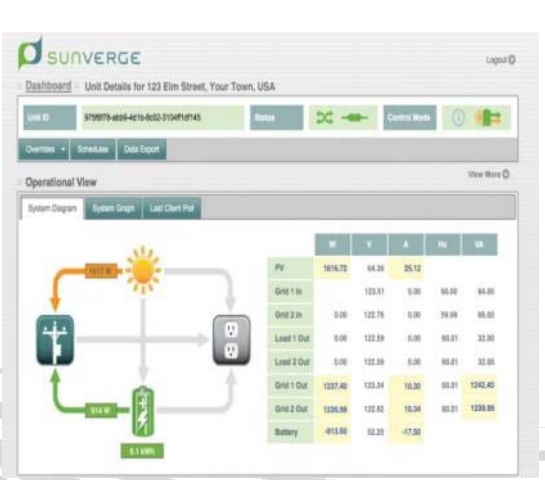
ARRA FOA 85 Topic 4: High Penetration Solar Development





- $5.9M Project ($4.3M DOE)
- Anatolia SolarSmart[SM] Homes Community
  - High building efficiency measures
  - 2kW PV systems
- Installing 15 RES (5kW/8.8kWh) and 3 CES (30kW/34kWh)
- Will firm renewables, reduce peak load, regulate voltage and improve reliability
- Partners include GridPoint, SunPower, Navigant, NREL, SAFT (lithium ion)
- Installing utility and customer portals to monitor PV, storage, customer load
- Sending price signals to affect changes in customer usage
- Quantifying costs and benefits of this storage deployment to gain insights to broader application for SMUD

Residential Energy Smart Community Demonstration



- Thirty-four SMUD SolarSmart Homes with better than 40% efficiency over standard homes
- PV, smart appliances, HAN, lithium ion storage (4.5kW/10.7kWh)
- Partners Pacific Housing, Sunverge, Kokam
- $450k SMUD grant funded by DOE Assistance Agreement DE-OE0000214
- Objectives
  - Reduce demand and TOU charges through demand response
  - Minimize impact of PV variability, control ramp rates
  - Peak load shifting
  - Real-time visibility and analytics of aggregated load for the utility

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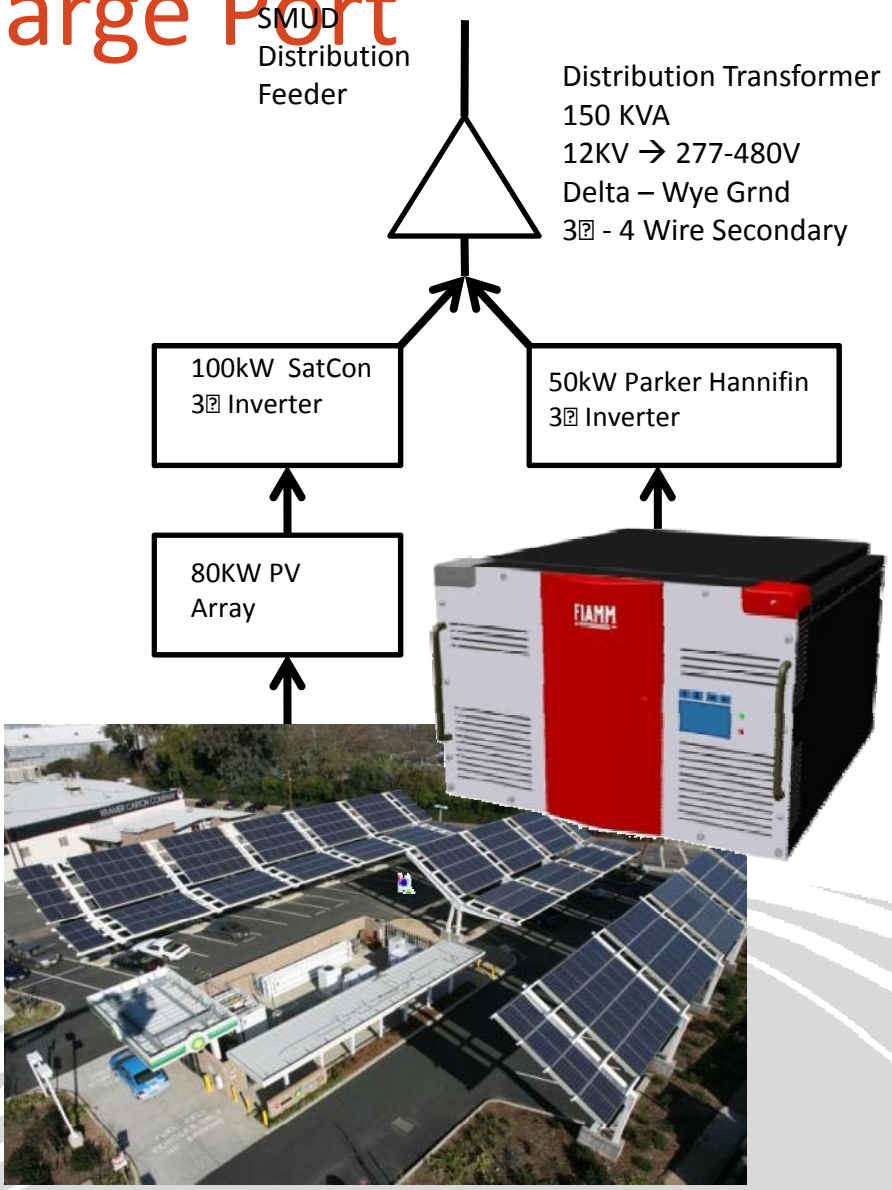
Solar EV Charge Port

- EPRI FIAMM SatCon project to augment 80kW PV array
- Parker Hannifin 50kW inverter
- FIAMM NaNiCl 50kW/130kWh
  - High specific energy (120 Wh/kg)
  - High temperature battery – 260-360□C
  - Long life and high reliability
  - Not susceptible to high ambient temp
  - Planned location for plug-in hybrid charging
- Objectives
  - Minimize impact of PV variability
  - Control PV and PHEV charger ramp rates
  - Voltage regulation and voltage sag mitigation
  - Peak load shifting



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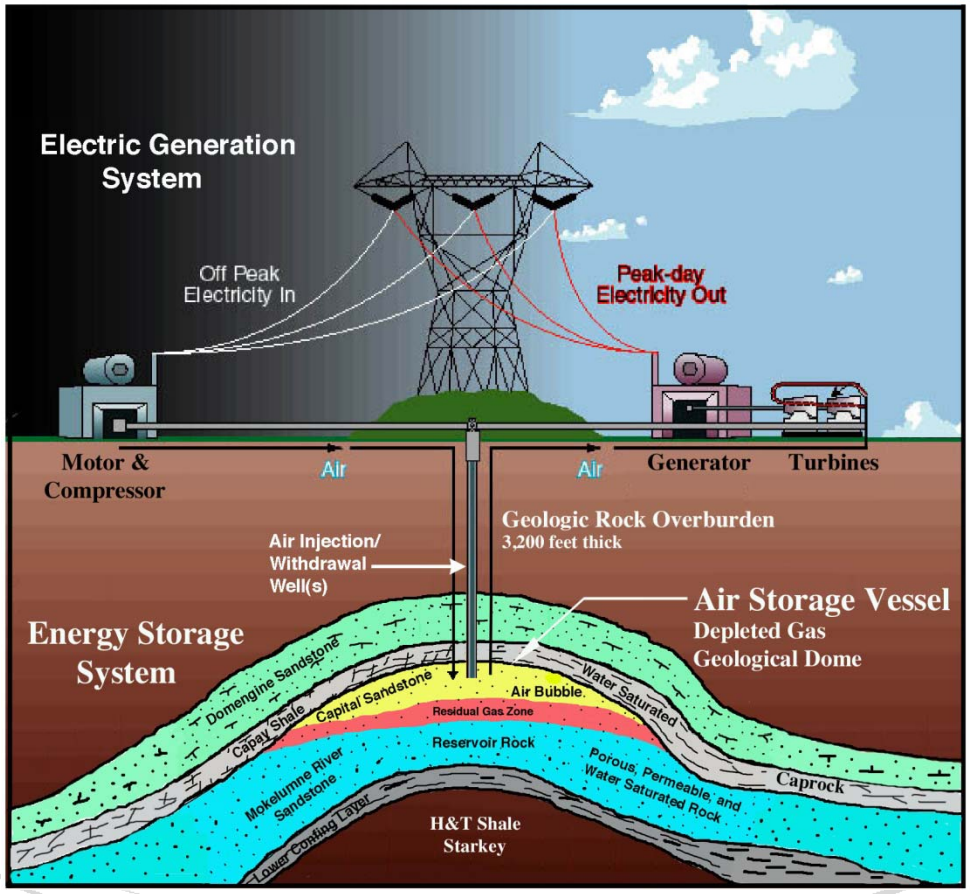
Bulk Energy Storage R&D



- Investigating compressed air energy storage and pumped hydro
- Mitigate variability of nighttime wind production and align it with utility daytime super peak
- Also considering seasonal arbitrage
- Turbo machinery is proven technology
- Reservoir is biggest unknown and risk
  - Natural gas storage proven
  - CAES injection and extraction rates could be as much as 5 times higher
- Conducting geotechnical modeling to determine feasibility to meet operational requirements of turbo machinery

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SMUD Pumped Hydro Project

Key Features of Iowa Hill

- New development potentially added to existing Upper American River Project (UARP), near Placerville, CA
- 400-MW Pumped-storage facility
- New 6,400 ac-ft reservoir atop Iowa Hill
- Existing Slab Creek Reservoir as lower reservoir
- Underground water conveyance and powerhouse
- 2.5-mile transmission tie-in connects to existing UARP transmission line

Benefits

- Helps meet load growth by increasing dependable capacity 400 MW
- Promotes intermittent, non-dispatchable renewable resources by helping to manage their energy output
- Supports load following, improves system reliability, provides voltage control and spinning reserves

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