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Energizing California's Communities with Renewables

Community Scale Generation at the Chemehuevi Community Center

September 29, 2015

Presented by:
Alfredo A. Martinez-Morales, Ph.D.
University of California, Riverside

Southern California Research Initiative for Solar Energy (SC-RISE)

www.scrise.ucr.edu

Center for Environmental Research and Technology (CERT)

www.cert.ucr.edu

UC Riverside CE-CERT:

College of Engineering- Center for Environmental Research and Technology

- **collaborative research center focused on *air quality*, *transportation*, and *energy***
- **brings together *academia*, *industry*, and *government* to develop and assess new technologies**
- **interdisciplinary center of approximately 45 full-time faculty and staff plus 60 graduate and undergraduate students**
- **contracts and grant activity at approximately $12M per year**

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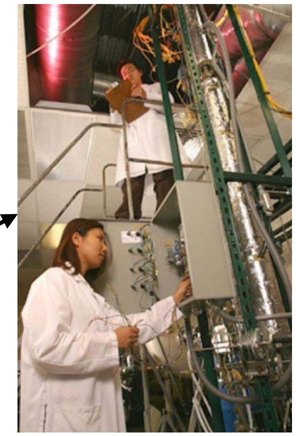
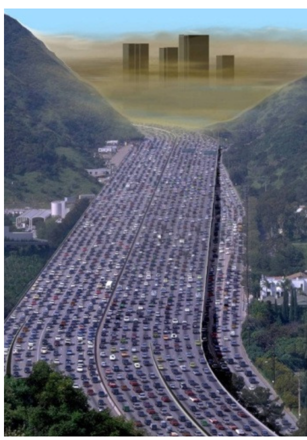
CE-CERT Laboratories

Atmospheric Processes

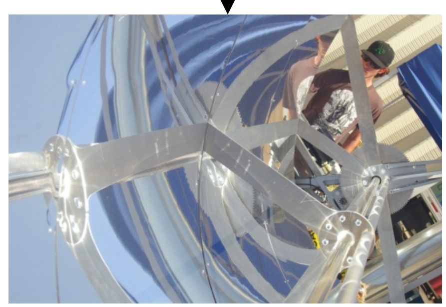


Sustainable Energy Systems

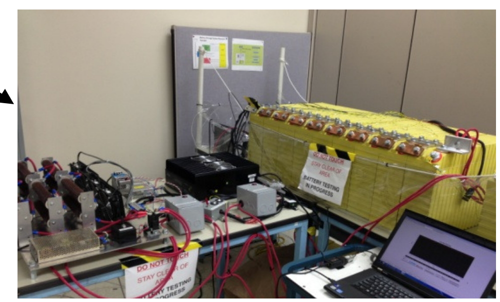
Emissions and Fuels



Intelligent Transportation Systems



Solar Energy



Energy Storage

Energy Needs and Driving Factors

- Today's global demand for energy is approximately 15 terawatts and is growing rapidly.
- Much of the U.S. energy needs are now satisfied from fossil fuels (heating, cooling, transportation, electricity, etc.).
- Fossil fuels are finite resources, which are running out and becoming more difficult and environmental riskier to obtain.
- There is a strong need to turn to alternative energy systems that are sustainable.

Energy and Environmental Goals Drive Change

In California, energy and environmental policy initiatives are driving electric grid changes. Key initiatives include the following:

- *33 percent of retail electricity from renewable power by 2020;*
- *greenhouse gas emissions reduction goal to 1990 levels by 2020;*
- *regulations in the next 4-9 years requiring power plants that use coastal water for cooling to either repower, retrofit or retire;*
- *policies to increase distributed generation; and*
- *an executive order for 1.5 million zero emission vehicles by 2025.*

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New Operating Conditions Emerge

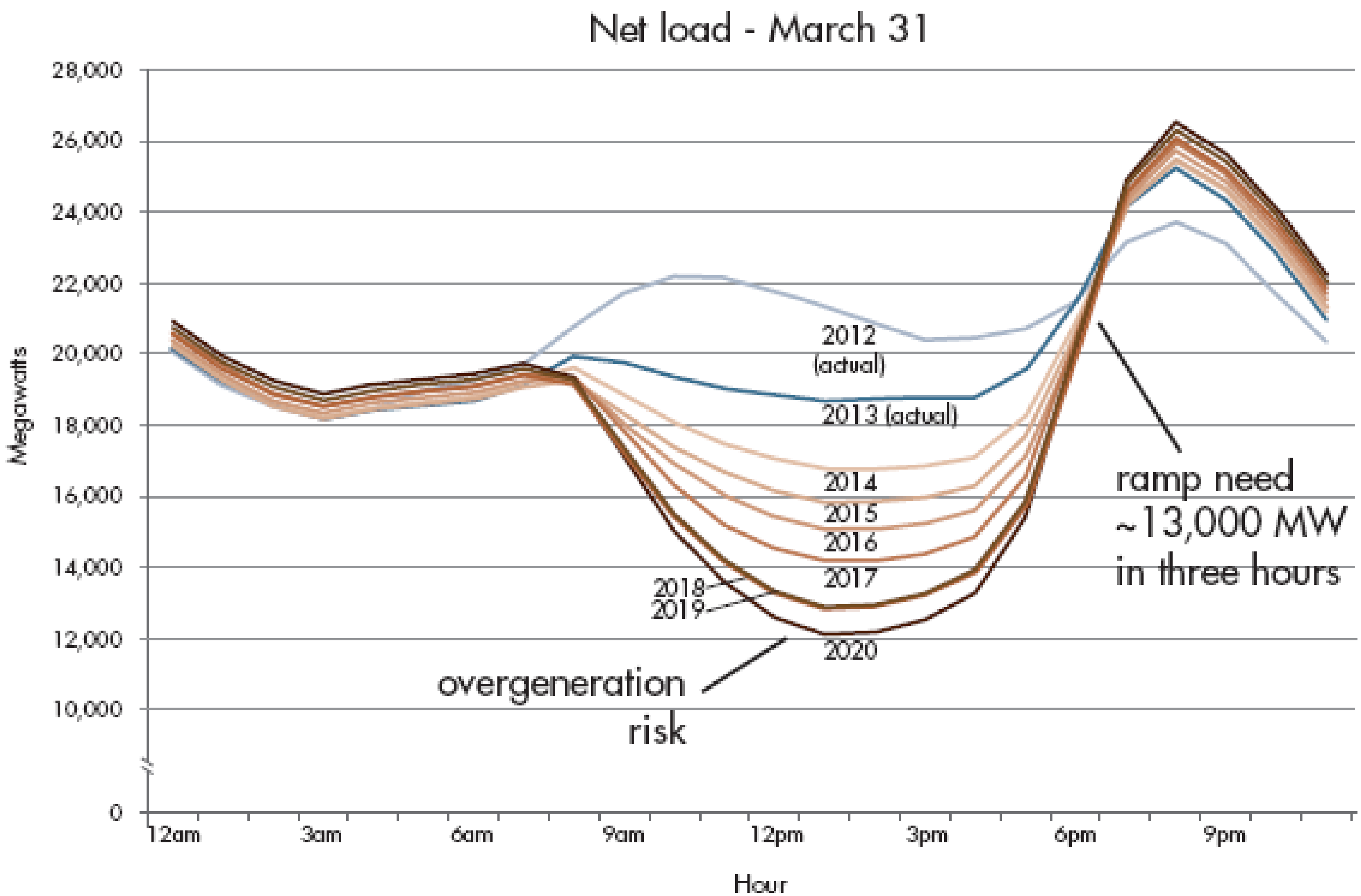
Real-time electricity net demand changes as policy initiatives are realized. Several conditions emerge that will require specific resource operational capabilities.

- *short, steep ramps – when the ISO must bring on or shut down generation resources to meet an increasing or decreasing electricity demand quickly, over a short period of time;*

- *overgeneration risk – when more electricity is supplied than is needed to satisfy real-time electricity requirements; and*

- *decreased frequency response – when less resources are operating and available to automatically adjust electricity production to maintain grid reliability.*

Steep Ramping Needs and Overgeneration Risk



Green Grid Reliability Requires Flexible Resource Capabilities

To reliably operate, the ISO requires flexible resources defined by their operating capabilities. These characteristics include the ability to perform the following functions:

- *sustain upward or downward ramp;*
- *respond for a defined period of time;*
- *change ramp directions quickly;*
- *store energy or modify use;*
- *react quickly and meet expected operating levels;*
- *start with short notice from a zero or low-electricity operating level;*
- *start and stop multiple times per day; and*
- *accurately forecast operating capability.*

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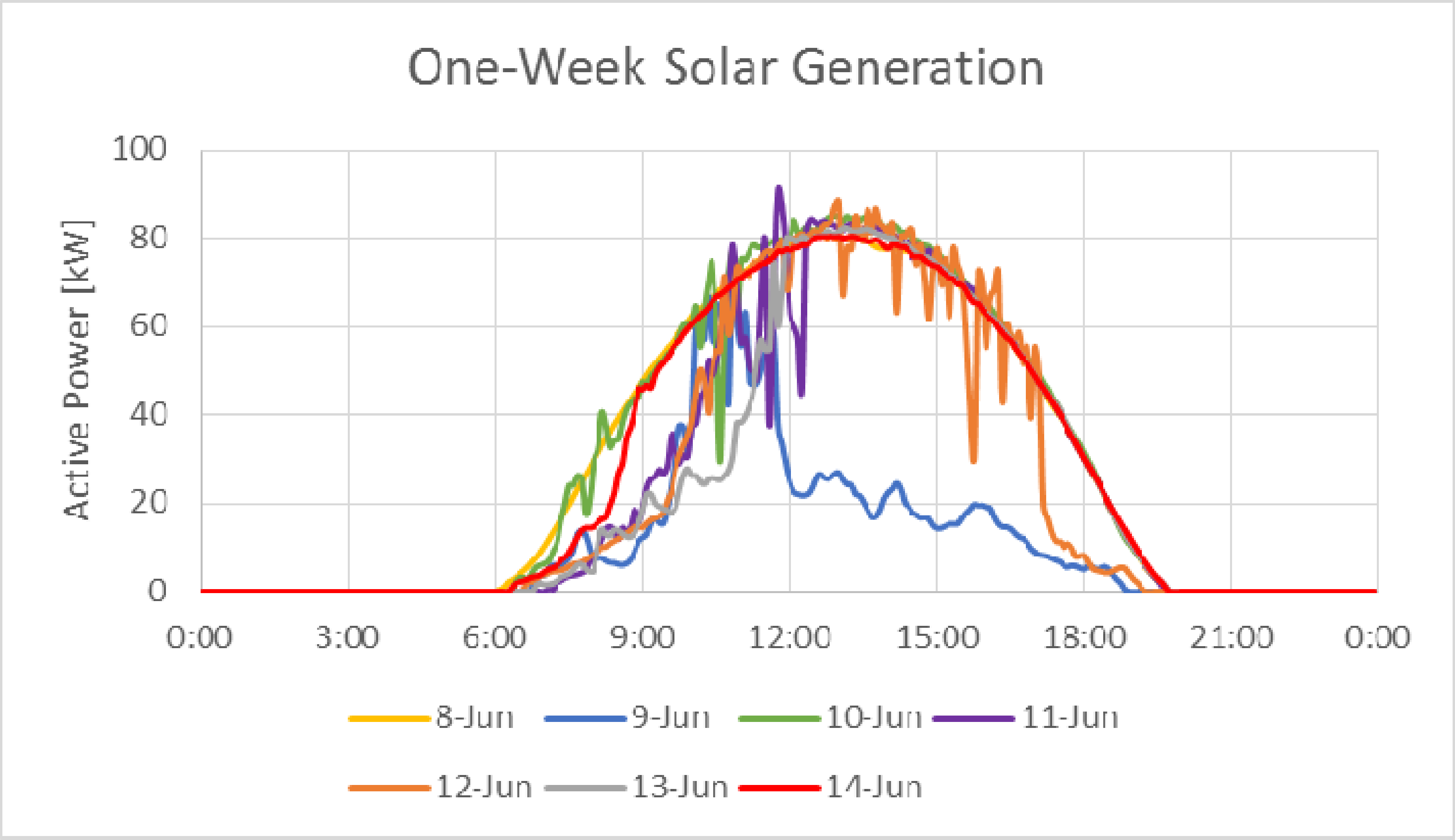
Solar Characteristics



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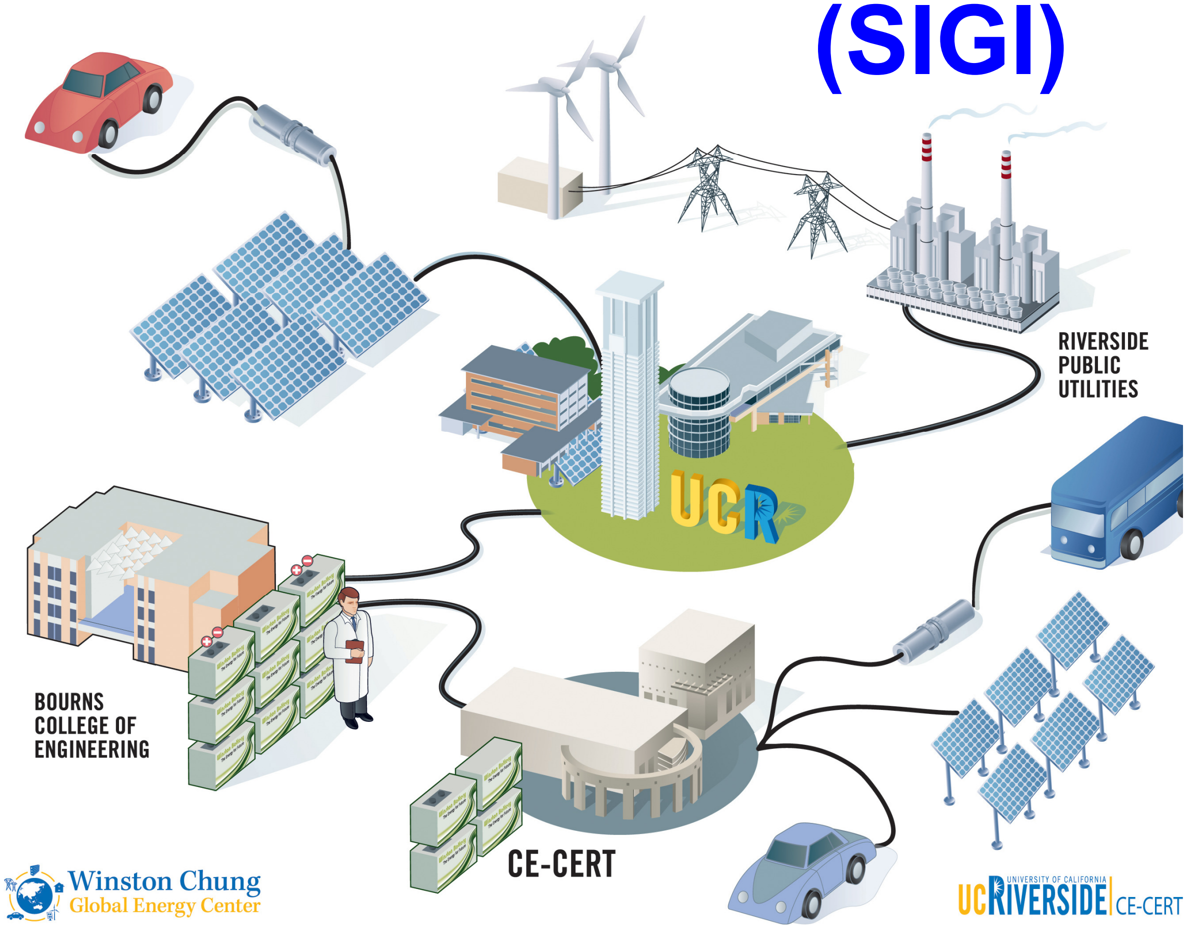
Sustainable Integrated Grid Initiative (SIGI)



- Load Management
  - reduces risk of grid failure/blackout (due to decreased peaks)
  - increases predictability of demand (flattens peak demand)
- Outage Prevention - relieves stress on grid
- Outage Support – if system includes stand-alone battery dedicated to critical loads
- Distributed Solar Systems SUPPORT the grid.

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SIGI Research Facilities

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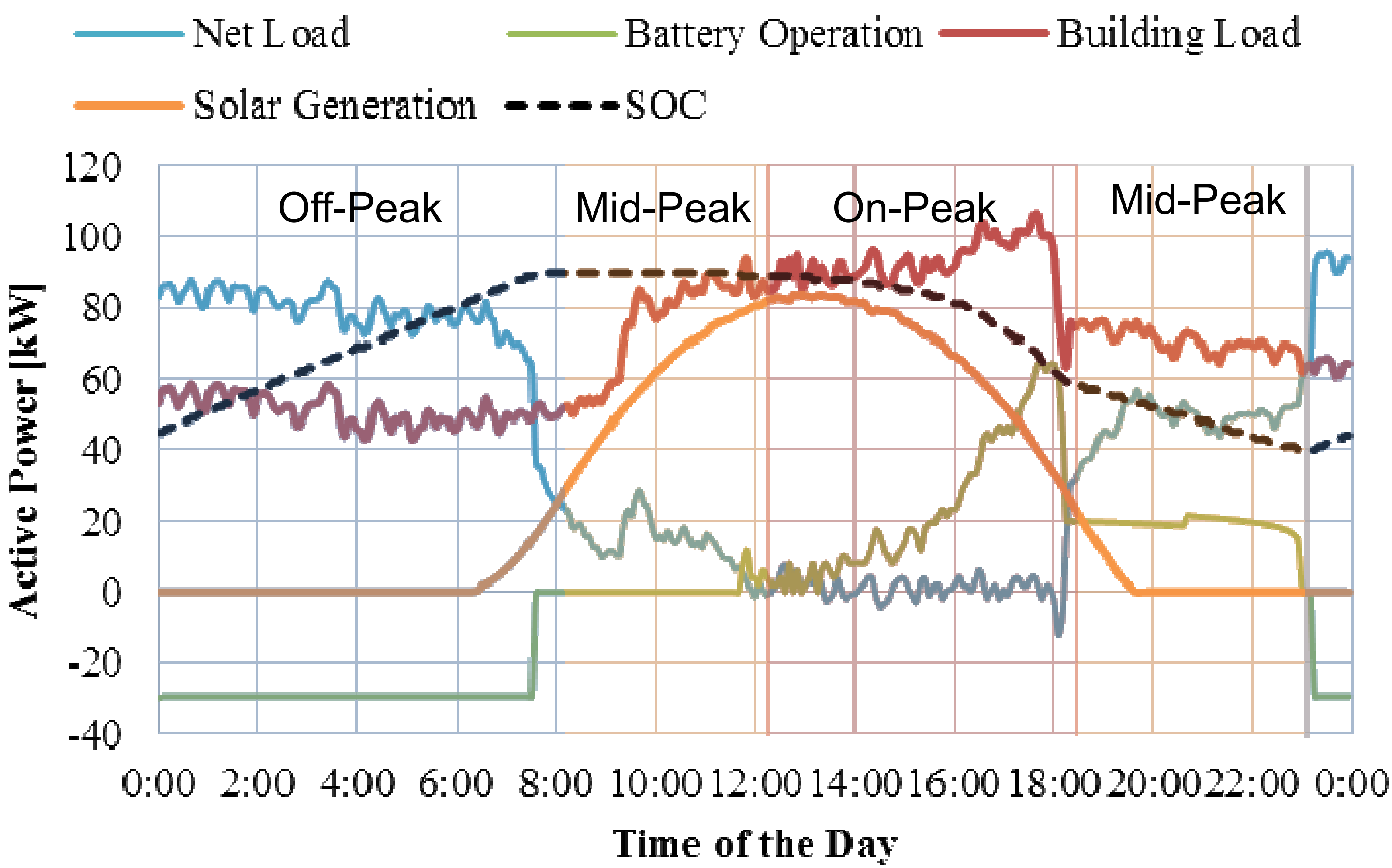
What Should We Know Before Optimization?

- **The Rate Schedule Time-of-Use (TOU) for Large General and Industrial Service**

Rate Period	Summer	Winter
	June to August	September to May
Off-Peak	11 PM—8 AM	9 PM—8 AM
Mid-Peak	8 AM—12 PM 6 PM—11 PM	8 AM—5 PM
On-Peak	12PM—6 PM	5 PM—9 PM

- **How to Design the Algorithm?**
  - Charge the battery bank during Off-Peak rate period; discharge during On-Peak rate period
  - Time interval period is chosen to be 5 minutes
  - kW optimization and kWh optimization

One-Day Experiment with Three Different Time Periods Control Algorithms



Cost Analysis: Comparison Between Different System Architectures

System Comparison	Energy kWh Savings($)	Load Demand Savings($)			Total ($)
		On-Peak	Mid-Peak	Off-Peak	
Real vs. Schedule	209.65	105.92	17.24	6.19	339.00
Real vs. No Battery	104.38	381.12	17.24	-33.10	469.64
Real vs. No PV or Battery	1182.82	584.56	126.26	-27.21	1866.43

June 2015 Electricity Cost Comparison for Different System Architectures

Different Situation	Energy kWh Savings($)	Load Demand Savings($)			Total ($)
		On-Peak	Mid-Peak	Off-Peak	
Real vs. Schedule	84.26	59.5	0	14.6	158.36
Real vs. No Battery	97.44	472.3	24.84	-24.7	594.58
Real vs. No PV or Battery	953.7	585.65	115.44	-24.7	1630.09

May 2015 Electricity Cost Comparison for Different System Architectures

Real refers to real-time control algorithm

SIGI Providing Relief to RPU

In September 14, 2014, the triple digit temperatures lead to RPU reaching a new all-time high electricity demand of 610 megawatts (MW). In the days to follow RPU send out an appeal to larger customers to conserve electrical energy, specifically between 2 pm to 5 pm. In response, CE-CERT's SIGI Testbed provided the flexibility to not only curtail the nominal power consumption of 365 kW from the three CE-CERT buildings, but also provided 225 kW back to the grid, resulting in a 590kW swing for three hours, as shown below.

- *CE-CERT Admin building net energy savings: 95 kW*
- *CE-CERT APL building net energy savings: 180 kW*
- *CE-CERT CAEE building net energy savings: 315 kW*

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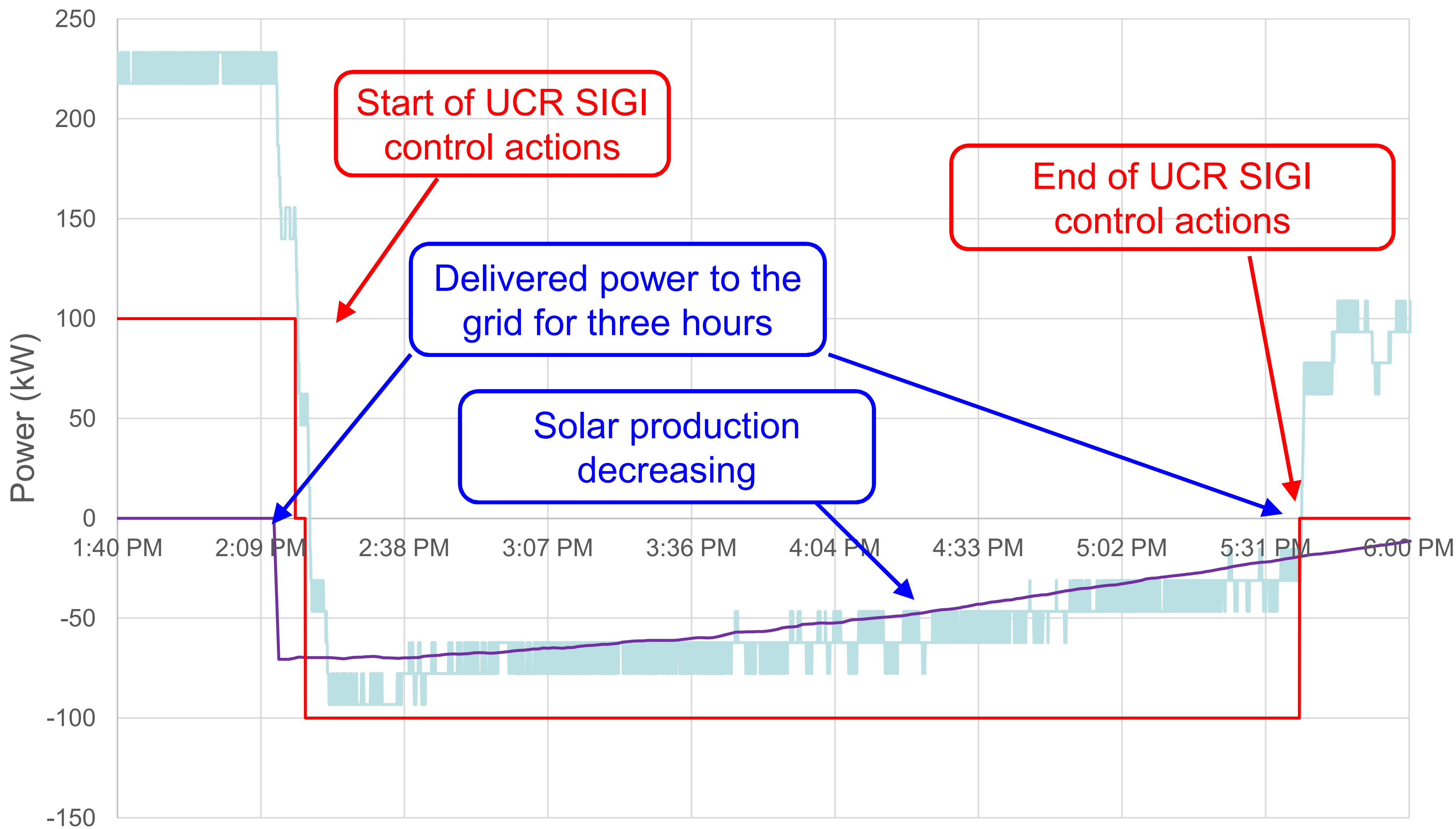
SIGI helps RPU during peak historic demand



Project Summary

- Project duration: start date – 10/15/15, end date – 07/31/18
- Deployment and demonstration of a microgrid system at the CCC.
- Microgrid system composed of 90 kW solar PV system, 60kWh/30kW flow battery energy storage system, data historian, control system, and energy management strategies.
- Energy management strategies include: 1) Peak Reduction, 2) Load Shifting, 3) Demand Response, and 4) Storage to Grid activities.

Project Benefits

Projected benefits to the CCC (over 20 years)

- Lower Energy costs (i.e. demand charge reduction)
- Improved data and energy management
- Increased grid stability, robustness, and reliability
- Support increased renewables and market-ready technologies
- Decreased GHGs emissions
- Workforce development & best practices

Industry Partners

- Solexel, Inc. (http://www.solexel.com) – 40 kW solar PV system
- Congenra Solar (http://www.cogenra.com) – 50 kW solar PV system
- Primus Power (http://www.primuspower.com) – 60 kWh/30 kW flow battery energy storage system
- OSIsoft (http://www.osisoft.com) – EMS monitoring and control software

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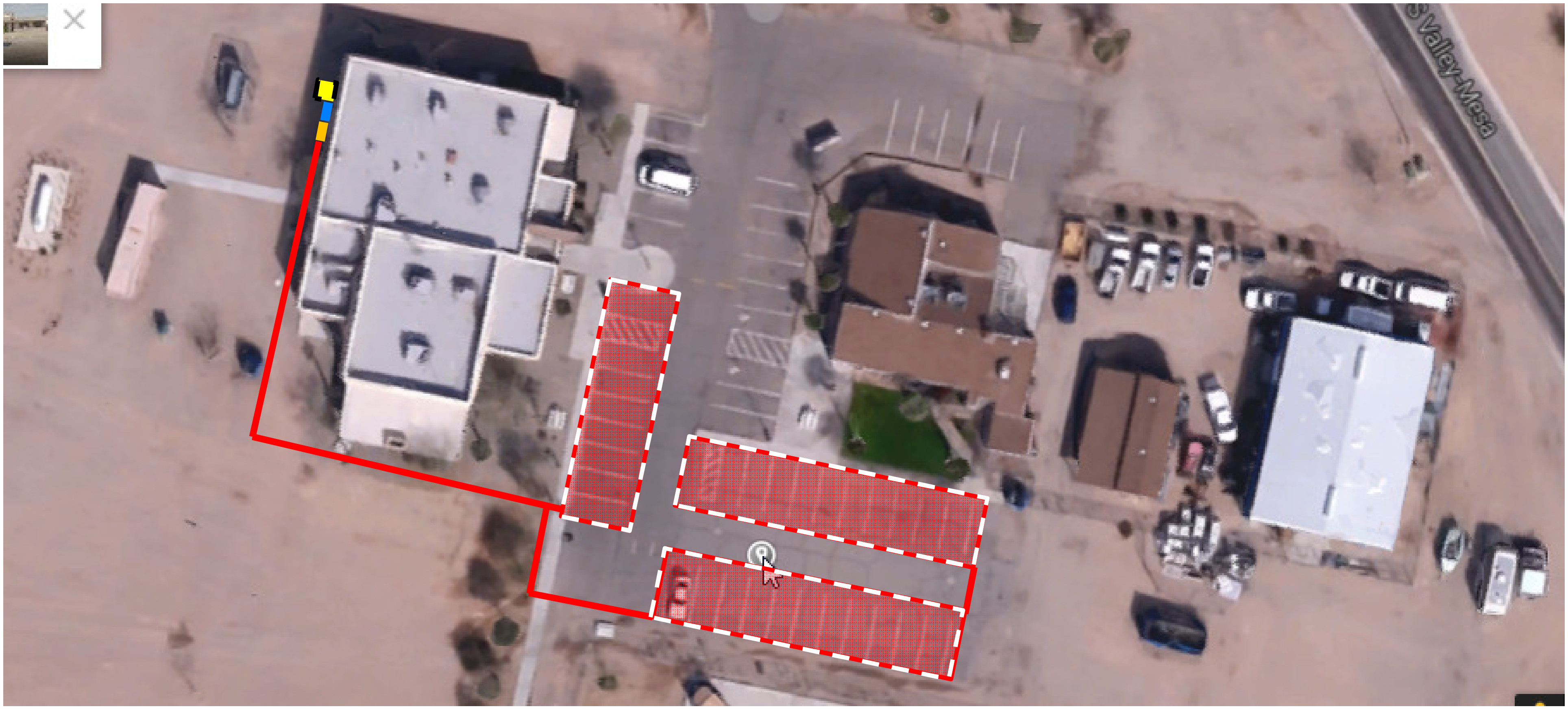
Project Site



Carport PV System

Flow Battery Energy Storage System/Charger-Inverter

50 kW Inverter

40 kW Inverter

Conduit


For more information please visit
www.scrise.ucr.edu
or email me at
alfmart@cert.ucr.edu

Questions?