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Learning Objectives

1. You will compare performance data to efficiencies in new construction on a new university campus.
2. You will identify common myths in trying to achieve energy efficiency and contrast them to practices transferrable to other campuses.
3. You will identify best practice lighting and HVAC technologies and design approaches.
4. You will identify one college campus' strategic approach to capital renewal.

UC SAN DIEGO MASTER CONTROLLER MICROGRID PROJECT

UC San Diego Operates a 42 MW Microgrid

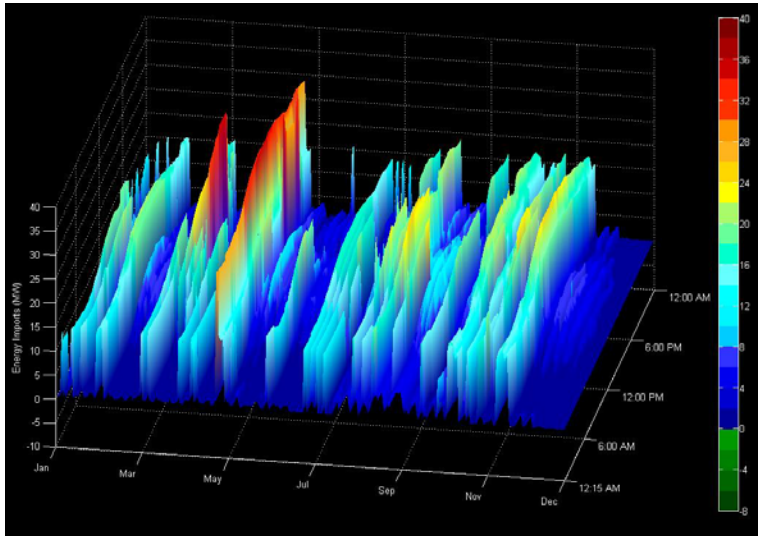
With a daily population of over 45,000, UC San Diego is the size and complexity of a small city.

11 million sq. ft. of buildings, $250M/yr of building growth

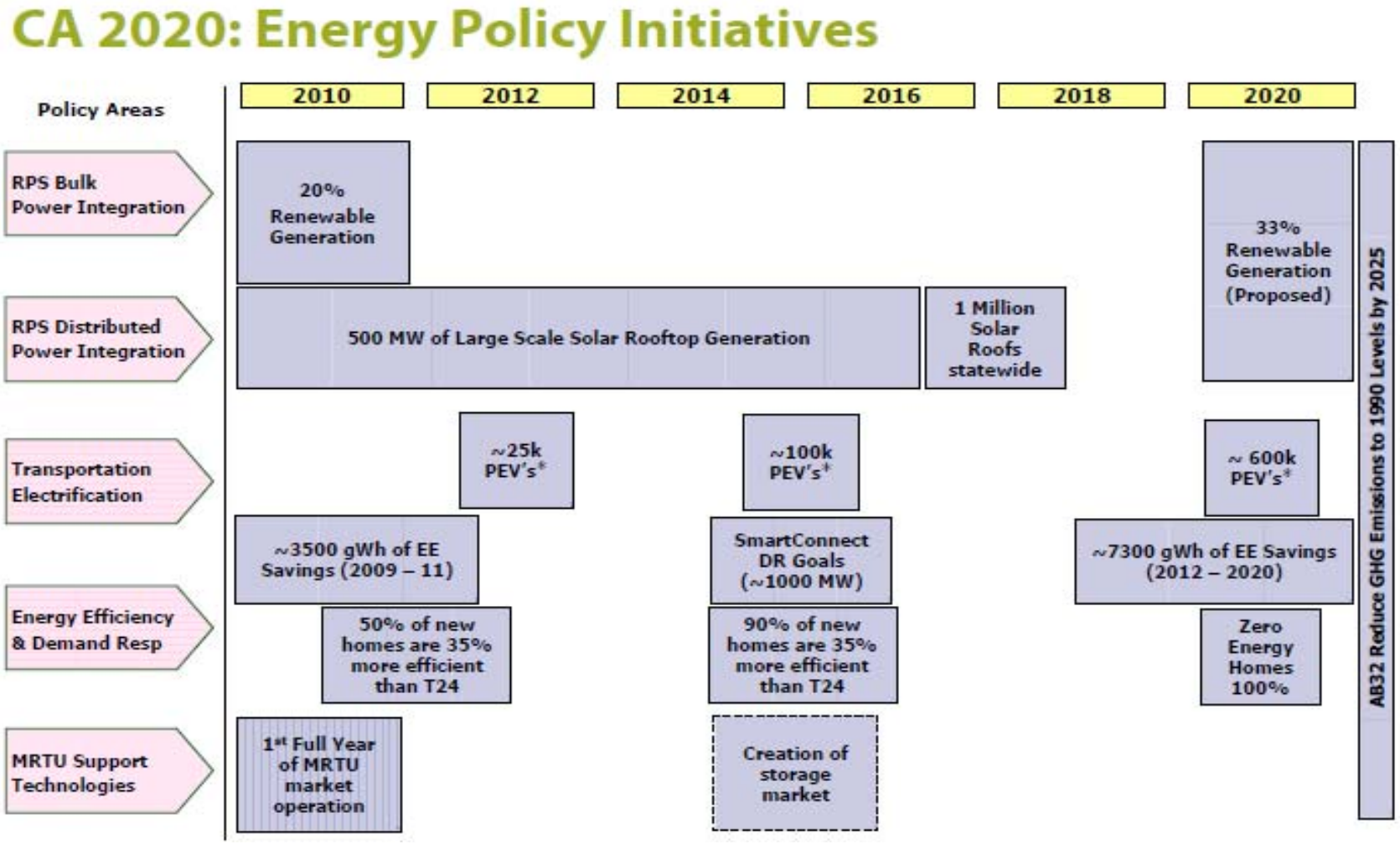
Self generate 80% of annual demand

- 30 MW natural gas Cogen plant
- 2.8 MW of Fuel Cells contracted
- 1.2 MW of Solar PV installed, additional 2 MW planned
- Twice the energy density of commercial buildings

UC San Diego grid imports 2007



California's Energy Policy Initiatives



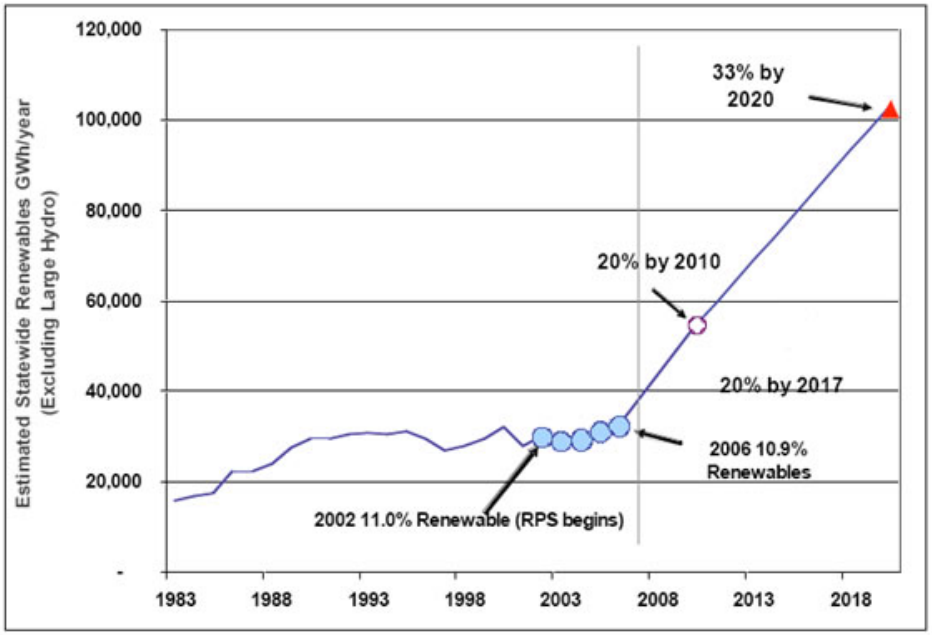
California's Energy Policy Renewable Energy Requirements

Generally considered the best renewable energy law in the nation, California's Renewable Portfolio Standard (RPS) became effective in 2003.

As originally written, the RPS required retail sellers of electricity to increase the amount of renewable energy they procure each year by one percent such that the renewable energy content of their electricity portfolios would equal 20 percent by 2017.

Because of perceived progress towards this goal, the California Energy Commission (CEC) and Public Utilities Commission (CPUC) recently accelerated the 20% goal to 2010, and added a goal of 33% by 2020.

Currently Not on Track For 20% by 2010



Source: California Energy Commission, Gross System Power 1998–2005.[239]

Creating a *Green* Smart Microgrid

UCSD's Microgrid will embody all 7 Smart Grid Functions envisioned by the Energy Independence & Security Act, 2007

RESCO $2M program with CA Energy Commission will deploy:

- Advanced master controller for microgrids
- Optimizer re- scheduler platform for dynamic market signals allow optimization of storage and supply
- Real time data acquisition for analysis

UCSD's Perspective on Energy Storage

UCSD is pursuing 4 energy storage projects

- Distributed Energy Storage
- Frequency Regulation
- Optimized Thermal Energy Storage
- Grid to Vehicle Integration

UCSD has issued a $3.4M RFP for 2 MW / 10 MWH of Advanced Energy Storage and currently in negotiations.

The result will be a smart microgrid that is nationally replicable and scalable

Thermal Energy Storage

14% Daily Load Shifting with Thermal Energy Storage

- 3.8 Million gallon thermal energy storage tank
- Heat recovery drives 3 steam expansion chillers that provide 9,750 refrigeration tons (33 MW) of cooling
- Equivalent to an annual electricity savings of 7-14 GWh and peak load reduction of 5-10 MW

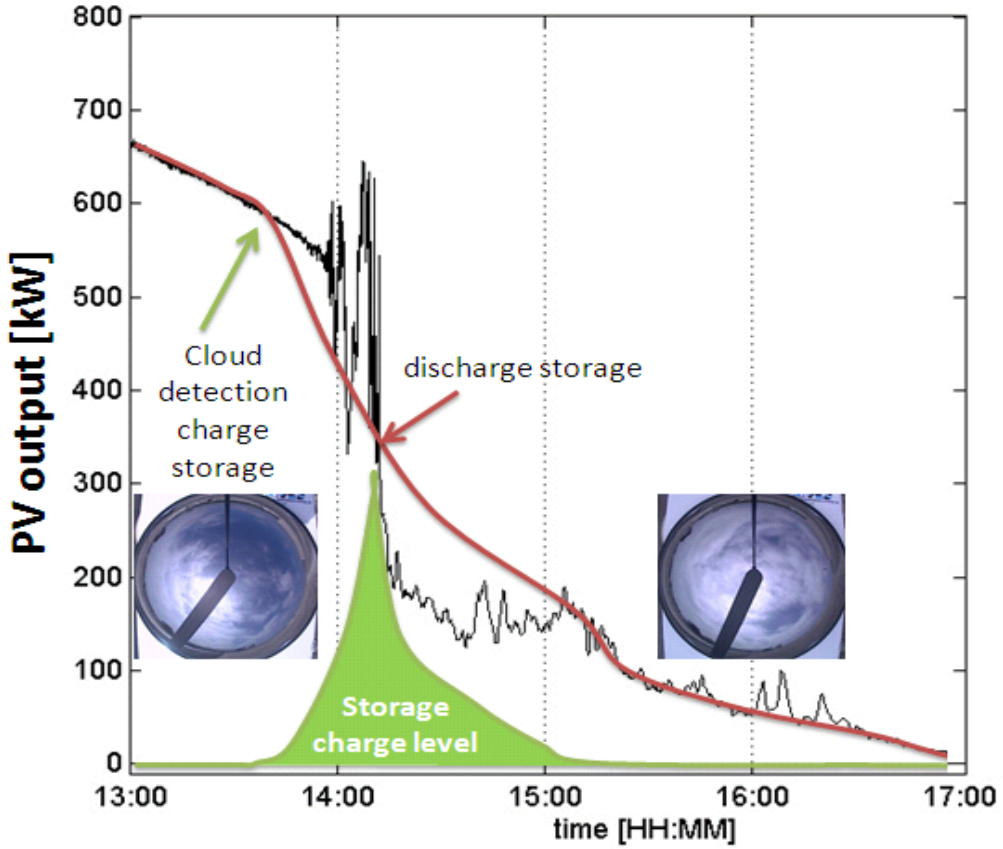
Integration of Solar with Storage Optimization

16 advanced weather stations across campus provide dense network of microclimate data

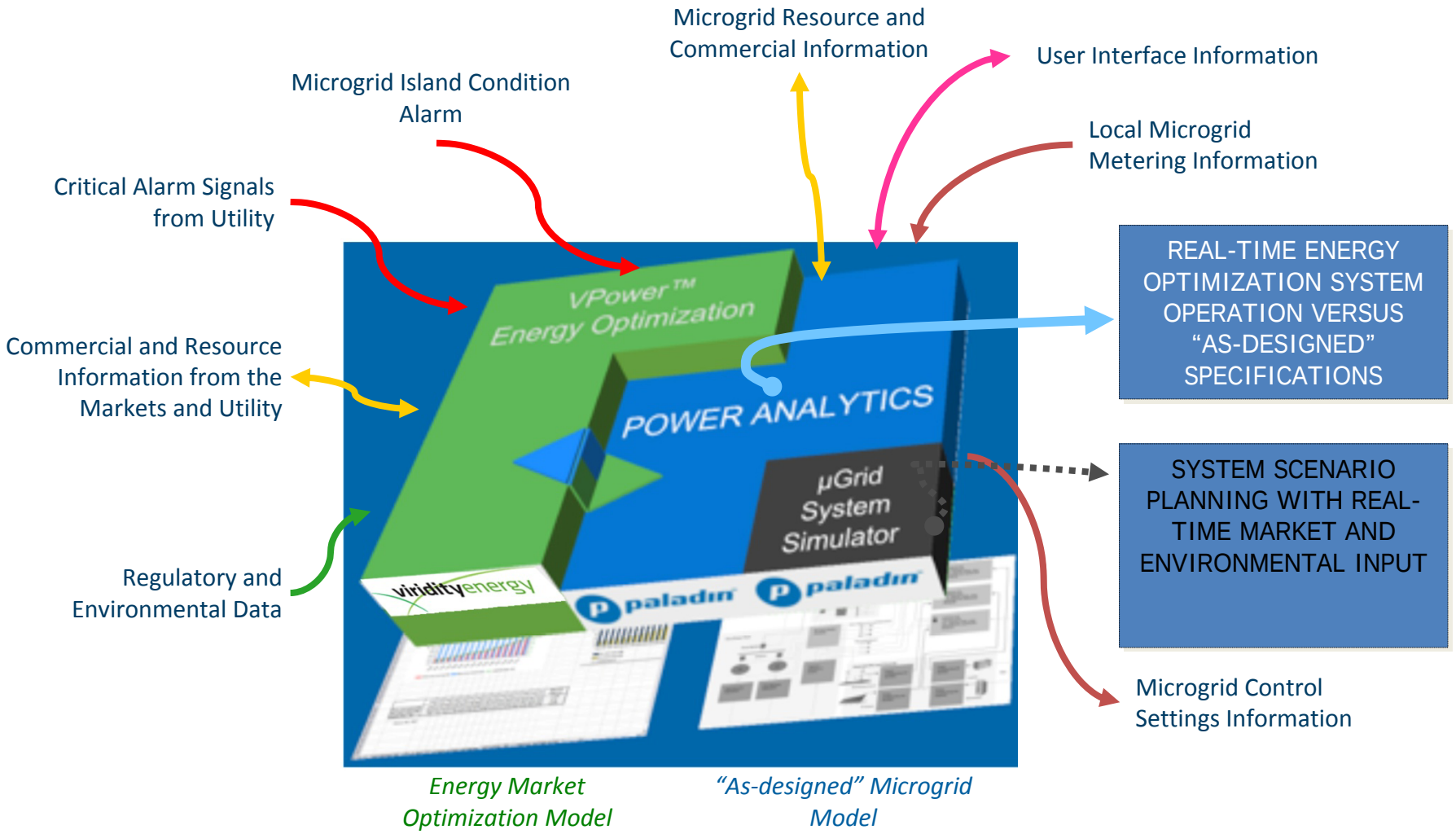
Automated Cloud Detection Alert has the potential to Manage Energy Storage in Real Time

- Automated cloud detection and alert
- Energy storage control based on PV output drop
- Decrease PV ramp rates from 50 kW/sec to 1 kW/sec
- Avoid voltage flicker and power outages

Energy Storage Controller for High PV Penetration



Power Analytics with Paladin SmartGrid™



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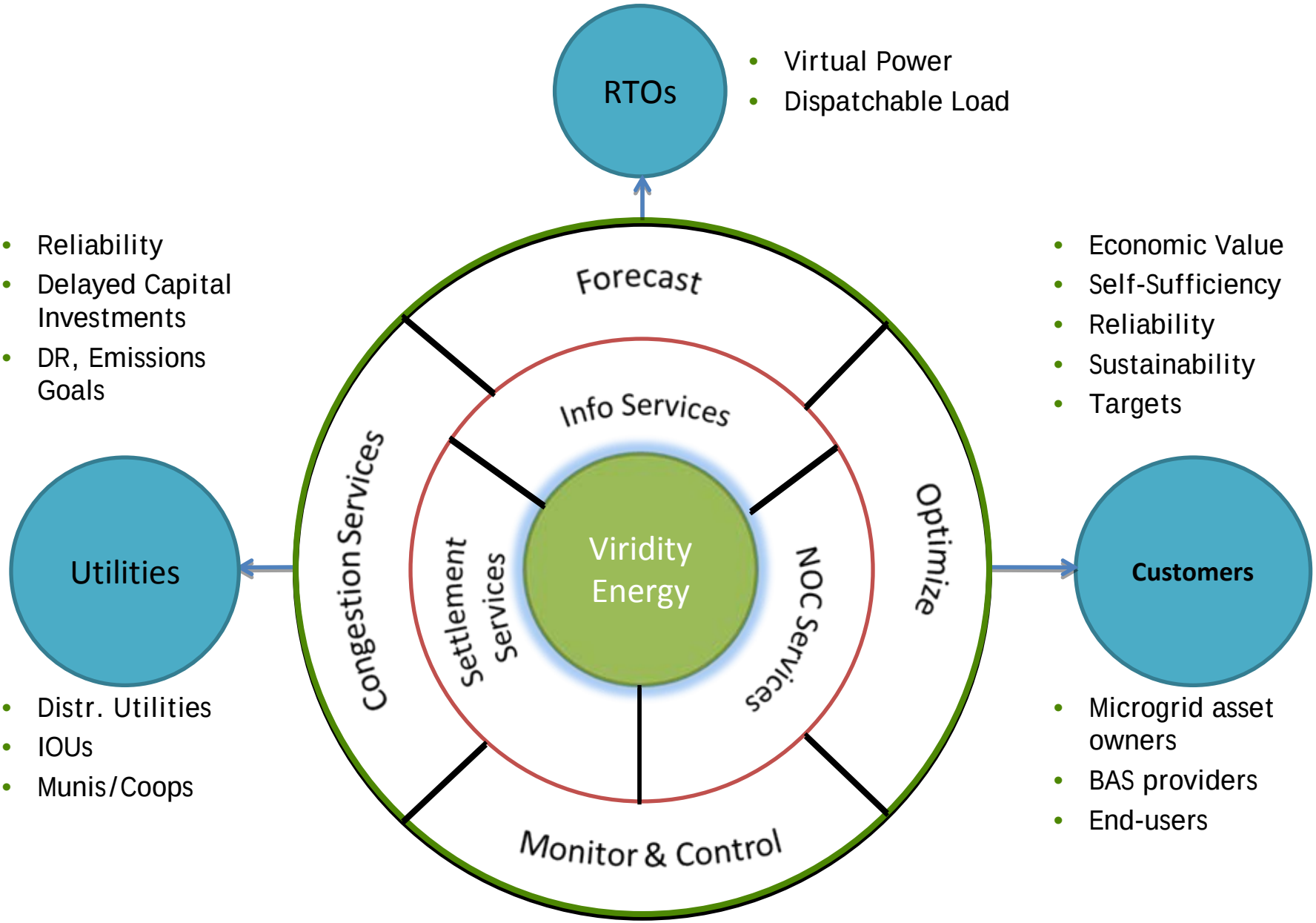
Viridity Energy's VPower™

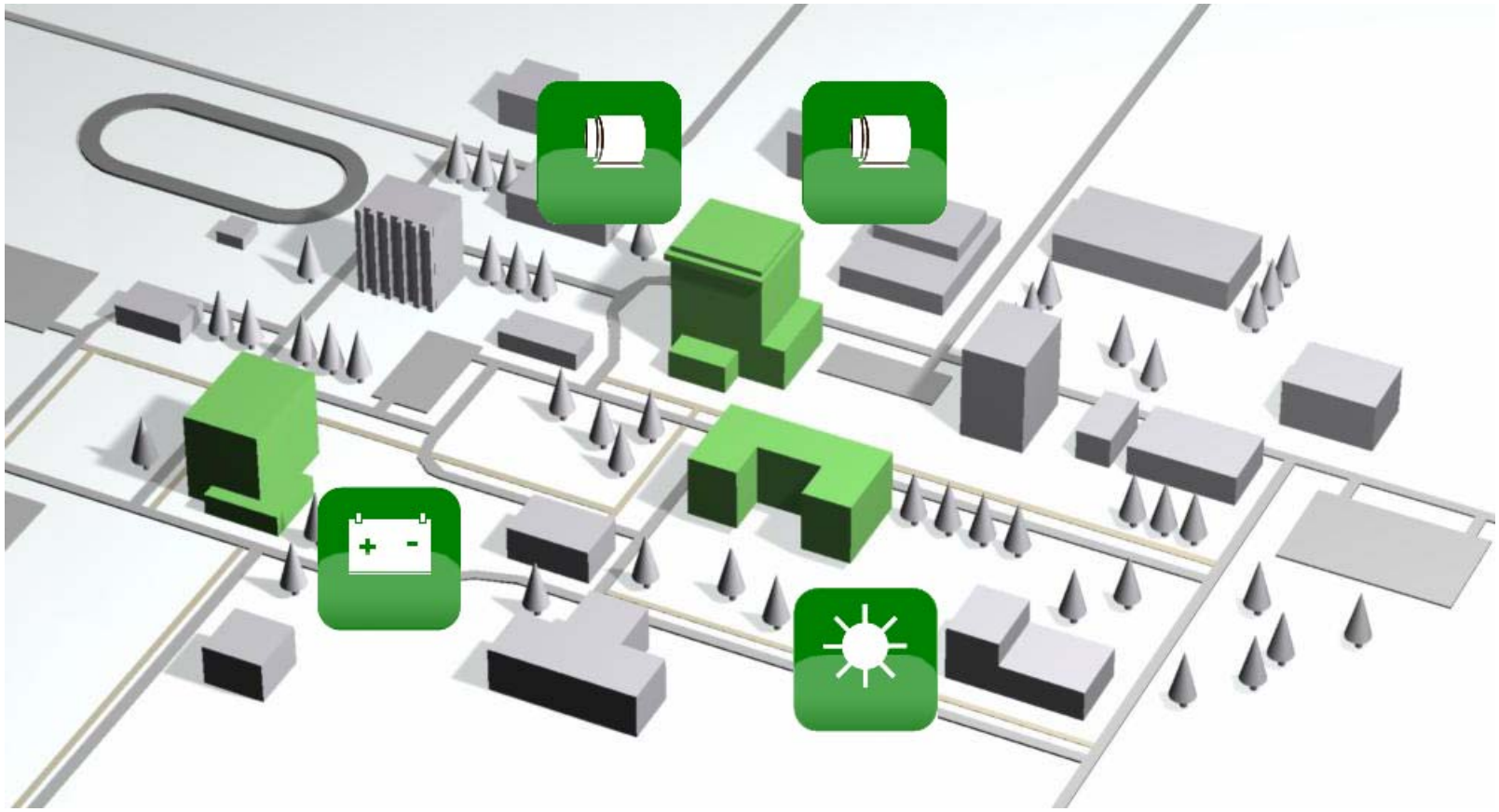


UC San Diego Microgrid Demonstration

Smart Grid Master Controller Screen

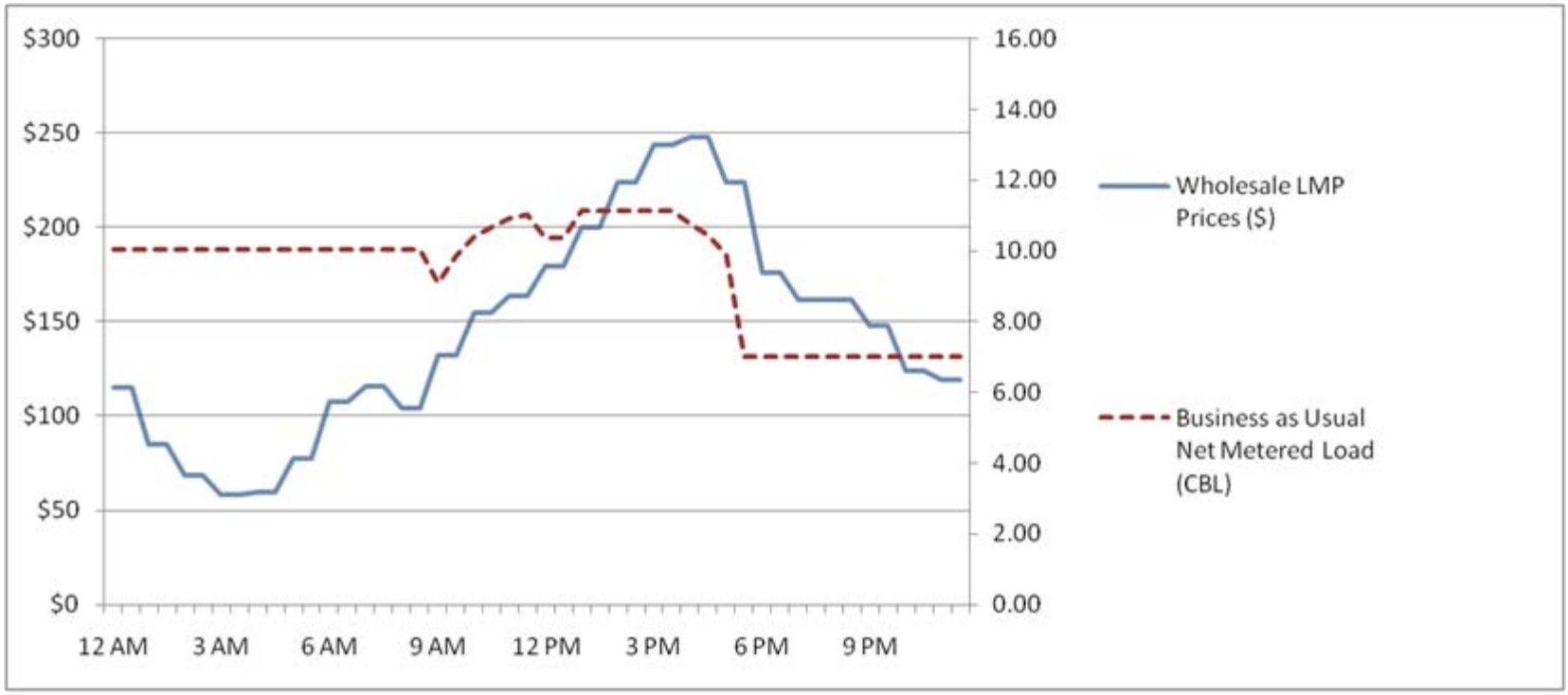
Philadelphia Campus example in PJM ISO

Date: June 27, 2008 / Pre-optimized load: 11 MW / Electricity Costs: $60 per MWh



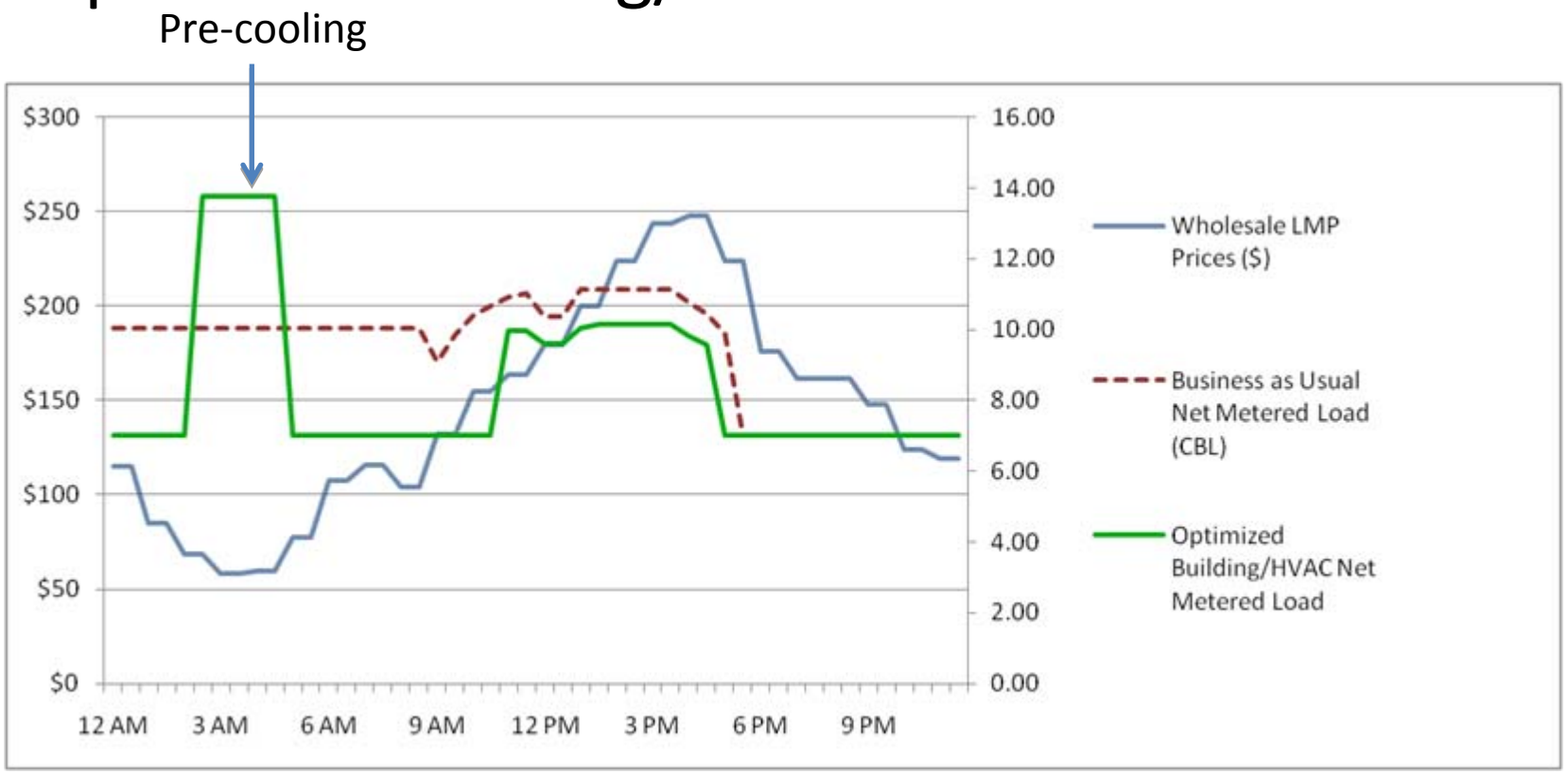
A Greater Philadelphia Campus

Business as Usual



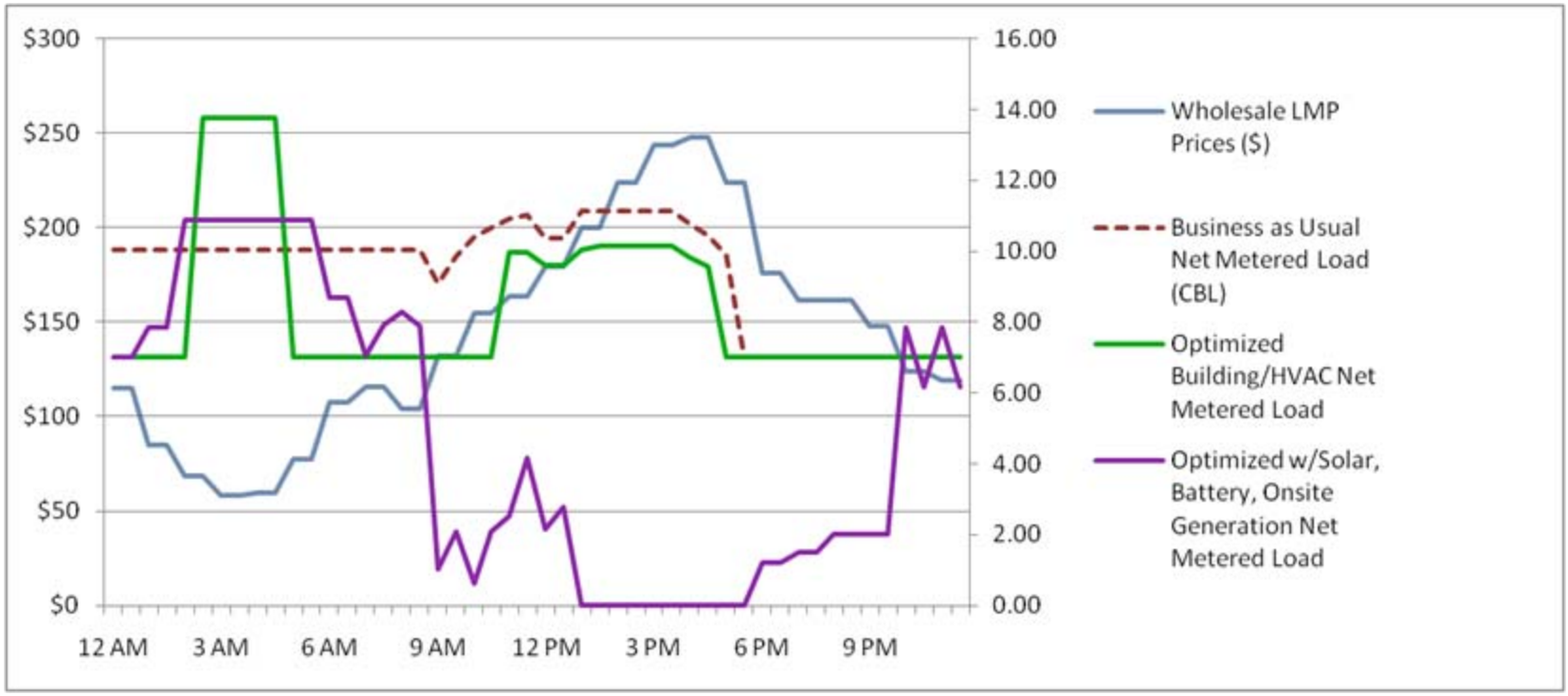
Business as Usual	
Daily Electricity Bill:	$13,574
Supply Savings:	n/a
Virtual Generation Revenue:	n/a
Total Daily Economic Benefit:	n/a

Optimized Building/HVAC Net Metered Load



Optimized Building/HVAC Case	
Daily Electricity Bill:	$12,153
Supply Savings:	$1,422
Virtual Generation Revenue:	$3,108
Total Daily Economic Benefit:	**$4,530**

Optimized w/Solar, Battery, Onsite Generation



Optimized w/ Solar, Storage, and Onsite Generation Case	
Daily Electricity Bill:	$6,723
Generation Costs:	($13,218)
Supply Savings:	$6,851
Virtual Generation Revenue:	$17,832
Total Daily Economic Benefit:	**$11,465**

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Case Studies

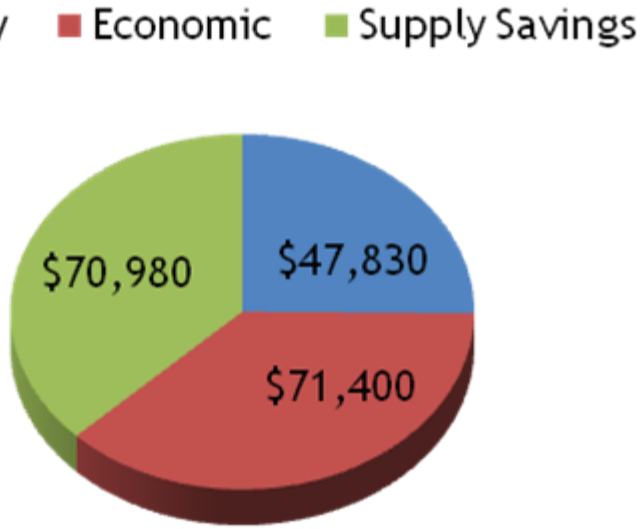
Benefits and Savings Comparisons With Other Campuses

Harvard University

1 MW, ISO-NE territory, HVAC Optimization of 5 Buildings
Financial analysis

Annual Benefit Summary

Capacity	$47,830
Economic	$71,400
Supply Savings	$70,980
less gen. costs	($28,665)
Total Benefit:	$161,545



Assumptions:

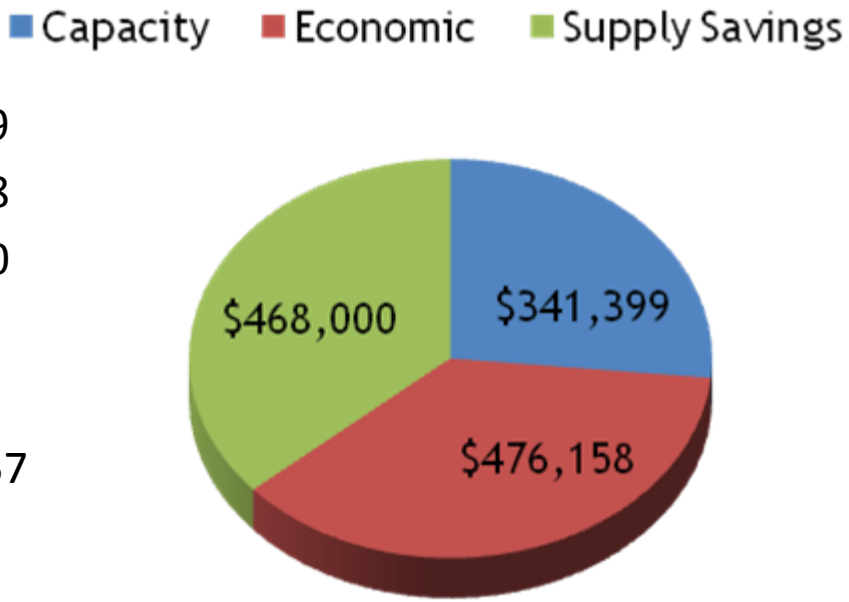
780 hours/yr of Economic (DALRP) participation
1 MW of load management via HVAC optimization for
5 buildings with no capital investment

Greater Philadelphia Campus

10 MW, PJM territory
Financial analysis

Annual Benefit Summary

Capacity	$341,399
Economic	$476,158
Supply Savings	$468,000
less generation costs	$0
Total Est. Benefit:	$1,285,557



Assumptions:

780 hours/yr of Economic participation
10 MW of load management

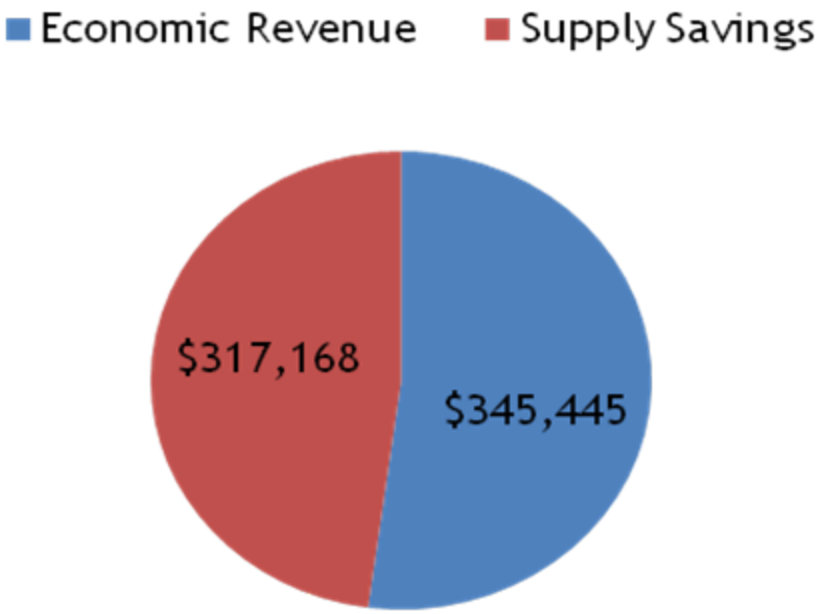
Note: LMP data is PJM PECO Zone average for 2007, 2008, ILR payment is 2010/2011 planning year, G+T = $37.50

UC San Diego

10 MW, CAISO Economic program participation
Financial analysis

Annual Benefit Summary

Capacity	NA
Economic	$345,445
Supply Savings	$317,168
Total Est. Benefit:	**$662,613**



Assumptions:

780 hours/yr of Economic participation, assuming a real-time program similar in structure to those of PJM and ISO-NE

- estimate of hours could likely be double for UC San Diego

10 MW of load management via HVAC optimization and storage-based load shifting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Summary

Thank you for your time!

QUESTIONS??

This concludes The American Institute of Architects Continuing Education Systems Program