Local Impact, National Influence, Global Reach

UC San Diego's Leadership in Microgrids

DOE-CPUC High Penetration Solar Forum

Dr. Frieder Seible
Dean, Jacobs School of Engineering

Our Story

UCSD was established in 1960 on a mesa overlooking the Pacific. Its roots go back to the 1903 birth of Scripps Institution of Oceanography. UCSD's founder, Scripps scientist Roger Revelle, had one criterion for the new UC campus:

"It must be distinctive."

UCSD achieved Revelle's goal in record time, rising meteorically in academic rankings, and making San Diego a global hub of scientific innovation.

ACHIEVING THE EXTRAORDINARY
1960 50 2010
UC San Diego
Local Impact, National Influence, Global Reach

Campus Quick Facts

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

As a **research** and **medical institution**, we have **FOUR** times the energy density of commercial buildings

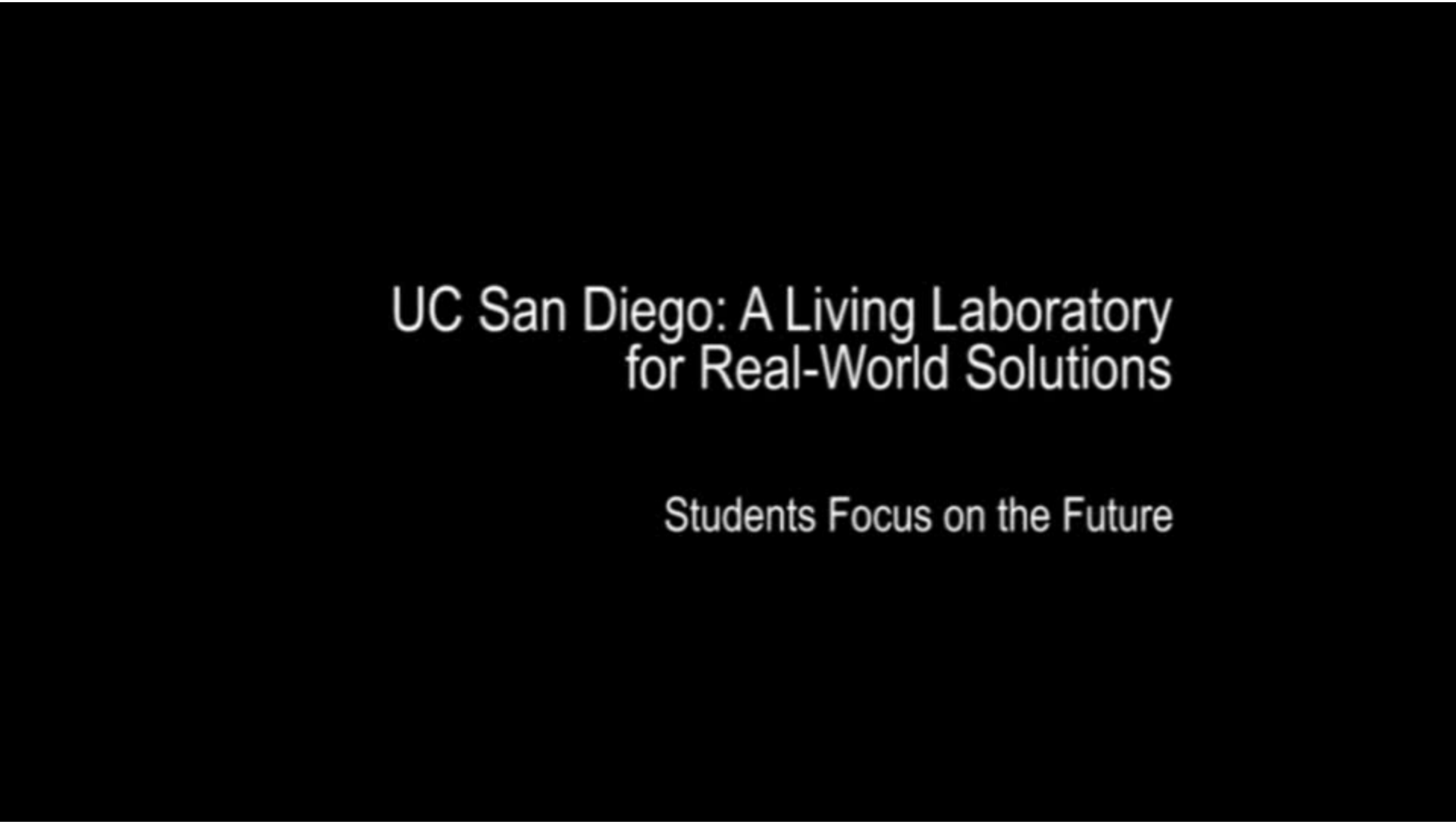
12 million sq. ft. of buildings, $200M/yr of building growth

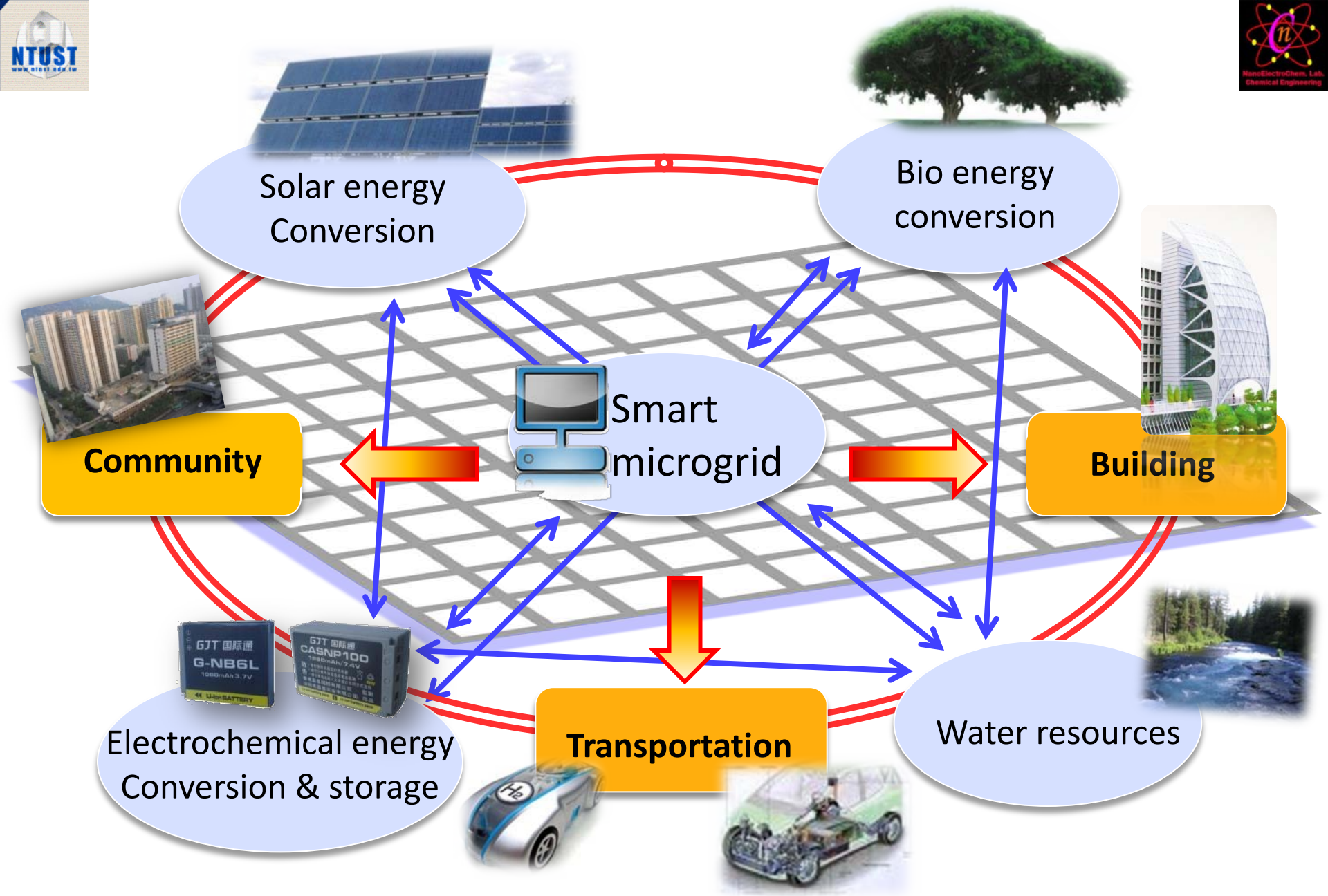
Self generate 82% of annual demand

- 30 MW natural gas Cogen plant
- 2.8 MW of Fuel Cells contracted
- 1.2 MW of Solar PV installed, additional 2 MW planned

UC San Diego Operates a 42 MW_{peak} Microgrid

Students Focus on the Future

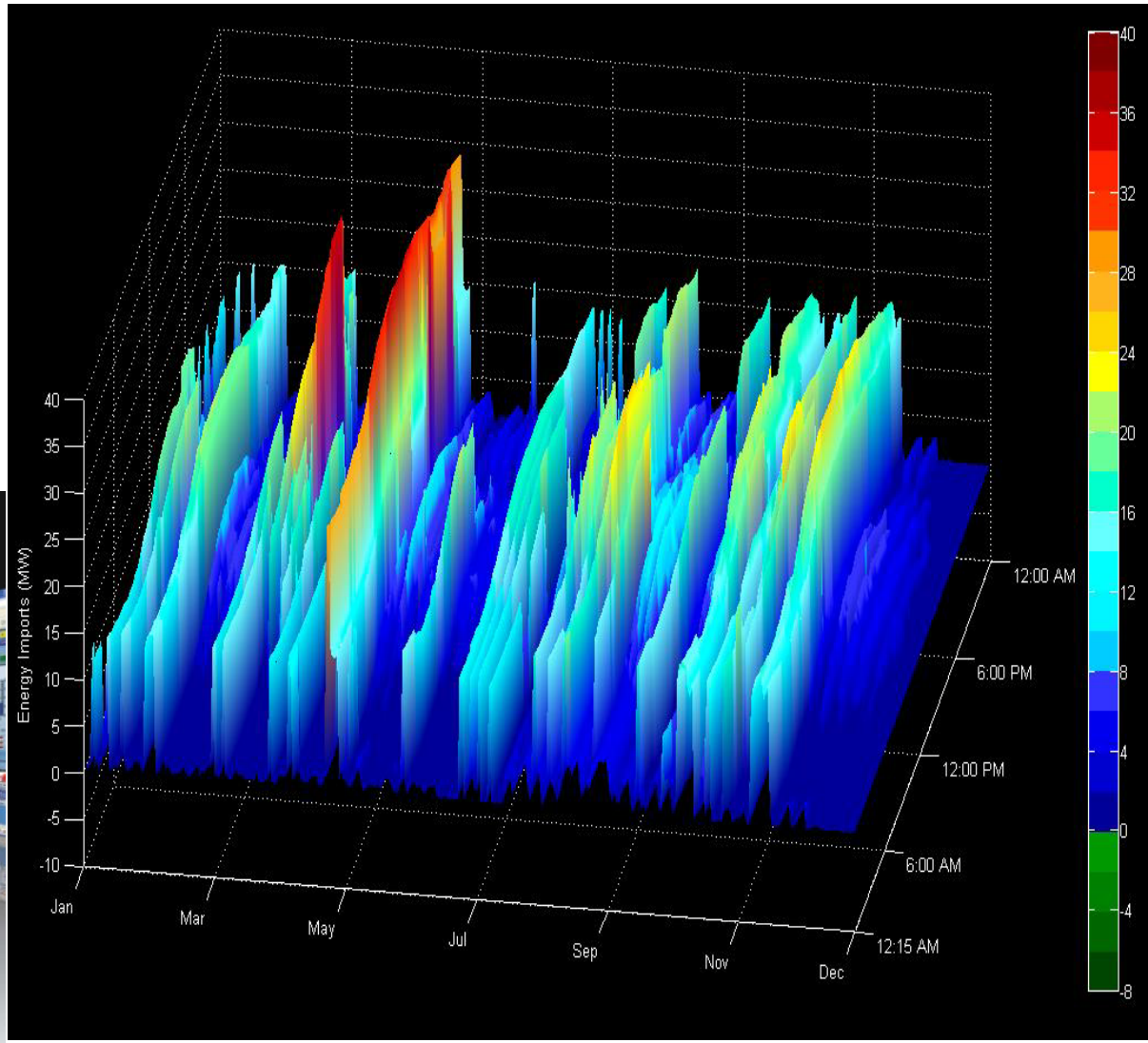



Solar energy
Conversion
Bio energy
conversion
Smart
microgrid
Community
Building
Electrochemical energy
Conversion & storage
Transportation
Water resources

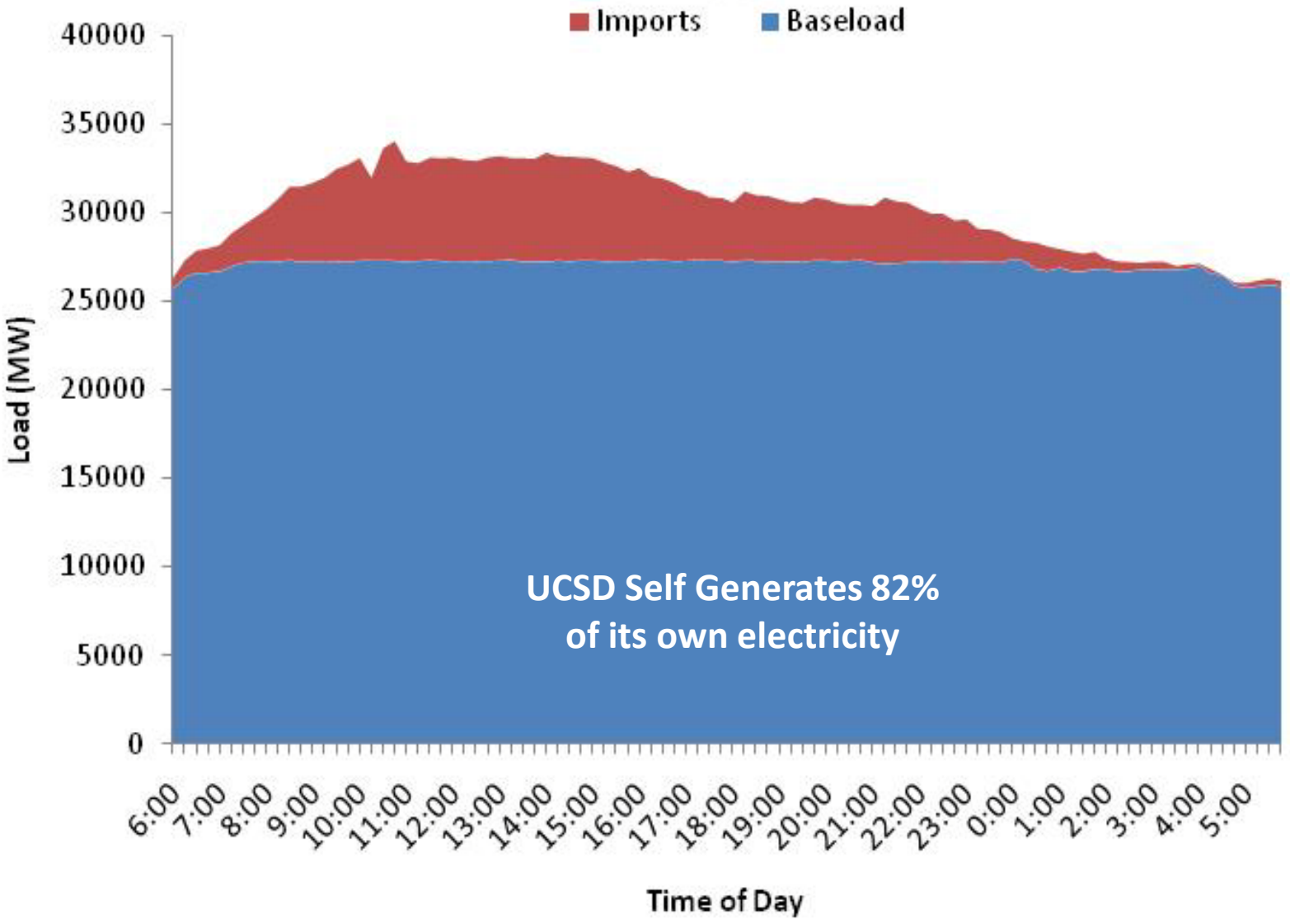
Creating a *Green* Smart Microgrid

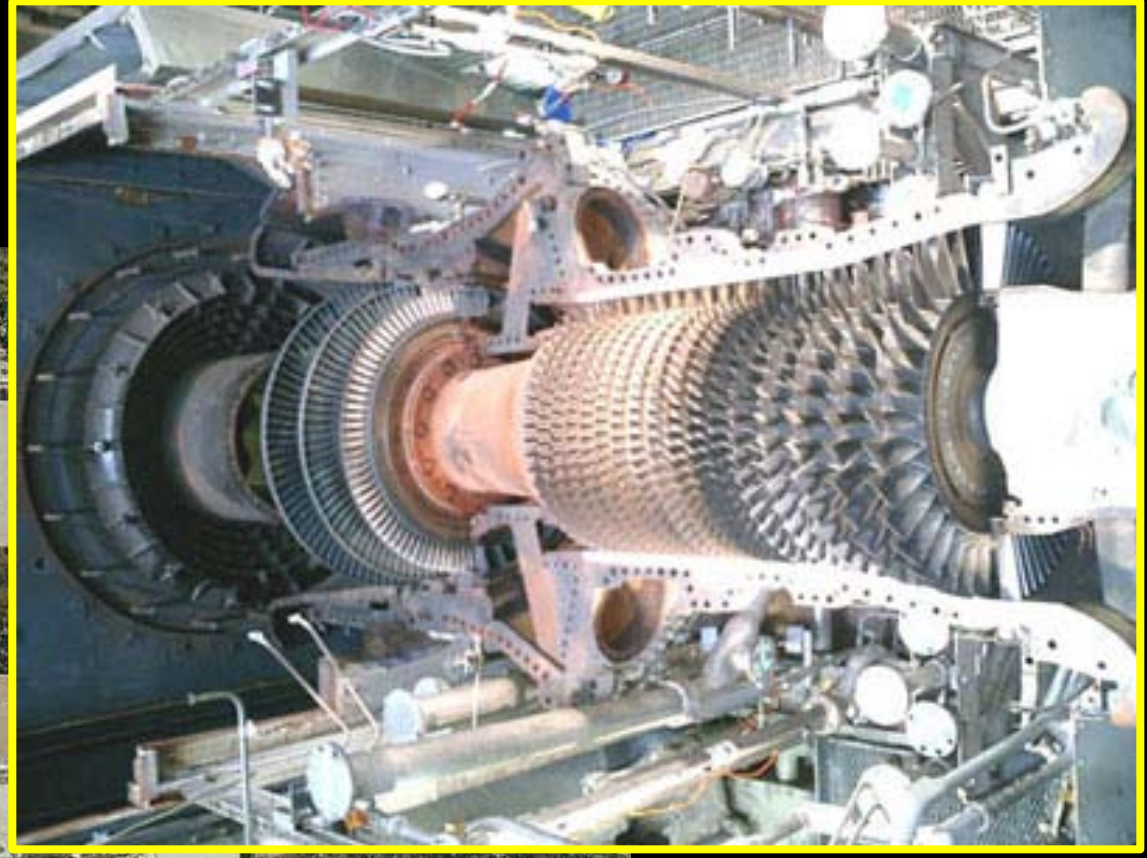
Goal is to create an Unparalleled Granularity of Knowledge for dynamic and efficient operations

The use of San Diego Super Computer will provide an unprecedented real time data computing, analysis, and visualization.

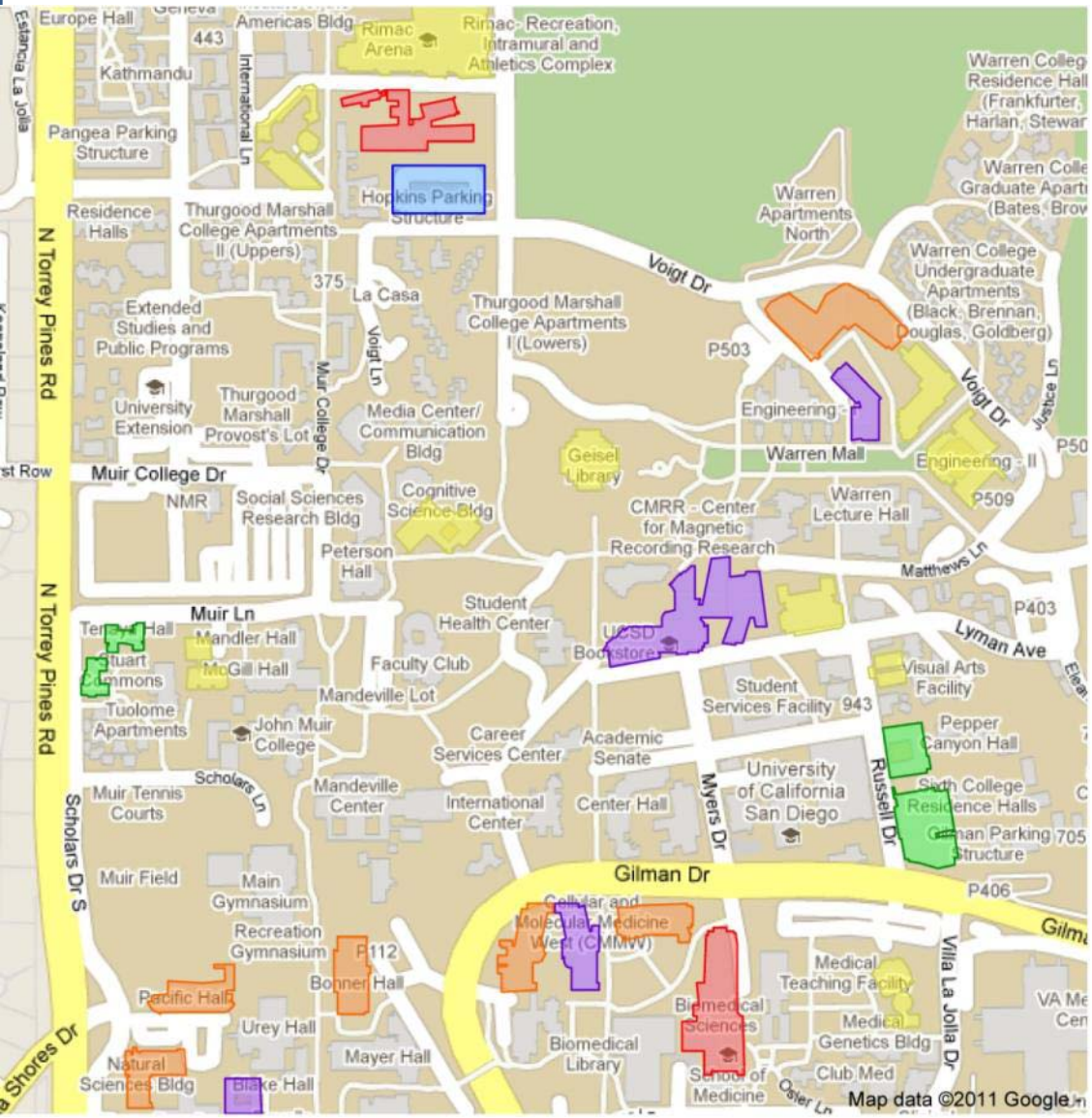


UC San Diego Typical Load Profile





Campus Energy Dashboard Map



Colors for the buildings correspond to their individual power usage (on average):

Red: 1000+ kW
Orange: 500-1000 kW
Yellow: 100-500 kW
Green: 50-100 kW
Blue: 50- kW
Purple: Meter is currently out of service

Energy Dashboard Sample

Computer Sciences Engineering Dept

- Overall Energy Usage Meters
- Main Power Meter
- Breakdown of Power Usage

- CSE Building Sub-Meters
- Building Machine Room
- Building Overall Lighting
- Building Mechanical Load
- Building Plug Loads

- Individual Circuit Meters
- EBU3B Server Room Monitor Panel T1203B
- EBU3B 4th Floor Lighting
- EBU3B 3rd Floor Lighting
- EBU3B 2nd Floor Lighting
- EBU3B Server Room UPS Minitoring Panel
- EBU3B Emergency Lighting Monitoring Panel E0222A
- Monitoring Main Mechanical Sub Station MP0102
- Monitoring Panel T1203C in Server Room
- EBU3B 1st Floor Lighting
- Monitoring Panel T1203A in Server Room
- Monitoring Panel M Server Room Equipment
- EBU3B Basement Lighting
- EBU3B Main Building Power Sub Station A
- EBU3B Main Building Power Sub Station B
- EBU3B Elevator Load
- Chilled Water Loop Flow

Energy
Energy Efficient Computing

NSF Project GreenLight:
New Ways to Measure Energy Efficiency of Computers

As part of research project, UC San Diego is consolidating Computer servers in energy-efficient mobile facilities.

Goal: Towards the Net-Zero Energy Building

-The CSE building at UCSD is an ideal research test bed.
-Currently the CSE building consumes 80 kBTU/ft^2.

Increased energy efficiency

Deploy SleepServer
- Machine room: 142 kW → 71 kW
- Plug loads: 130 kW → 70 kW

Occupancy Driven HVAC and Lighting
- Intelligent Lighting: 50 kW → 11 kW
- Occupancy HVAC: 65 kW → 40 kW

- End goal is to reduce energy usage down to 42 kBTU/ft^2!

Solar PV energy generation

Install solar cells on roof top of CSE
- Generates energy during peak times
- Can feed back to grid during emergencies

Use large-capacity battery systems
- Stores energy from grid during off-times

CSE Solar energy: 2700 m^2 roof	111 kBTU/ft^2
Solar PhotoVoltaic: 20% efficient	22 kBTU/ft^2

- End goal is to achieve energy production of 42 kBTU/ft^2!

Intelligent energy management

- Energy Dashboard measures and monitors energy usage
- Sanyo SES will be integrated to control energy consumers
- Implements demand-response mechanisms when needed

Current Energy Research Efforts and Projects

The Energy Dashboard (http://energy.ucsd.edu)

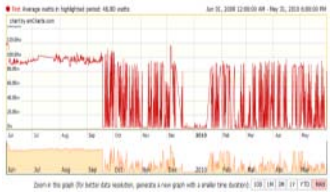
-Visualizes real time energy usage across the CSE building and entire UCSD campus

- Can monitor and detect energy events

SleepServer and *Somniloquy*

-Allows computers to "sleep" while mainting their network presence, 50+ **user deployment currently**

- 68% average reduction in energy consumption!

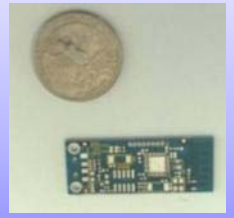


Low-Cost Presence Sensors

-Able to detect occupancy in zones and rooms

-Mass deployable due to lost cost

-Reports to a server to drive HVAC/Lighting

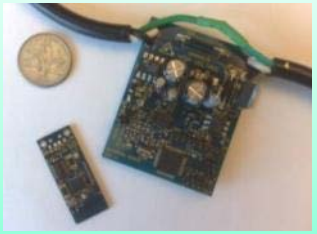


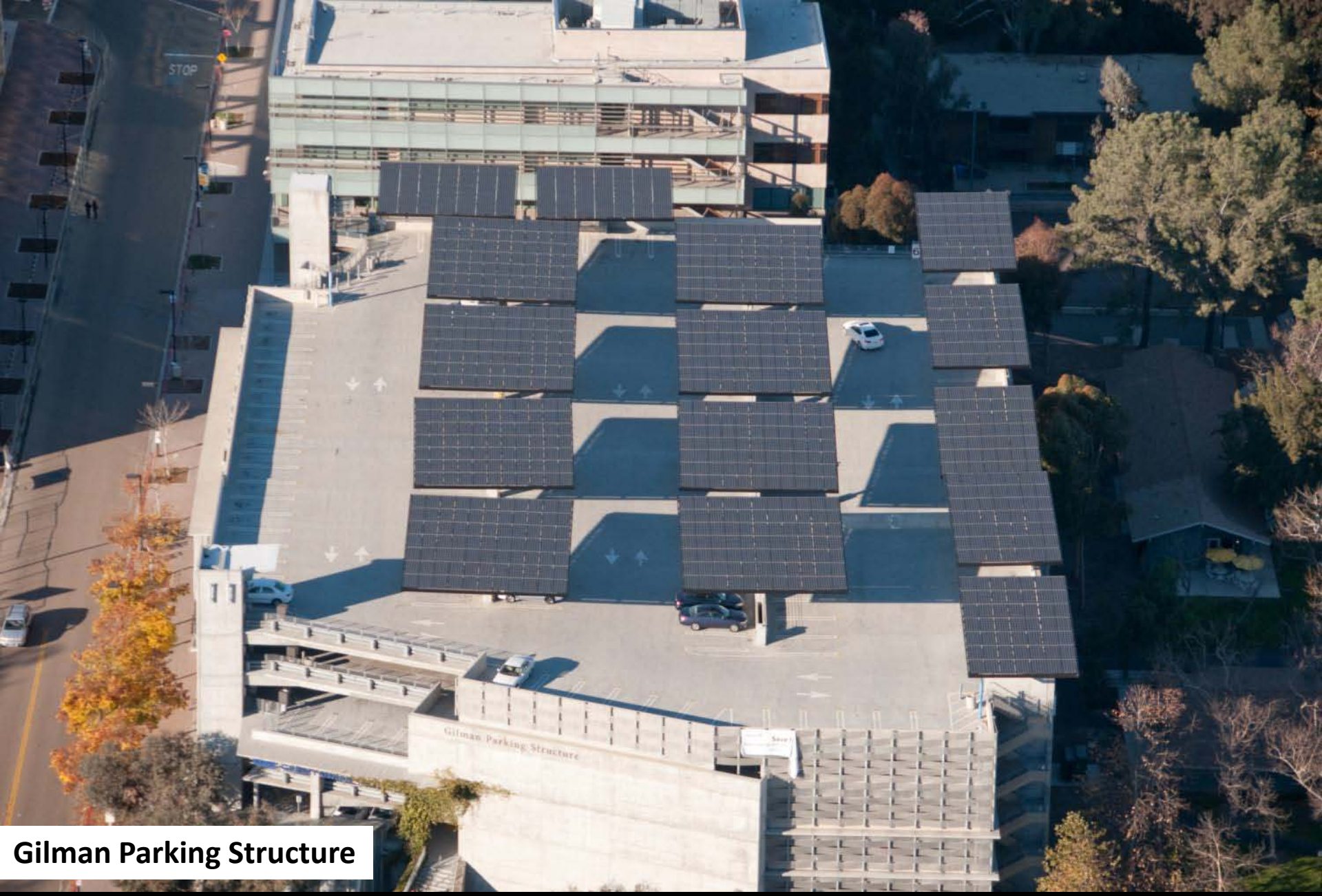
Synergy Energy Meters with Actuation

-High accuracy energy meters for less than $20

-Wirelessly communicates to central server

-Energy usage data used to drive demand response



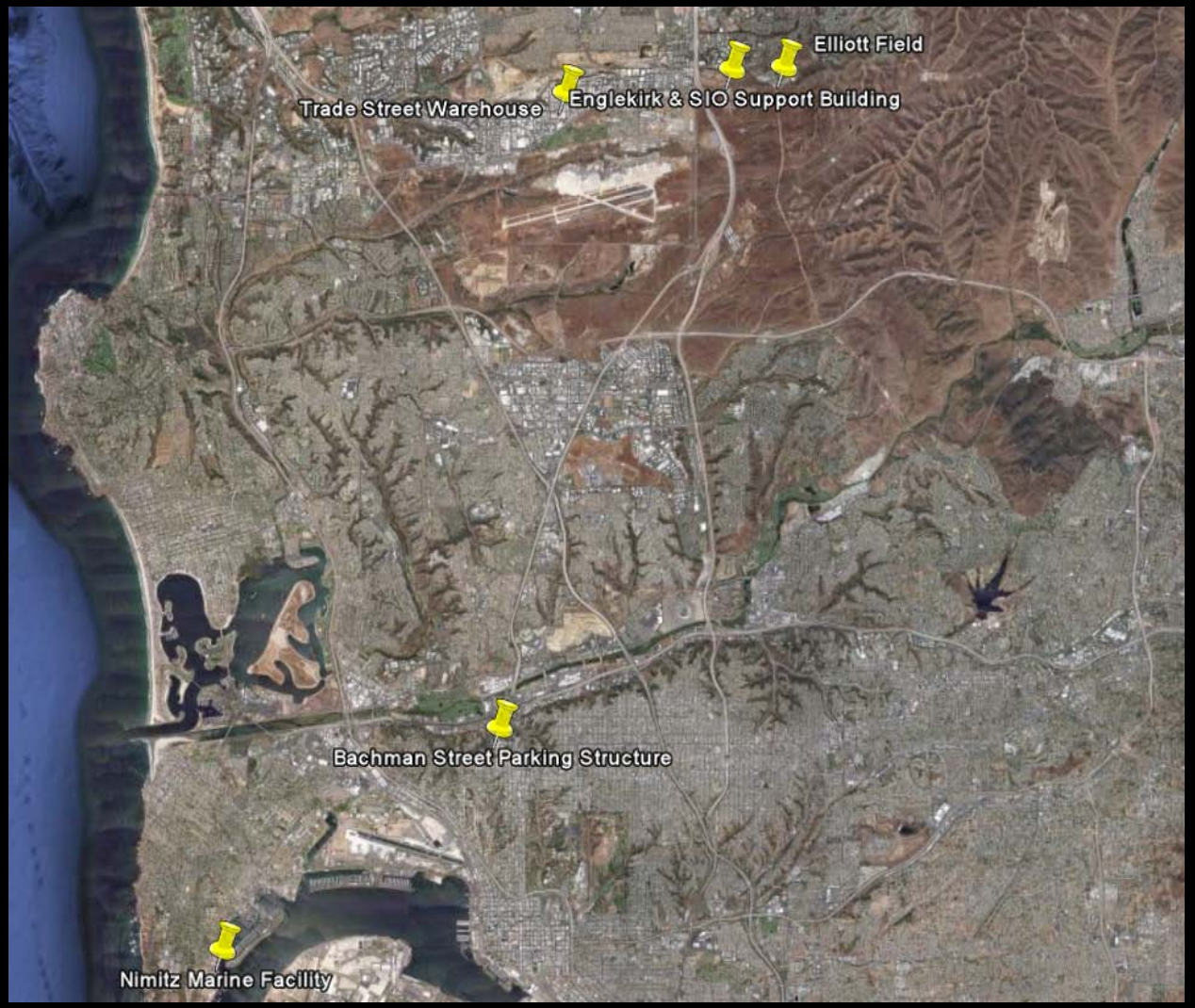


Gilman Parking Structure


© 2010 Google
32°52'59.00" N 117°13'46.26" W elev 330 ft

Hopkins Parking Structure

900 kW Off Campus Sites with Clean Renewable Energy Bonds



900 kW RFP issued for 5 PV Off Campus Sites roof & ground; fixed & dual axis tacking (CPV)

Potential for Another 2 MW of PV Integrated with Storage

Smart City San Diego …

A collaborative approach from strategy to execution

UCSD-GE-SDG&E-City of San Diego-CleanTech San Diego Collaborative

UCSD's Legacy Infrastructure Enables Zero Carbon Emissions, DC to DC On Peak Charging

- Funded $3.5M of Solar PV
- Funded $17M Fuel Cell

Governor Designated San Diego as the Latest Innovation Hub

San Diego iHub Now Joins California's Innovation Corridor to Advance State's Economic Innovation and Global Competitiveness

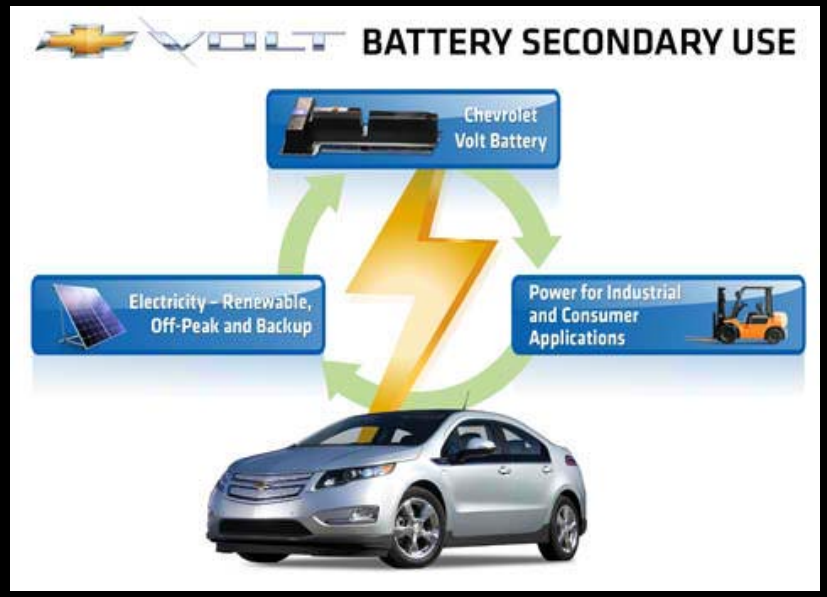
The San Diego iHub wil be focused on the convergence of three clusters: mobile health, biofuels, and solar energy and energy storage

UCSD as R&D leader of CA's iHub for solar energy and energy storage

Demonstration of Sanyo modular PV Integrated Storage System

SDG&E has a CPUC rate case filing for $80M in energy storage

CEC/NREL/CCSE Endurance Testing of "Repurposed" EV Batteries



All in conjunction with $2.5M of ARRA/CEC funding for Modeling Mitigation of High PV Penetration and $.5M of Solar Forecasting

Role of the Research University in "Innovation"

Provide the Human Capital

Provide the Intellectual Capital

Partnership with Industry is Critical to Insure Impact!

Jacobs School of Engineering

- **194 Faculty** (10% National Academy Members)
- **5,862 Students** (Fall 2010)
- **Largest engineering school in California**

#9 **Among World's High Impact Universities.**

High Impact Universities Ranking, 2010

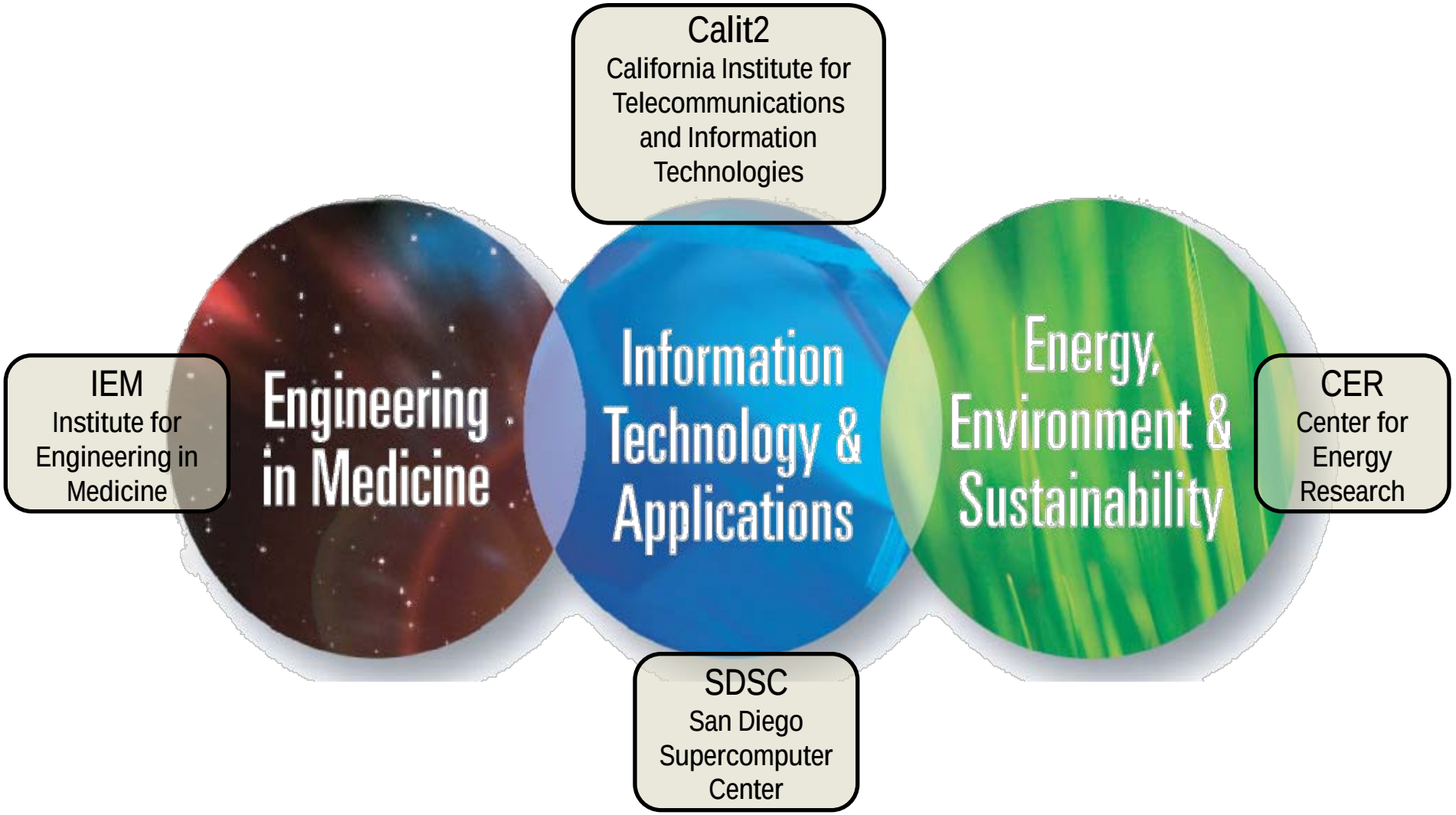
#10 **in the World for Engineering, Technology and Computer Science.**

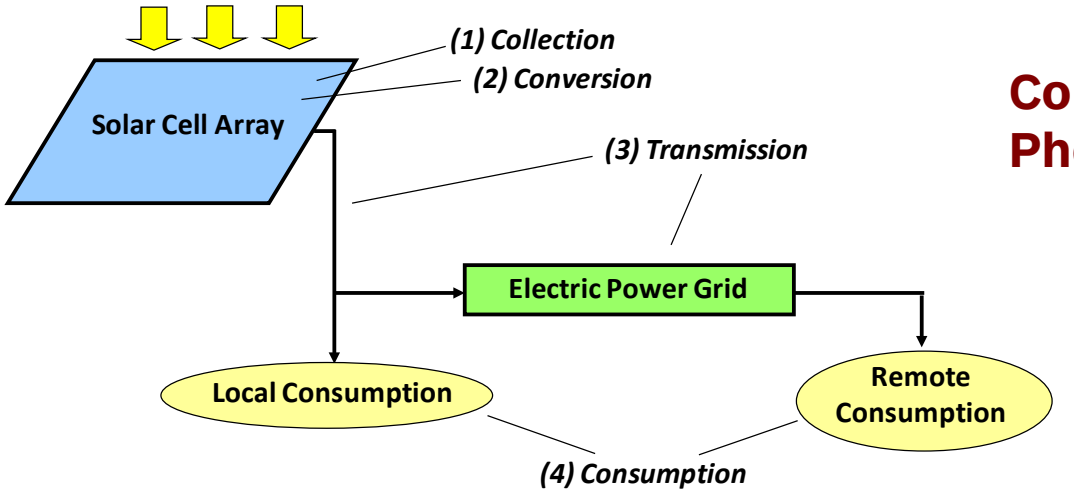
Academic Ranking of World Universities, 2010

#1 **for Biomedical Engineering.**

2010 NRC Rankings

Strategic Research Focus



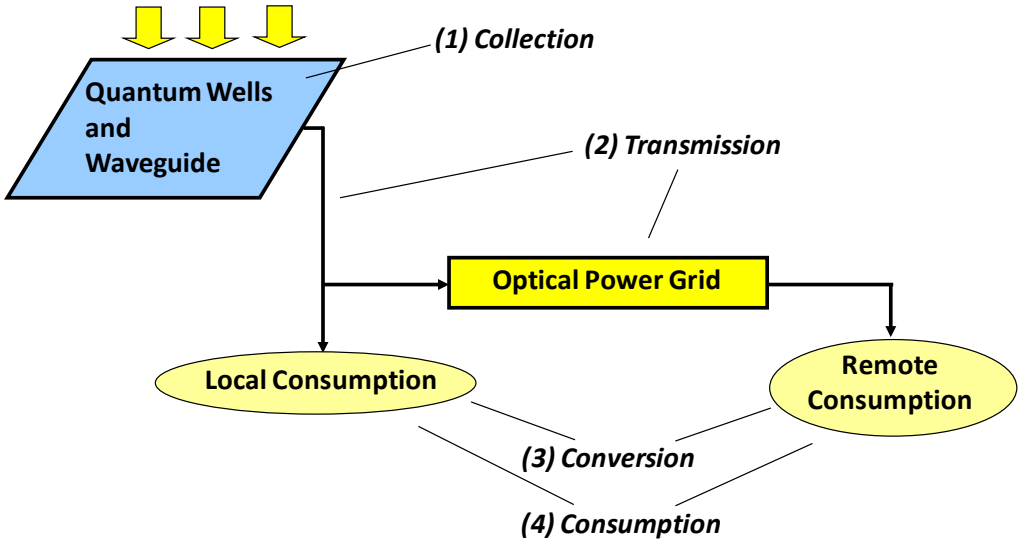


Conventional Photovoltaic Systems

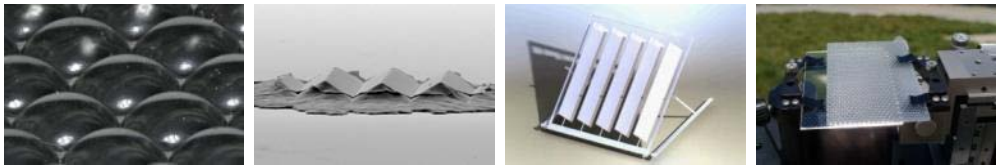
In conventional photovoltaic systems, most of the sun's energy ends up as heat loss right at the collection/conversion point.

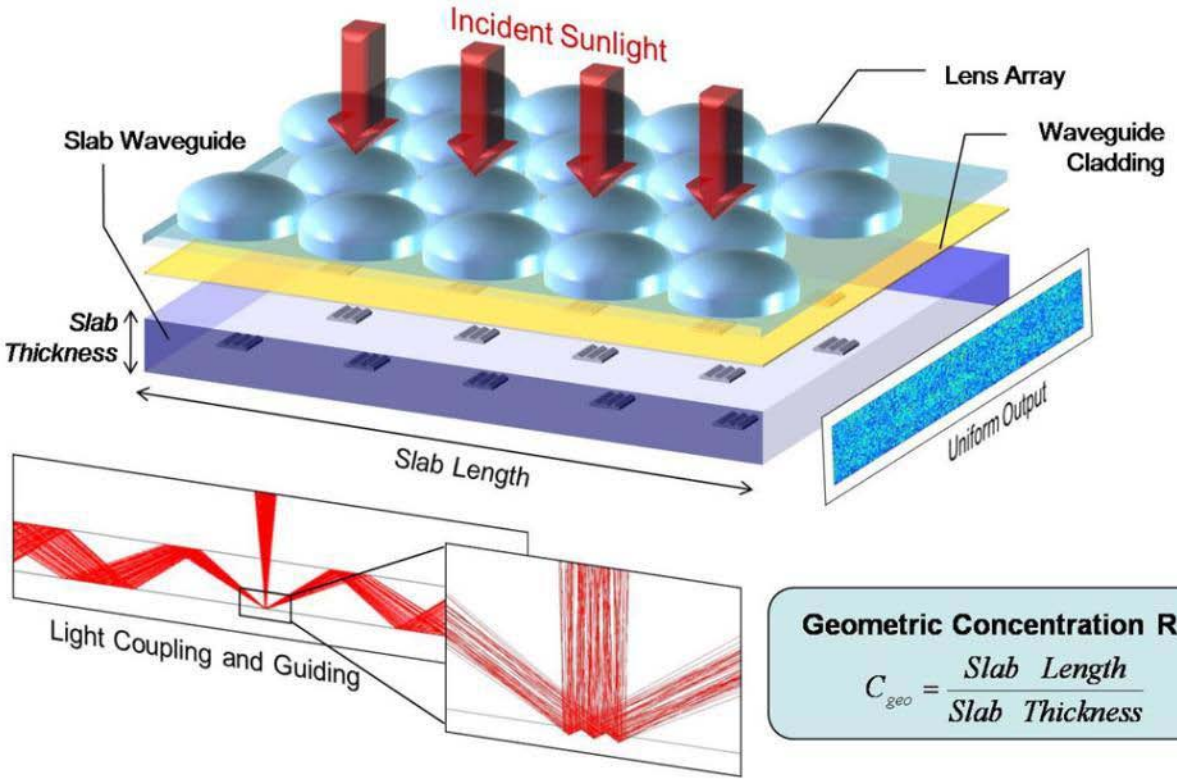
New Approach funded by Von-Liebig

VON LIEBIG CENTER
FOR ENTREPRENEURISM AND TECHNOLOGY ADVANCEMENT



Micro-optic Solar Concentration: Planar CPV Design, Analysis and Prototyping



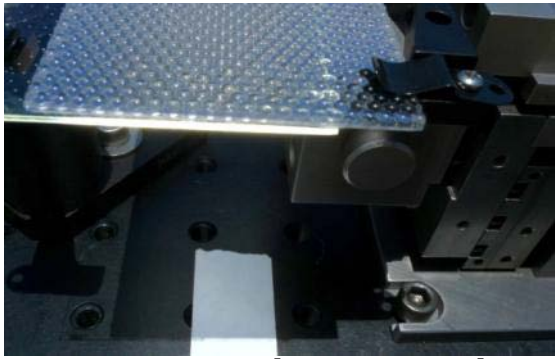


Geometric Concentration Ratio

$$C_{geo} = \frac{Slab\ \ Length}{Slab\ \ Thickness}$$

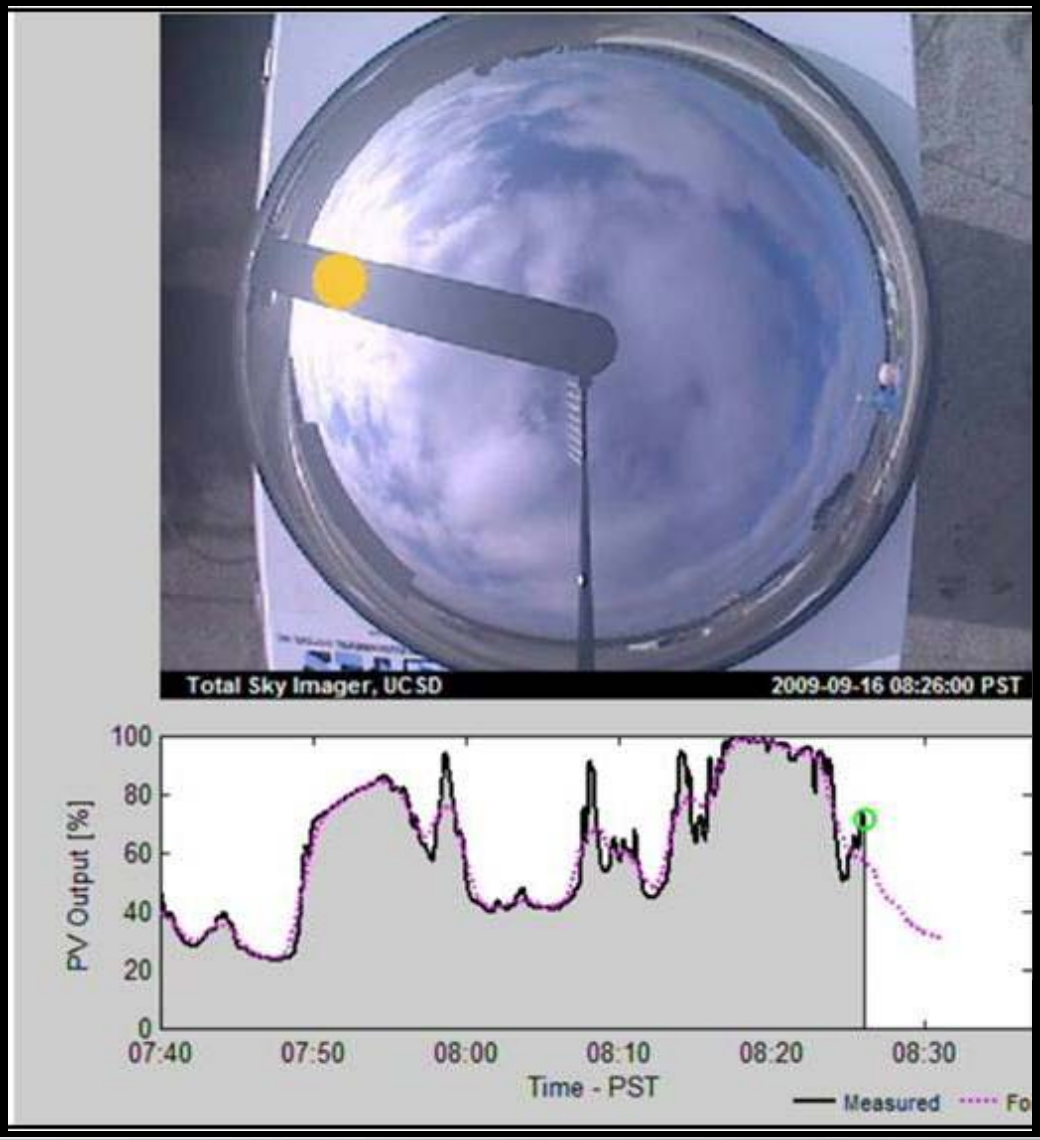
Layers Composing The Micro-optic Slab Concentrator

Prototype system illuminated w/sunlight



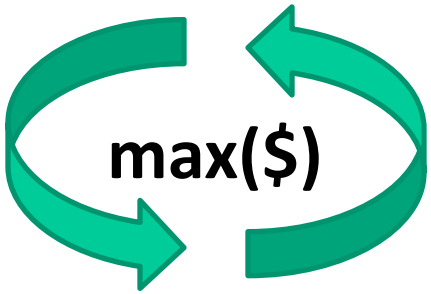
Concentrated output exits the slab edge

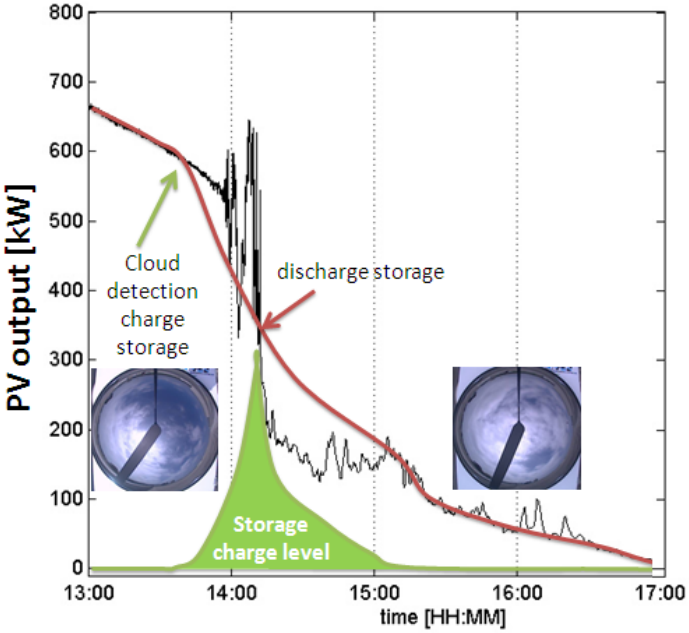
Solar Forecasting

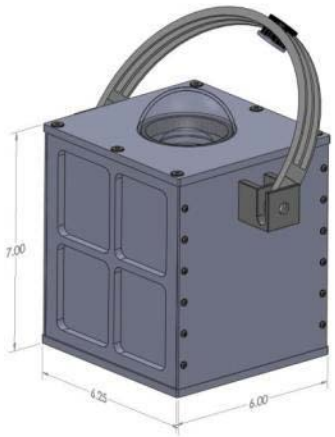


Integrate with Sanyo SES

- 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







- Optimize solar forecast using sky camera
- Integrate into Sanyo SES
- Evaluate demand charge benefits

Bi-National Mega-Region

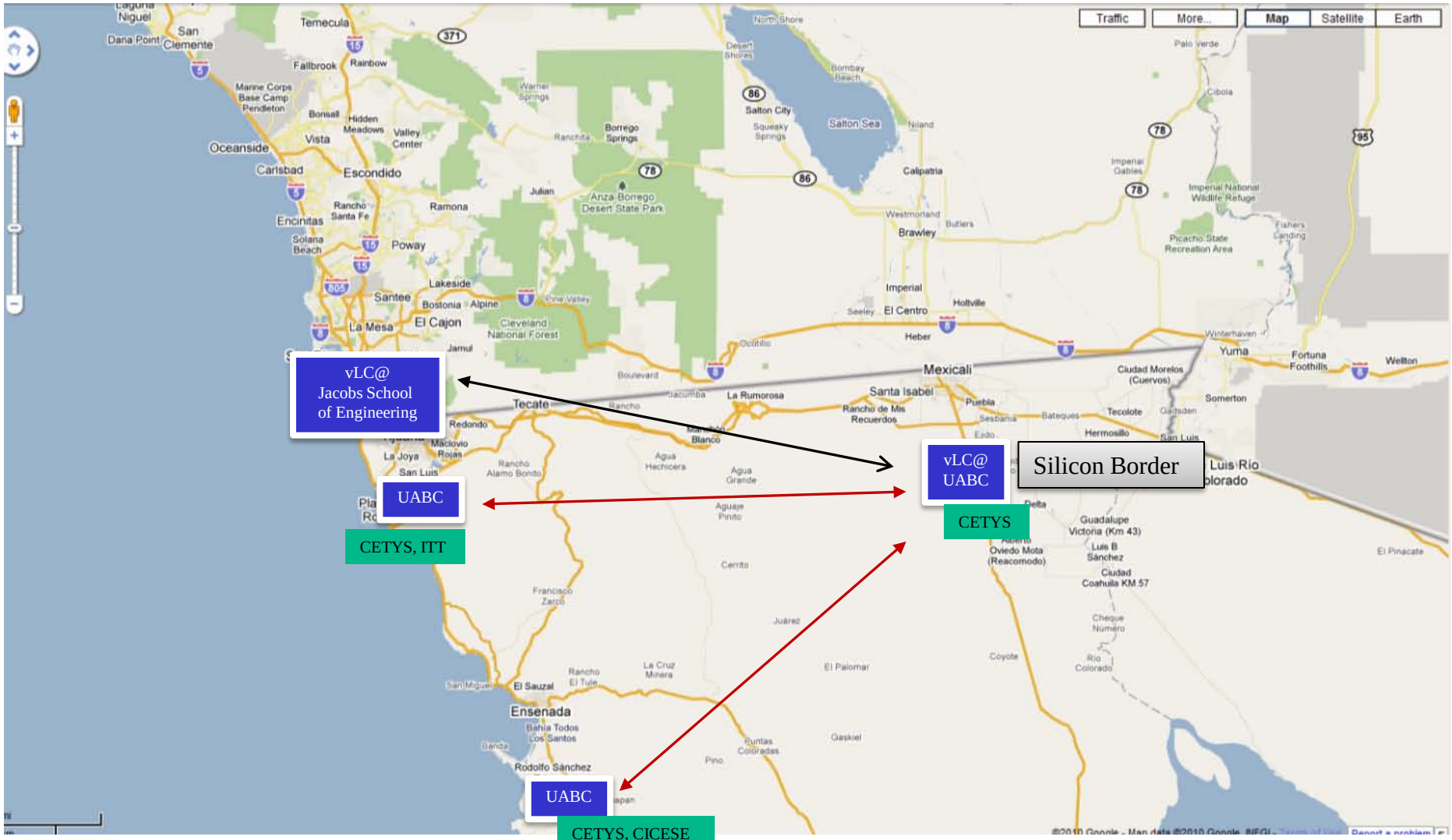
(San Diego-Imperial, Baja California, Mexico)

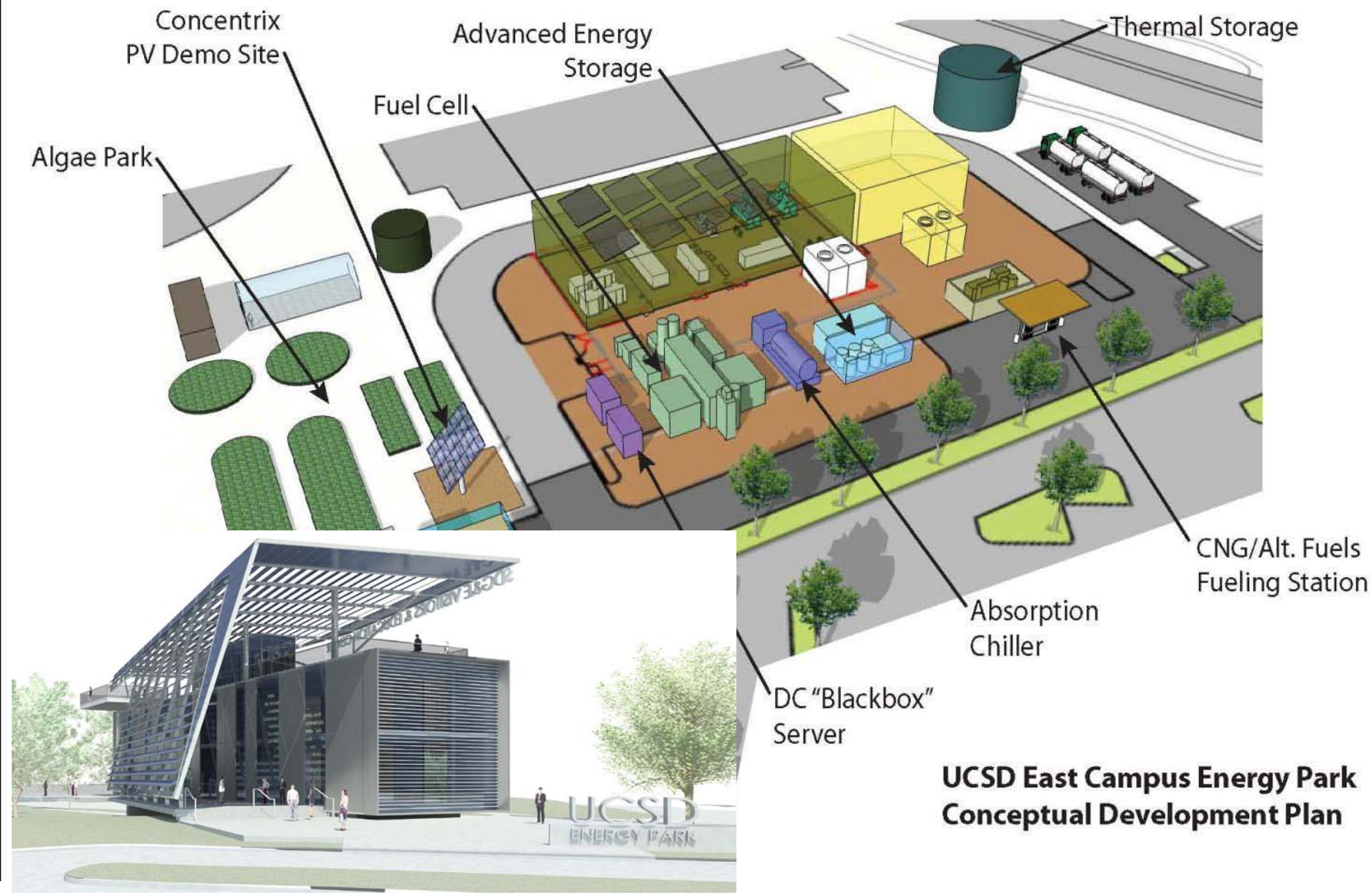
Image Courtesy San Diego Economic Development Corporation

Renewable Energy Potential

Solar	6,550 megawatts
Wind	3,495 megawatts
Geothermal	2,000 megawatts

UCSD-UABC Collaboration: Catalyze Economic Growth in the Mega Region through Education and Innovation Acceleration





UCSD East Campus Energy Park
Conceptual Development Plan

Thank You !