CEC Staff Workshop on Energizing California's Communities with Renewables: UCSD's Renewable Energy Secure Communities Project

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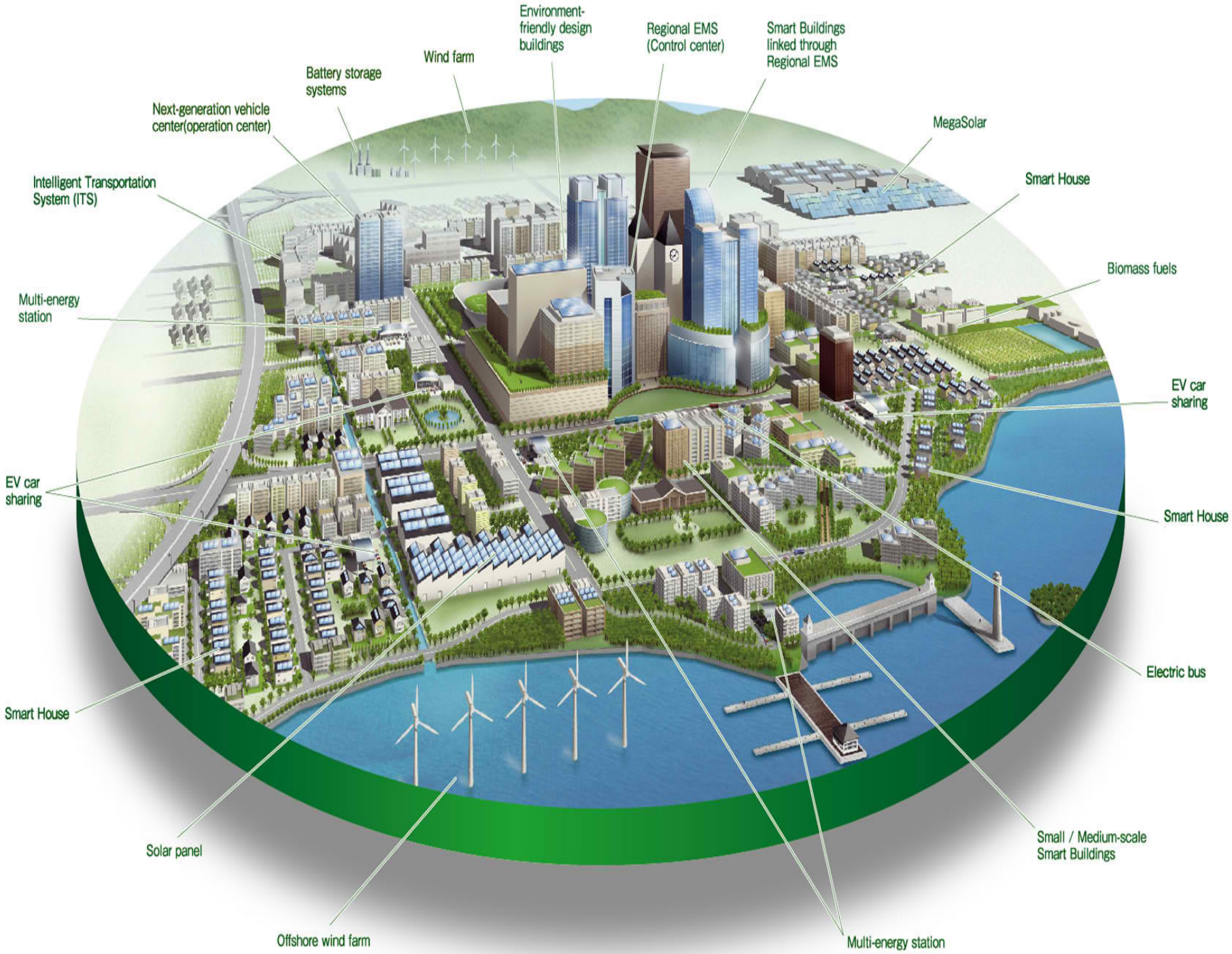
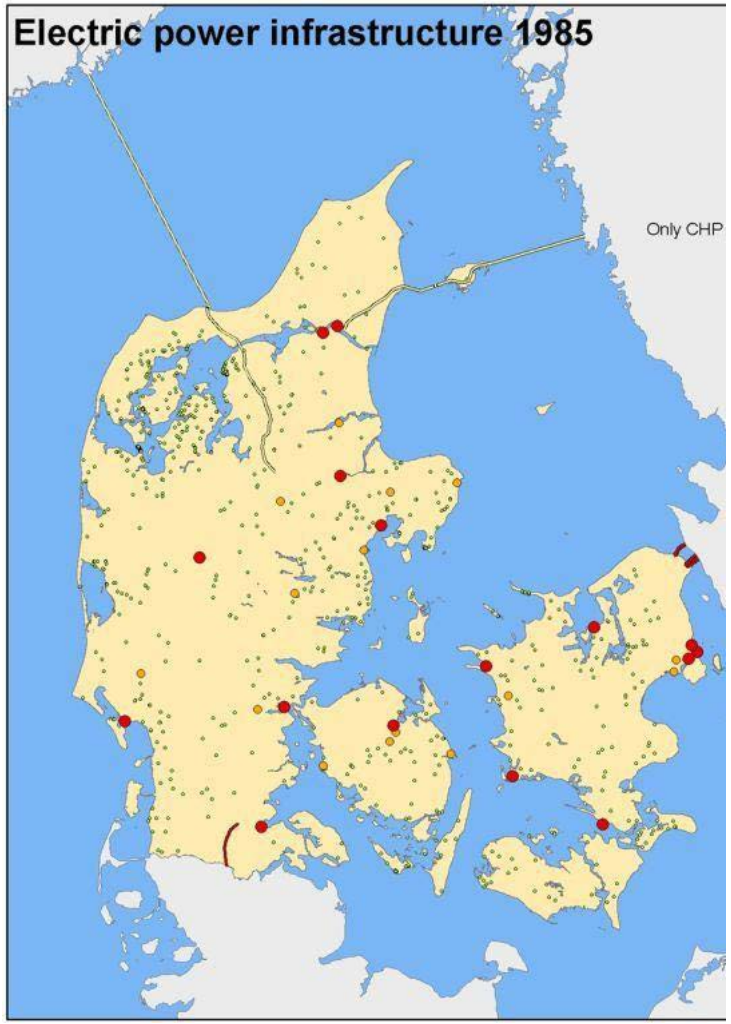
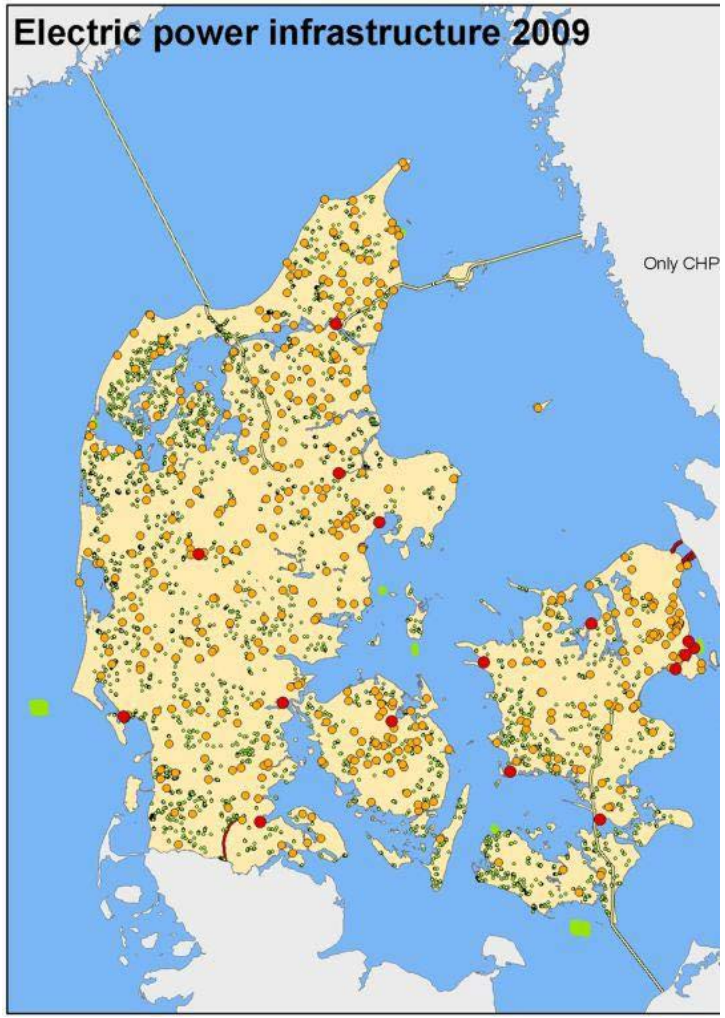
CA's future electricity system will consist of near zero net energy buildings, highly efficient businesses, low- carbon generation, sustainable bioenergy systems, more localized generation, and electrification of transportation, supported by a highly flexible and robust distribution and transmission infrastructure. *– CA Energy Commission, EPIC Funding Vision*

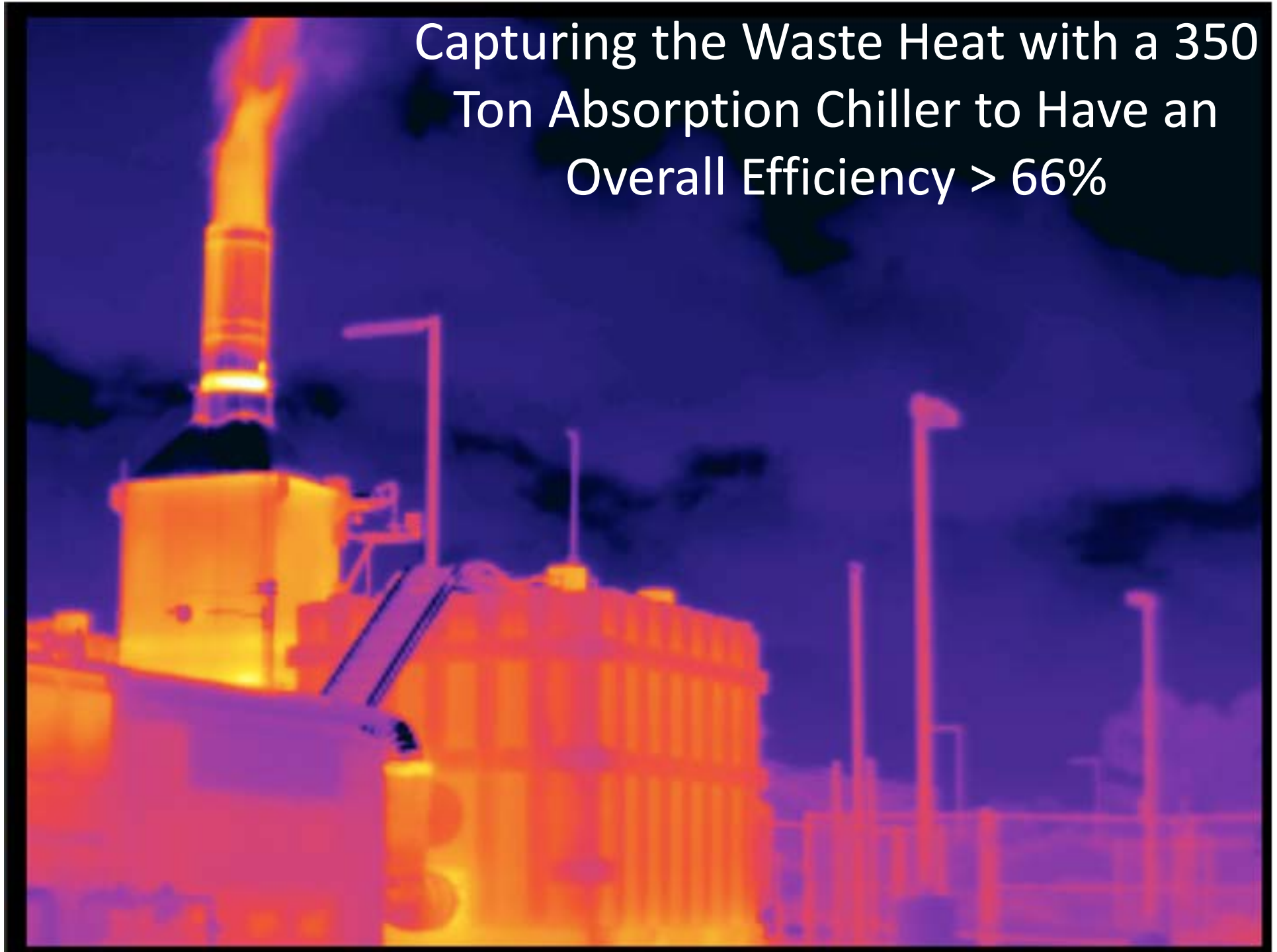

Environment-friendly design buildings
Regional EMS (Control center)
Smart Buildings linked through Regional EMS
Wind farm
Battery storage systems
Next-generation vehicle center(operation center)
MegaSolar
Intelligent Transportation System (ITS)
Smart House
Biomass fuels
Multi-energy station
EV car sharing
EV car sharing
Smart House
Smart House
Electric bus
Solar panel
Small / Medium-scale Smart Buildings
Offshore wind farm
Multi-energy station

Denmark's Decentralization of Energy Generation 1985-2009





2.8 MW Fuel Cell supplies 8% of baseload power with directed biogas renewable fuel


Capturing the Waste Heat with a 350
Ton Absorption Chiller to Have an
Overall Efficiency > 66%

The Direct Biogas, Ultra Clean Fuel Cell Will Be >66% Efficient

… And it fits on the footprint of a Tennis Court

Legend: Blue = Advanced R&D
Yellow = Early Commercialization

UC San Diego's Central Utility Plant

R&D and Early Commercial Opportunities by UCSD in Distributed Energy Resources & Grid Integration from CEC's Renewable Energy Secure Communities Funding to UCSD (2010-2014)

- Renewable, Combined Heat & Power (CHP) Fuel Cells
  - 2.8 MW Directed Biogas Fuel Cell
  - Integrated 350 Ton Absorption Chiller
- Solar Forecasting
  - $1M CEC for High-Fidelity Solar Power Forecasting Systems for the 392 MW Ivanpah Solar Plant (CSP) & the 250 MW CA Valley Solar Ranch (PV)
  - $1M Comprehensive Grid Integration of SDG&E Solar CSI IV
  - $2.4M from DOE & CEC for Improved Modeling Tools for High Penetration Solar
  - $0.3M Sub from $1.4M Mitigating Measures to High Ramps Rates of Soitec Concentrating PV & Maxwell Ultracapacitor
  - $1.4M CEC to Accelerate Distributed Renewable Resources Deployment
  - $1.6M CEC to Expand Distributed Energy Resources Deployment; $1.5M match
  - $2M R&D CA Solar Initiative (CSI) I & III
  - $0.5M DOE SUNRISE w/SMUD
  - $0.7M from Panasonic/Sanyo for Battery Storage Integration
  - $0.3M Sub from Enernex on CEC's Utility-Scale Renewable Energy
  - UC Merced-UCSD RESCO (Coimbra)
  - $0.3M Site Host to $1.5M CPUC/ NRG DC Fast Chargers & Grid Integration
- Next GenSmart Inverters
  - $0.6M Sub from $2M SunSpec Alliance CEC grant for Smart Inverter Interoperability Standards
  - Joint working relationship with Underwriters Laboratories (UL) (pending)
- Site Host for initial 25 kW Soitec Concentrating PV prototype
  - 140 MW Permitted in CA
  - $25M DOE SUNSHOT Manu Award to Soitec for San Diego Facility
- High Solar Penetration
  - $1.8M CEC/South Coast AQMD/EPA/SDG&E for Solar Forecast Based Optimization of DER in the LA Basin & UCSD Microgrid. $.2M match
  - $0.6M Site Host from $2M SunSpec Alliance's CEC Smart Inverter
  - 7 kW Soitec CSP
- Maximize Grid Benefits
  - $0.3M Site Host from $1.5M NRG's CEC Vehicle-to-Grid Grant (PON 14-301-3)
  - $0.5M Site Host from NRG's $1.5M CEC Integration of EVs to Maximize Grid Benefits (Pending)
  - LOST: CEC High Reliability Microgrid for Critical Infrastructure, PON 14-301, $5M + $9M Match Funding
- Solar Commercialization
  - Co-Lead $154M of Clean Renewable Energy Bonds awarded to San Diego Institutions; $15M to UCSD
  - 2 MW PV installed on campus and .8 MW off campus

R&D and Early Commercial Opportunities by UC San Diego's Subcontractors Resulting from CEC's Renewable Energy Secure Communities (RESCO) Funding to UC San Diego (2010-2014)

- Microgrid Controller (Power Analytics)
  - $3.2M DoD Env Security Tech Certification Progrram (ESTCP) for 3 San Diego Naval Bases
  - Confidential Client List for North American, Pacific & Europe to be Disclosed in 2015
  - Acquired by Causam Energy 8/2014
  - Sub to UCSD on DOE SUNSHOT/CEC High PV Penetration Mitigation
  - BMW 2nd Life EV Battery Interface
- Economic Optimization (Viridity)
  - Philadelphia Navy Shipyard Redevelopment
  - Con Edison Solutions
  - Southeastern PA Trans Authority (SEPTA)
  - Sub to SEPTA for battery & Supercapcitor for freq reg
  - Sub to Power Analytics on DOE ESTCP
  - $1.6M from CA Solar Initiative (CSI) for Innovative Bus Models, Rates & Incentives that Promote Integration of High Penetration PV with Real-Time Mgmt of Customer Sited Distributed Energy
  - Sub Secure Interoperable Open Smart Grid Demo
  - $.9M PA Energy Dev Auth
  - Former CEO now Chair NY Public Service Comm
- Big Data (OSIsoft)
  - SDG&E's Borrego Springs I Microgrid
  - SDG&E's Borrego Springs II Microgrid
  - Sub to Power Analytics on ESTCP with NAVFAC
  - Sub to ComED/IL Institute of Technology Microgrid Controller
  - Sychrophasors R&D
- Energy Storage
  - Thermal
    - Augment 4 M gal with new 1.2 M gal Thermal Storage integrated with Renewable Combined Heat & Power (CHP) Fuel Cell w/ SEP and CPUC Permanent Load Shifting Incentive
  - Electric
    - Early Commercial 2.5 MW/5 MWH battery from BYD of China w/CPUC Self Generation Incentive Program (SGIP)
    - Tesla PV Integrated 200 kW/400 kWh Storage at Warehouse Application
    - $3.3M, 4 Yrs ARPA-E Cycling Hardware to Analyze and Ready Grid-Scale Electricity Storage (CHARGES)
    - Site Host 30 kW/30 kWh Panasonic/ Sanyo PV Integrated Storage Demo
    - Site Host BMW 100 kW/180 kWh Repurposed EV Battery
    - Site Host NREL/CSE Repurposed EV Battery Life Test Cells
    - Site Host 100 kW/300 kWh ZBB Flow Battery Demo
  - Mechanical
    - Site Host to $1.8M CEC grant to Amber Kinetics' 100 kW-15 minute Flywheel (pending)
- Washom's Consulting
  - Chief Architect of Lana`i Hawaii Microgrid

UCSD East Campus Utility Plant

"The UCSD Microgrid provides insight into how the future California smart grid can operate with higher penetrations of renewable resources, integrate more distributed energy resources, and achieve higher levels of energy efficiency (including demand response) into a smooth operating electrical system. Understanding how and when microgrids draw from and sell back to the grid is essential for an evolving energy paradigm. By working with the CEC and other partners, the UCSD microgrid has become a superior advanced-knowledge transfer system that can educate others about the value of an integrated and functioning microgrid for years to come." Clean Energy States Alliance's State Leadership in Clean Energy (SLICE) Award to CEC, 2012"