Interconnection: A 'Smart' Systems Approach

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Overview of Smart Grid Technology

- Components of Smart Grid Vision that will advance interconnection and integration of renewables include:
  - Electricity Storage
  - Electric Vehicles and the Grid
  - Demand Response
  - Renewable Distributed Generation by 2020
  - Reducing Costs of PV Systems
  - Adding PV on Distribution Circuits
  - Case Study: Synchrophasers

Smart Grid activities increase system visibility and functionality, informing interconnection and integration issues.

Near term R&D to understand the impacts of Increasing PV Capacity on a Distribution Circuit

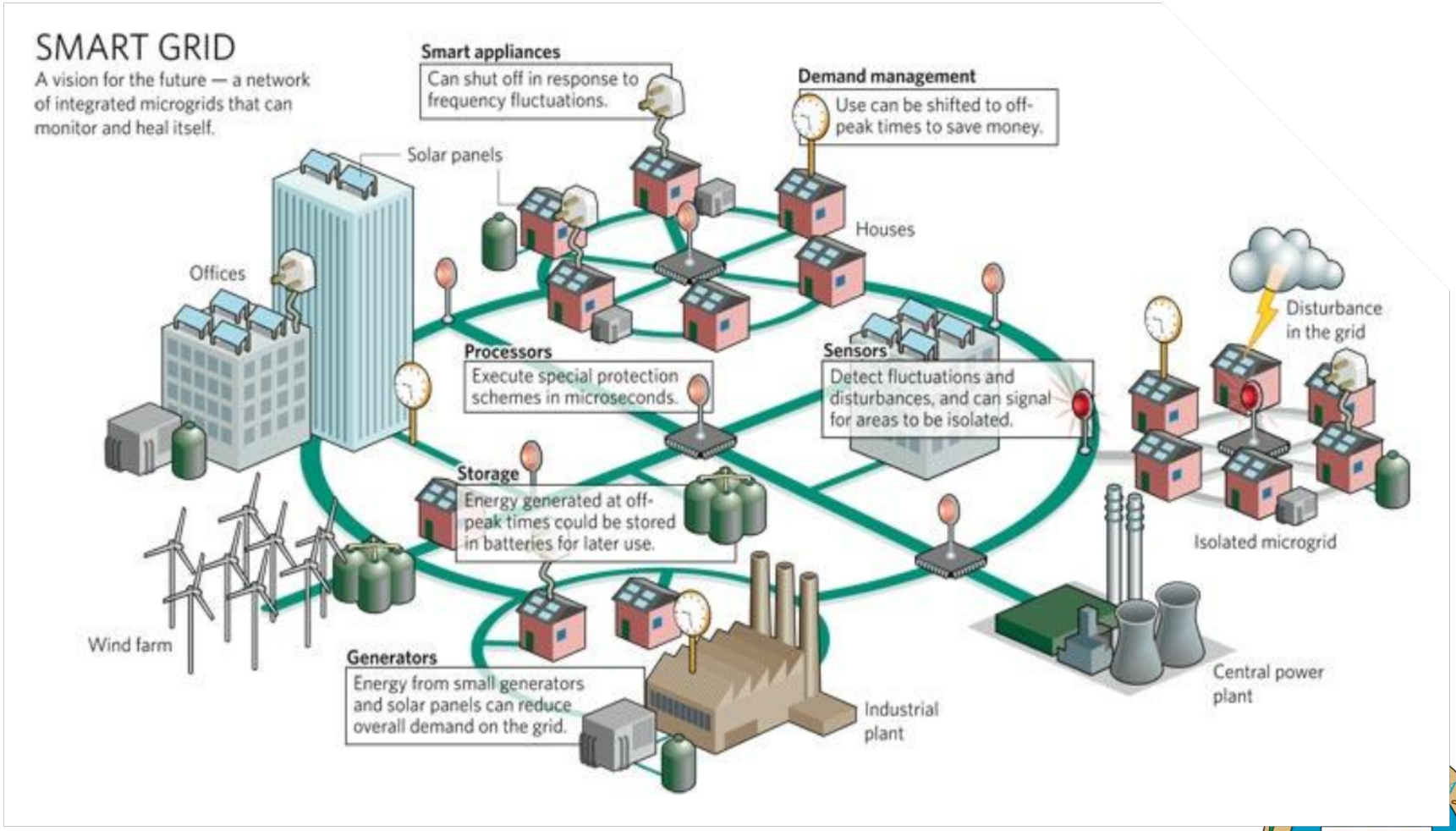
- Max capacity of PV on a circuit is limited
- Adding smart grid functions to PV inverters increases circuit capacity
- 25%-100% more PV allowed with autonomous Volt/VAR control
- Need to replace aging distribution infrastructure with “smart grid”

Thank you!

- What grid changes are needed to effect greater interconnection?
- What research needs to be done?

The following slides are samples of PIER R&D which support renewable energy policy goals.

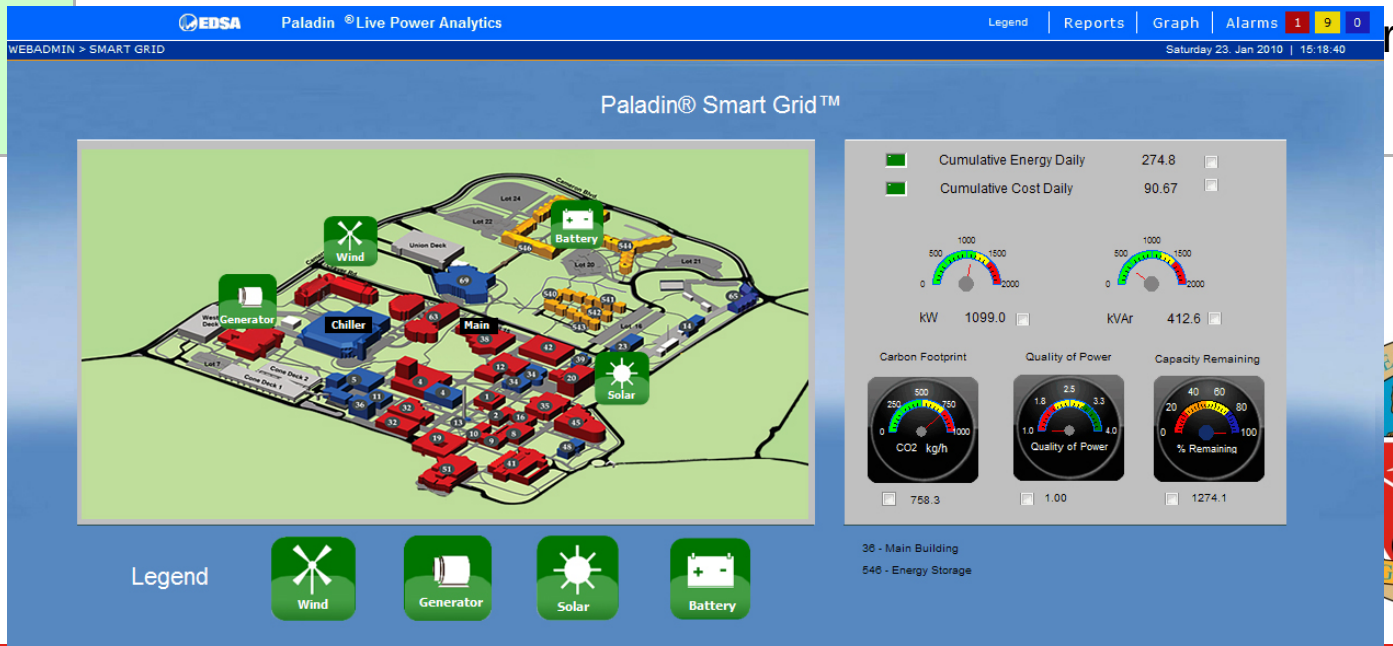
Smart Grid


SMART GRID
A vision for the future — a network of integrated microgrids that can monitor and heal itself.
Smart appliances
Can shut off in response to frequency fluctuations.
Demand management
Use can be shifted to off-peak times to save money.
Solar panels
Houses
Offices
Disturbance in the grid
Processors
Execute special protection schemes in microseconds.
Sensors
Detect fluctuations and disturbances, and can signal for areas to be isolated.
Storage
Energy generated at off-peak times could be stored in batteries for later use.
Isolated microgrid
Wind farm
Generators
Energy from small generators and solar panels can reduce overall demand on the grid.
Industrial plant
Central power plant

UCSD Microgrid Project Summary

Show how microgrid resources can provide grid support to the larger Smart Grid

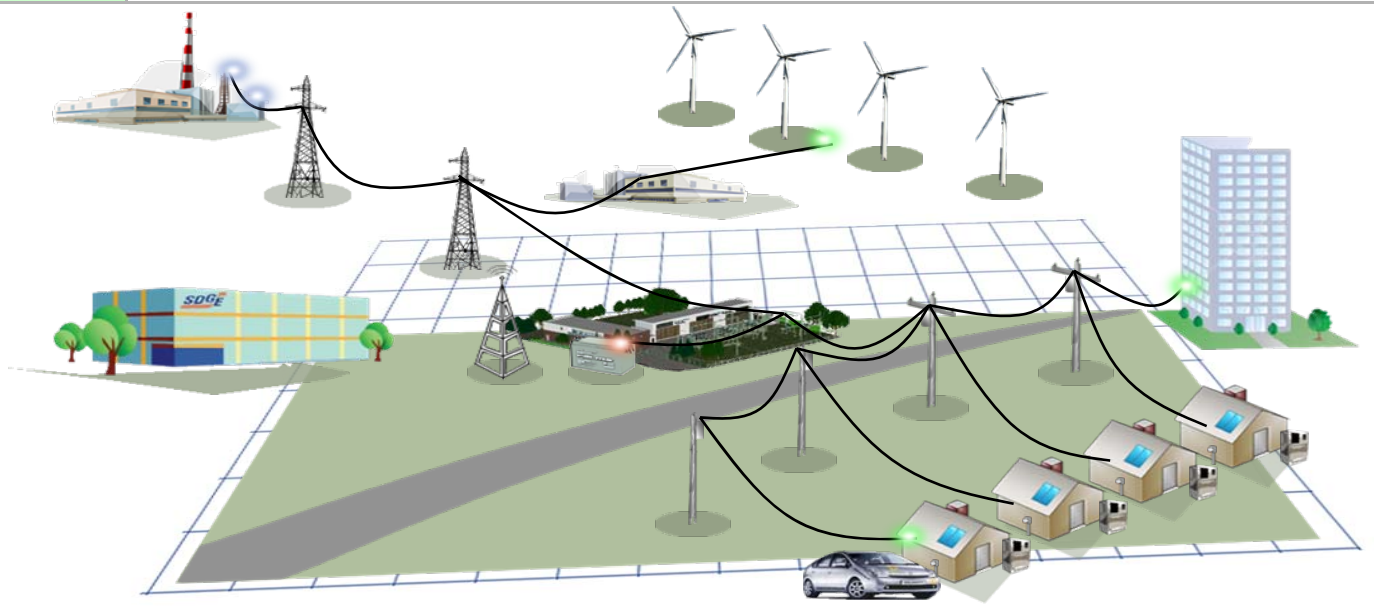
Budget:	$2.4M ($435K UCSD, $2.4M CEC) Leveraged 60M
Benefits:	• Provide observability of the operation of the microgrid to the CAISO • Demonstrate an integrated solution that combines PV and electric energy storage to mitigate the intermittency of renewable generation on a microgrid.
Goal:	Provide the CAISO the ability to observe its operations since this rid



SDG&E Borrego Springs Microgrid Project Summary

Utilize advanced technologies to integrate and manage distributed resources within the Smart Grid

Budget:	$15.2M ($4.1M SDG&E, $7.5M DOE, $2.8M CEC, and $0.8M partners)
Benefits:	• Reduce the peak load of feeders and enhance system reliability • Accommodate various generation and storage configurations
Goal:	Successfully engage/inform Borrego Springs community



Distribution Management System

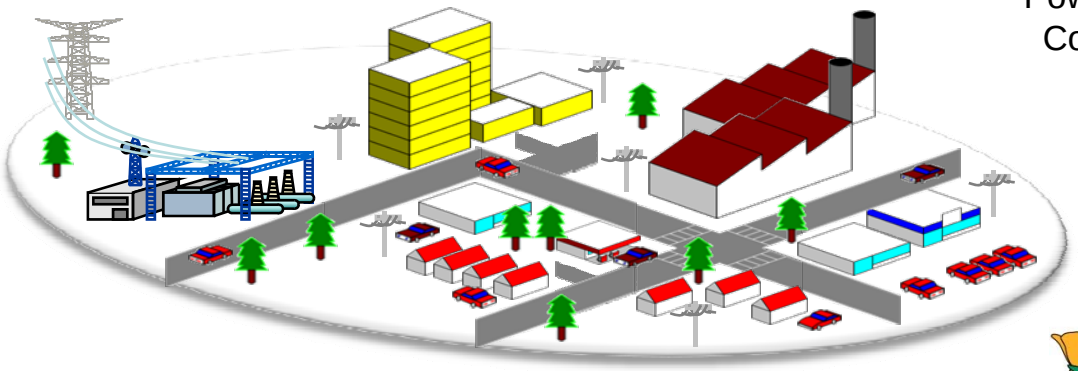
Microgrid Master Controller

SCADA System

Information
Electricity Pricing
DER status
Demand Response Programs
Network status
Community Objectives
Load and Resource Profiles

Distributed Energy Resources
Utility-scale Energy Storage
Rooftop PV Solar
Micro-turbines
Building Energy Storage
Community Energy Storage
Distributed Generation
Home Energy Manager
PEVs
Ground PV Solar Array

Grid Resources
Capacitor Banks
Voltage Regulators
Automated Switches
Power Electronics
Communications



National Energy Technology Laboratory

STATE OF CALIFORNIA ENERGY COMMISSION

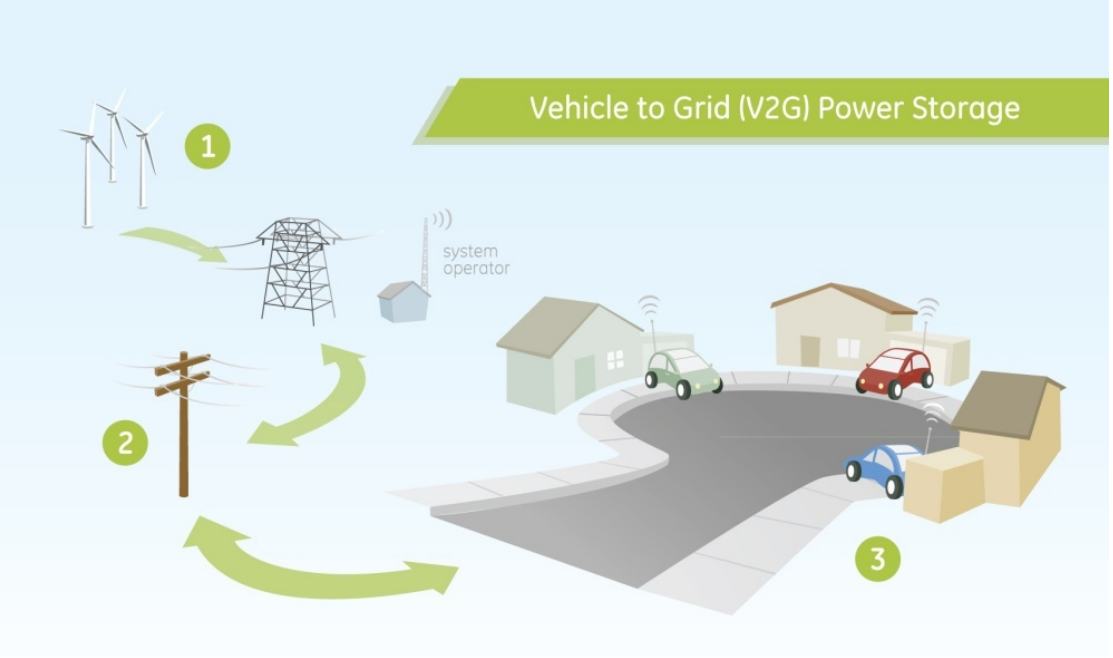
The Future: Microinverters with Volt /VAR and Communication

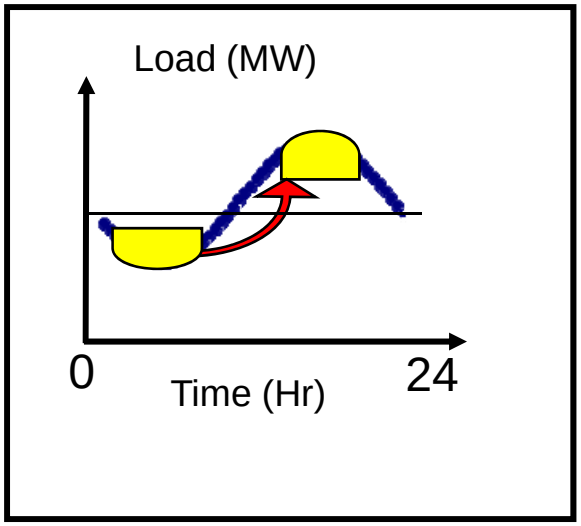
215 watt Microinverter

- Microinverters have already cut costs of installation by 15%
- Less wiring cuts the labor by an additional 60-70%
- Shading on one panel does not affect entire PV string
- Volt VAR can increase the renewable capacity of a feeder by 100%

Electric Vehicles to Grid (V2G)

- Vehicle-to-grid technology uses parked EVs as supplemental storage on the grid

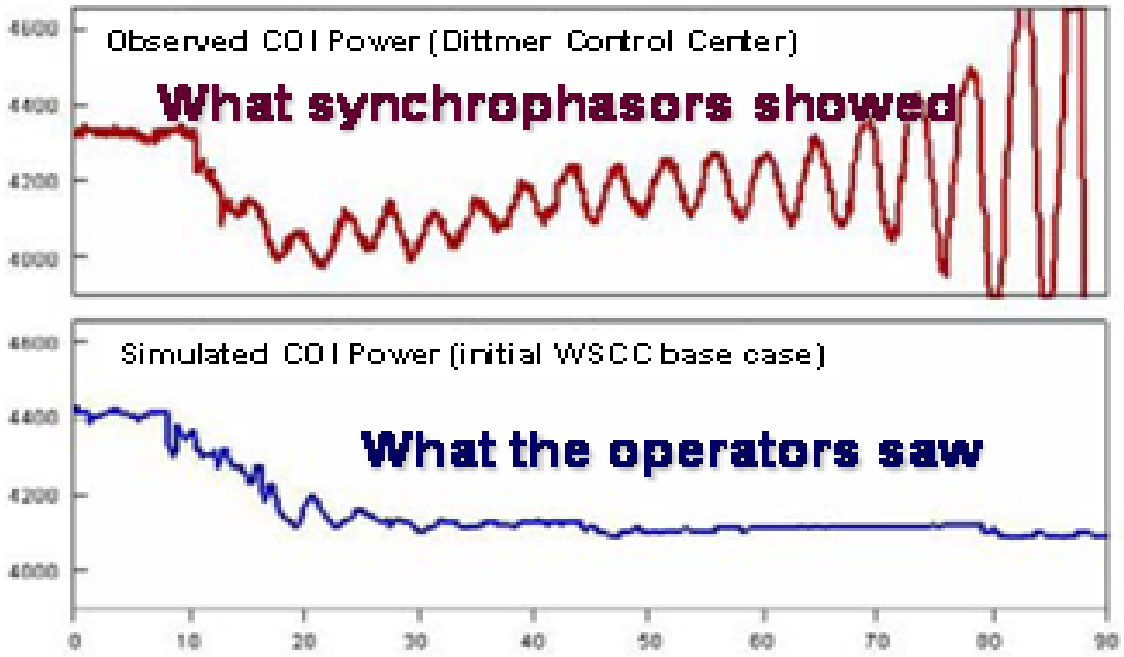




- At peak hours, consumers sell the energy stored in EV batteries back to utility companies
- AutoDR can automate this activity

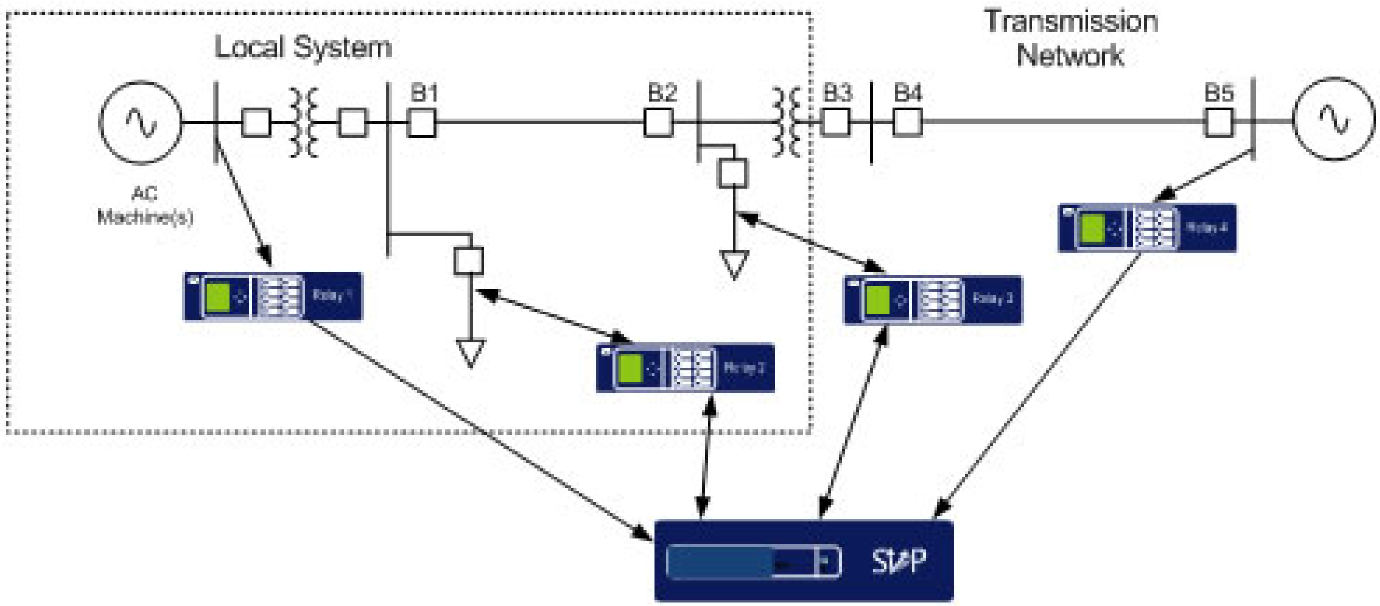
Synchrophasors

- From basic research through development, demonstration, and final commercialization – a 10+ year effort
- Increasing deployment will result in increasing capability



Key to Success: Involve end users, promoters and other supporters early – stakeholders will push the development to a commercial product

Next Step: Synchrophasors at the Distribution Level



- Presently used at the distribution level in a few microgrid pilots
- Increasing DG penetration will drive need for such sensors
- Ideas are being generated on how to use synchrophasors in distribution applications