

# SmartGrid as the Swarm

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The electrical power grid can be represented as a swarm of interoperable nodes. Currently, the utility acts as a central control point to provide a predetermined voltage and frequency range. The nodes in turn have to abide by current constraints or be cut off by circuit breakers. As the nodes get smarter and the grid converges to a smarter grid, distributed sensing and control are necessary to ensure stable and efficient operation of the grid.

University of California -San Diego campus is a great example for the smart grid. The campus can provide nearly all of its electricity, and as such can act as an independent microgrid. Examples include stable resources such as a methane powered plant and variable resources like Photo Voltaic (PV) cells. A water chiller storage is also present working as both energy and heat storage. The campus has different types of loads, ranging from a large fleet of electric vehicles, to one student housing, large office buildings and at the other extreme, San Diego Supercomputing Center. More than 85,000 parameters are monitored continually throughout the grid, at fine time granularity to enable experimentation and, eventually, the development and implementation of distributed control. Currently the UCSD system is centrally controlled on campus. The next level of negotiation occurs between UCSD and the local utility, at which point the campus connects to the grid. However, both the grid power provider, and the campus operators have identified the ability to design and implement efficient and stable distributed control algorithms as one of the key needs going forward due to a large proliferation of renewables, energy storage and electric vehicles.

To evaluate this idea, the UCSD microgrid is being represented in OpenDSS, an open source, three phase simulator for SmartGrid designs. The output of OpenDSS can be verified against the measurements stored in the campus database. The simulation will model all key components of the microgrid, and will enable implementation of control strategies at various distributed locations. The system will have the ability to either draw on the measured data or to use external simulators and/or databases for input, such as HomeSim [1] which provides information on residential electricity usage, and UCB's building energy consumption database [2]. The goal of this study is to understand and show how a swarm of sensors and controls that are a part of the UCSD microgrid, can achieve stable and efficient operation using distributed sensing and control strategies, and to develop a system that enables larger scale studies.

[1] Venkatesh, J., et al. "HomeSim: Comprehensive, Smart, Residential Electrical Energy Simulation and Scheduling."

[2] [www.openbms.org](http://www.openbms.org)