Sustainable San Diego

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In our world of over seven billion people, about half of the population lives in a city—and the numbers are quickly growing. This fast rate of urbanization is placing significant strains on urban infrastructure. Cities are expected to enable efficient, sustainable transportation and energy systems that feed robust economic development and healthy job markets, even as they face significant challenges including increasing populations, aging infrastructures, and declining budgets. Increasingly, urban performance depends not only on a city's physical infrastructure, but also on the availability and quality of knowledge and data communication and the social infrastructure. Enabling Smart(er) cities of the future that drive sustainable economic growth requires sophisticated tools for data analysis and predictive analytics to enable better decision-making, coordination of reources, and proactive resolution of problems.

The University of California, San Diego, Clean Tech San Diego, OSIsoft, San Diego Gas & Electric, and the Predictive Analytics Center of Excellence (PACE), the San Diego Supercomputer Center are working to develop a "*Sustainable Communities*" project in San Diego to address these challenges. The goal of the project is to deploy a comprehensive data infrastructure that connects the various physical infrastructures of downtown San Diego enabling sustainable Smart(er) City and surrounding community. These physical infrastructures include electrical, gas, water, waste, buildings, transportation and traffic, along with their individual communications support systems. The significant volumes of highly granular, time-series data from each of the physical environments is collected and is published in a cyber-secure, private cloud. UCSD and PACE's Big Data analytics and energy sustainability researchers will perform predictive analytics on both the real-time and historical time-series data for developing models for detailed load forecasting, load shaping and demand response, all aimed at driving city-scale energy efficiency. Smart(er) City Analytics focuses on data-driven analyses of resource consumption, renewable integration, economic activity and human behavior patterns to improve city's sustainability and efficiency. With the emergence of the new Smart Grid technologies like intelligent metering, we have the potential to enable the truly intelligent dynamic system that can predict and respond to human activity, consumption and behavior patterns. An additional need for a data driven Smart(er) grid is emerging with the increase of peak demand and the challenges of the integration of renewable resources due to its intermittency. An impending solution for peak shifting and renewable energy smoothing is through the usage of energy storage devices. Energy storage power control problem with loads, energy storage devices and renewable resources connected to the grid still remains an unsolved challenge. Discovering most efficient and optimal ways to utilize predictive models, leverage green energy and energy storage within the context of the users (in terms of lower energy cost and higher green energy efficiency) through the intelligent distributed system control is a modern day research challenge. The large scale data management systems, including ways to deploy a scalable system for this complex application create architectural challenges exacerbated by the need for real time query processing infrastructure and new querying methodology. These challenges spread across many disciplines from architecture, intelligence to engineering and control.

UCSD/SDSC researchers are also simultaneously utilizing the existing fully functioning UCSD Microgrid to analyze data on both the main SDGE grid and the UCSD Smart Grid. By sharing data with these researchers, the industry collaborators and city partners are gaining new insights into the "crowd-sourced" data. Our proposed project will enable the city of San Diego to drive city-scale energy efficiency, load-shaping, battery storage and demand-response applications that will lower electricity consumption and cost, discover and anticipate grid instabilities, educate the public, and improve both quality of life and economic development. The "Sustainable Communities" project provides the motivation for a number of research questions in the management of large-scale real-time data streams, real-time big data analytics, battery storage system utilization and distributed control, and residential electrical energy simulation and scheduling.