A California Solar Initiative (CSI) Research, Development, Demonstration, and Deployment Program Grant

Task 4.2 Deliverable:
Report on the Expansion of the Distributed Energy Resource (DER) Model

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Grant Title:
Innovative Business Models, Rates and Incentives that Promote Integration of High Penetration PV with Real-Time Management of Customer Sited Distributed Energy Resources.

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Definitions and Abbreviations

Name or Abbreviation	Definition
Chiller	A component of HVAC systems, the chiller can remove heat energy from a medium (such as water), to be used in cooling buildings, water, etc. Some of the chillers at UCSD are be driven by electricity and some by steam.
CSI	California Solar Initiative
Electric Storage	A battery for storing electrical energy.
HRSG	Heat recovery steam generator.
kW	Kilowatt. A unit of electric power.(1 thousand Watts)
MW	Megawatt. A unit of electric power. (1 million Watts) MWh is a Megawatt-hour a measure of electric energy.
PV	Photovoltaic electrical generation (A solar panel).
RESCO Grant	Renewable Energy Secure COmmunities (RESCO) Grant whose purpose was to develop and demonstrate integration of on-site renewable energy production using geothermal, heat pump technology and treated wastewater, solar photovoltaic, wind energy combined with on-site storage alternatives, lighting and HVAC building retrofits and electric vehicle charging stations (2009-2011).
Thermal Storage	Maintaining or modeling the quantity of thermal energy in some medium for later use. The storage could be accomplished by cooling or heating. The medium could be water, ice, building construction materials, etc.
UCSD	University of California at San Diego
Virtual Power Plant	An aggregation of distributed generation, storage, and loads that can be used in the same manner as traditional generation.

Summary

Viridity Energy has enhanced the data model developed under the RESCO Grant at UCSD in order to analyze the impact and behavior of a wider range of distributed resources in support of the CSI #2 Grant objectives. The RESCO data model included 20 UCSD campus resources. The goal of the data model expansion was to consider an additional 20 on- and off-campus resources that would enable the ability to optimize the community's generation, energy storage, demand response and load resources and allow the analysis of PV integration strategies.

Twenty-four on-campus resources were added to the data model. In addition to the photovoltaic resources modeled under the RESCO Grant, the model now contains UCSD batteries (including banks of batteries to model various categories of electric vehicle fleets), fueled generators and an independent UCSD boiler which supplies steam to the steam chillers.

We reviewed several off-campus facilities near UCSD to determine if their resources (load, storage or generation) would complement the on-campus resources in demonstrating the Virtual Power Plant concept. We found that for a variety of reasons mentioned below, the off-campus facilities were not directly suitable.

Enhanced Model

The first VPower™ delivery to UCSD utilized a simplified model of the UCSD thermal and electrical system. To improve the accuracy of the solutions, to achieve additional economic savings, and to provide additional flexibility in the resources to be modeled, enhancements were made. These include enhancements to VPower™, and enhancements to the UCSD resource model.

VPower™ Application Enhancements: VPower's model of generation resources that utilize multiple inputs and produce multiple outputs was enhanced. An example of resources with multiple outputs could be a fueled generator which produces electricity that additionally produces steam from its heat recovery steam generator (HRSG). An example of a resource with multiple inputs could include a generator which uses a mix of two types of fuel, or a resource model in which the water used for cooling along with the fuel needed to be modeled as an explicit input.

With the VPower™ enhancements, during modeling time the analyst can configure VPower™ to schedule the consumption of multiple inputs either automatically in a way that is economically optimal, assuming the resources are so-capable. Or they can be set to consume the inputs in a fixed ratio. Likewise the outputs associated with a multiple output resource can schedule the outputs in whatever ratio determined to be economically optimal, or they can be assigned a fixed ratio.

Additional VPower™ enhancements were made to the connection modeling between non-electrical outputs and their destination. The connection model allows a generator of steam, or chilled water, to feed that output to a specified device (or devices). Once again, the enhancement allows the destination of outputs to be specified as a fixed ratio, or to be determined as part of the optimization.

UCSD Resource Model: The UCSD data model was enhanced to include additional resources to add accuracy and flexibility in the simulation scenarios and allows us to study our proposed strategies for high penetration PV integration. In order to facilitate accurate power network analyses, distributed energy resources that had been aggregated for diesel generation and solar

arrays were modeled separately (since they are connected to the grid in reality). This will enable the VPower optimizer to create energy schedules that observe the electrical network constraints within UCSD's microgrid more accurately.

As part of the enhanced on-campus model, an independent USCD boiler was included in the model to supply steam in addition to the heat supplied by the exhaust heat recovery steam generators. Steam chillers were linked to the steam production. With Viridity's VPower™ enhanced thermal model, the output of the chillers (both electric and steam) are configured to supply chilled water to the 3.8 million gallon thermal storage tank at UCSD. Inclusion of this storage device with the resource optimization allows us to observe UCSD potential to shift demand.

Figure 1 is a Representative Block Diagram of the modeled resources.

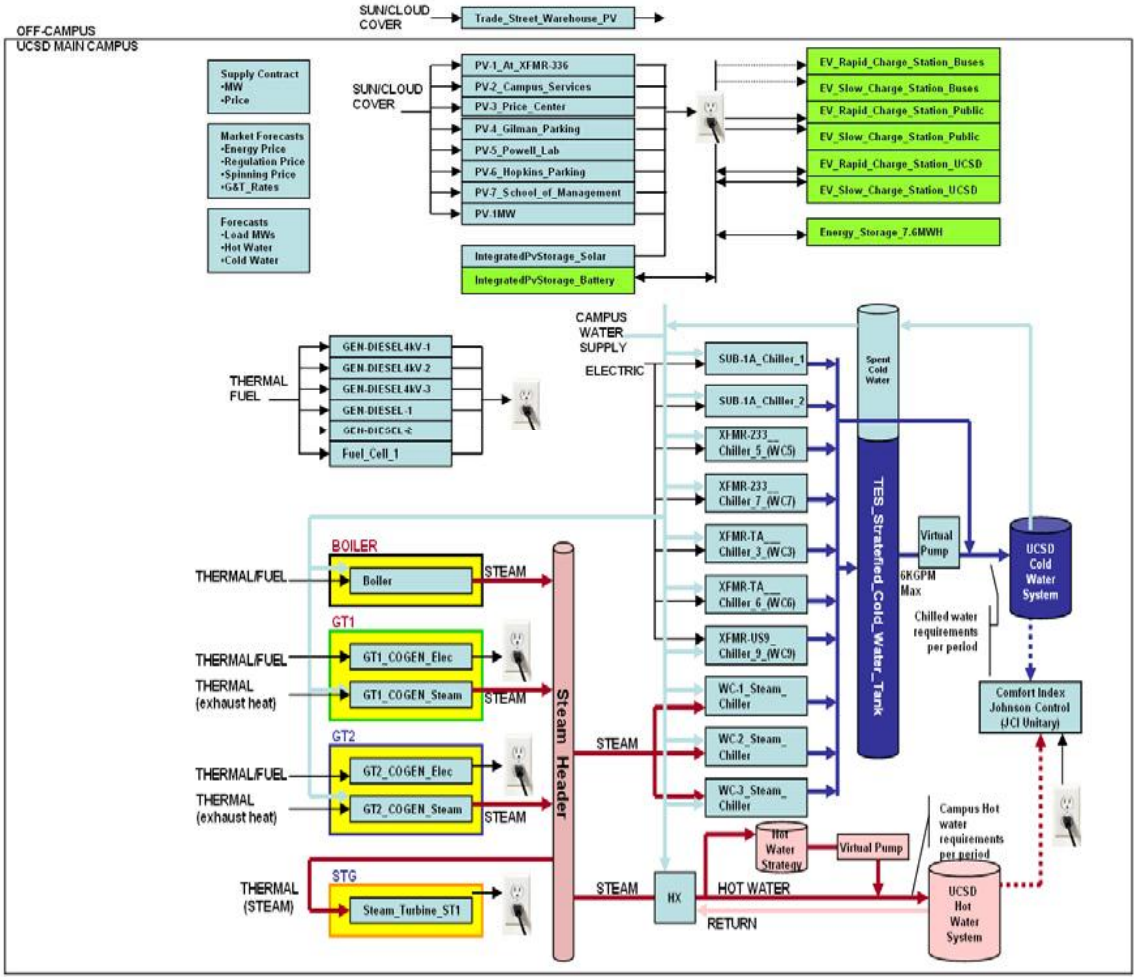

Figure 1.

Off-Campus Facility Evaluations

Viridity created a list of contacts and general site characteristics for municipal and commercial site program candidates in order to evaluate both interest and suitability of off-campus facilities to participate in the program. Our intended focus was sites that have 300 kW of solar or more, some controllable/flexible load, and some storage capability.

In April, we began the process of contacting the site managers and explaining the program. We primarily focused on city- and commercially-owned buildings and the San Diego school district all served by San Diego Gas & Electric (SDG&E). The process was very time consuming, mostly because we needed to explain in detail both the program and the virtual power plant concept to get buy in from various levels of site management, before qualifying the true suitability of the site and proceeding with our information gathering and modeling. If there was interest, we discussed the site's energy characteristics relative to our target configuration and tried to schedule a site visit for further evaluation.

In general the site managers had a level of interest and had already begun taking steps to manage their energy usage. However, we found as we talked with site managers, that the candidate facilities had either small amounts of PV (55kW or less), very little controllable load, or other factors such as site security, that would limit the suitability and value of the site in the program.

The City of San Diego

Various sites were identified through the City of San Diego as potential candidates for the CSI program, but ultimately two facilities were chosen for further evaluation; the Alvarado Water Treatment Plant and the City's Administration building at 9601 Ridgehaven Court.

The Alvarado Water Treatment Plant was identified as the preferred candidate with its high energy use and a large 1.1 MW solar PV installation. Utility meter data was supplied by the City for analysis but unfortunately due to heightened security measures around the plant, Viridity was unable to gain access to the site for the necessary engineering site evaluation.

After numerous attempts and with access still being denied, Viridity moved onto the City's Administration Building at 9601 Ridgehaven Court. The Administration Building was viewed as a potential site with its 55 kW PV system and advanced Building Management System (BMS) functionality. An engineering site visit was conducted and upon evaluation was determined to be an unsuitable candidate for the program. The relatively small PV system and minimal controllable load were the main contributors to the decision.

Other city-owned buildings were evaluated but we found most to have installations of 30kW of solar or below.

The Port of San Diego

With the assistance of the Port Authority, Viridity identified the Port of San Diego's Administration Office building at 3165 Pacific Highway as a potential facility to be used in the CSI program. A detailed site evaluation was conducted with the administration building having a maximum demand of 360 kW. Through the site visit, engineering personnel identified that the Air Handling Units, chillers, cooling tower, boilers and pumps are fully controlled by the Building Management System (BMS). The facility also has a 30 kW solar PV installation that is connected to the building's main electrical distribution board.

Although the site did have control over its resources mentioned above, the actual controllable load to respond to and adjust to PV production was minimal. With this, in addition to the relatively

small size of the PV system, the site was determined not to be a suitable candidate for the CSI program.

Other Sites

The only two sites we identified with 300kW or above of solar were the water treatment plants. However, none of the water treatment sites had additional distributed generation or an ability to adjust load in response to PV production.

We evaluated the Reuben H. Fleet Building which has 100kW of solar, but it is owned by SDG&E and because the PV system is on the SDG&E side of the meter, the solar production does not offset the building's metered load.

Additional sites were identified by going on the San Diego Solar Map portal http://sd.solarmap.org/solar/index.php which outlines the PV installations in San Diego County, giving both a location and size of PV installation. Multiple sites were identified through this approach and pictures were taken of the identified sites. None of the sites through this method were chosen for further analysis.

Lessons Learned

Security

Several site candidates had restrictive physical and/or cyber security parameters. This limited our ability to assess the physical site resources in order to gather data necessary to model the site's resources. Cyber security could restrict the external monitoring and control functions necessary for rapid customer responses to pricing and dispatch signals.