GreenLight Technical Report 2011

DC Power

1.A.1. Greg Hidley: All DC server facilities – DC-DC Instrument Experiment

One area of campus energy savings in Information and Communication Technology (ICT) will result from Direct Current (DC) powering of computers in UCSD server facilities. In a traditional server facility, AC power is provided at a high voltage, stepped down to a lower distribution voltage, converted to DC in multiple locations to run the computers' chips, memory, and disks, support battery backup (UPS) systems, and network communications equipment. In some cases it is converted back to AC and again back to DC multiple times. Each conversion loses power and generates additional heat, both of which reduce the overall power (and cooling) efficiency (PUE) of the server facility. As seen in Figure 18 below, by providing DC power directly to the server facility instead of AC, many conversion steps are bypassed and less heat is generated, leading to overall higher efficiency and thus increasing the amount of work per watt that can be performed. In addition, emerging sustainable energy technologies to be installed at UCSD are most efficient at generating DC power (e.g., photovoltaics, biomass converters, fuel cells, etc.) and are a natural fit for powering all-DC facilities and complementing the higher energy efficiency of such facilities with the usage of renewable and cleaner forms of energy.

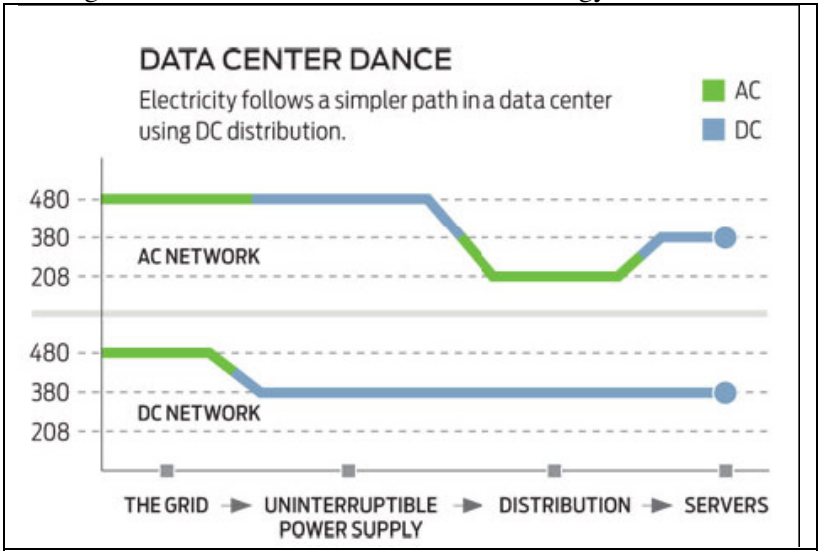

Figure 18: AC/DC Power Distribution Conversions

Two racks of the Instrument have been dedicated to emerging Direct Current (DC) technology research. The DC-DC design concept is to have located in a rack enclosure a rectification system for 400 VDC. Thus, inside the Sun MD, the servers fitted with special DC-DC power supplies that are designed to run on 380 VDC will be oblivious to the external power supply being 480 VAC from the grid distribution.

The DC-DC experiment will provide a fully instrumented environment to measure the actual achievable efficiencies when using a DC environment. We anticipate the replication or expansion of applications and testing efforts of the AC-DC (existing) GreenLight instrument racks to the DC-DC GreenLight instrument racks. We have installed 6 Sun Nehalem 4270, 6 Intel 2700 and 1 Sun 4540 Thumper with special Delta custom DC-DC power supplies and brought them online in AC mode at the end of Year 2. They are now available to GreenLight researchers.

By the middle of Year 3 the above systems were up and running in DC mode. As each system is dual power supply capable, has both an AC-DC and a DC-DC power supply connected to a separate power feed, we are able, by switching two breakers, to change the mode of operation of all 13 systems above from AC mode to DC mode. The Emerson prototype 20kwatt DC power rectification system and Delta custom power supplies have undergone extensive testing by EPRI in Knoxville, Tenn. The system was installed at UCSD during Year 3. In Year 4 we are proceeding with the installation of custom DC measurement equipment and will begin to run power efficiency experiments using these systems.