Facilities Engineer

Energy Storage Flywheel Systems Vital in Keeping Data Centers Free From Power Interruptions

Pentadyne Power Corporation (www.pentadyne.com), a leading commercial manufacturer of clean energy storage systems using advanced composite flywheel technology, announced its participation in a milestone demonstration project at the Sun Microsystems' campus in Silicon Valley to prove that the nation's data centers can conserve massive amounts of energy and drastically reduce their utility bills by using direct current (DC) architecture to run power-hungry servers connected to the Internet.

The best minds on energy and data center issues -- including researchers and system engineers at the US Department of Energy's Lawrence Berkeley National Laboratory (www.lbl.gov), California Energy Commission (www.energy.ca.gov/commission), Sun Microsystems (www.sun.com) (NasdaqNM:SUNW - News), Intel (www.intel.com) (NasdaqNM:INTC - News), Cisco (www.cisco.com) (NasdaqNM:CSCO - News), Pentadyne and others -- joined together to develop a working demonstration to prove how the nation's data centers could amass billions of dollars in utility savings by using DC architecture that would conserve thousands of gigawatt-hours of energy per year. One gigawatt-hour is enough energy to power more than 60,000 average homes for a year.

With 17% of the nation's data centers located in the San Francisco and Silicon Valley areas, the massive reduction in energy utilization from DC-powering could help mitigate California's energy crisis and summertime rolling blackouts. On a nationwide basis, the reduced demand on utility power generation could cut yearly emissions of smog-forming NOx by two million pounds and reduce carbon dioxide greenhouse gas emissions by nearly a billion pounds, according to US EPA utility power plant emission statistics.

The technology demonstration is being conducted at Sun Microsystems in Newark, Calif. Pentadyne supplied the flywheel-based clean energy storage system connected to a rectifier that converts the incoming utility grid AC into 400-volt DC power. Pentadyne's fast spinning composite flywheel replaces conventional UPS (uninterruptible power supply) battery banks that store energy to seamlessly continue power to the data center equipment in the event of a blackout or other power disturbance.

The demonstration project proves that using DC power instead of alternating current (AC) can reduce energy needed to run data centers by up to 20 percent and improve overall system reliability. Servers from major manufacturers have been tested to operate within the DC architecture.

"Powering and cooling today's data centers has become a critical factor as new high-density blade servers come on the scene while energy costs are at all-time highs," said Pentadyne President and CEO, Mark McGough. "The traditional approach of using AC power and chemical batteries in large data centers will no longer be a viable solution in the near term. Combining DC-powered equipment with clean energy storage flywheel-UPS systems eliminates costly, maintenance-laden and polluting batteries, radically cuts cooling system needs and the energy to run those systems, and improves overall server reliability while dramatically reducing floorspace needs. We're very pleased to be a part of this very significant technology demonstration."

According to a recent article on the subject in Energy & Power Management magazine, "Computers and servers equipped with DC power supplies, instead of AC power supplies, produce 20-40% less heat, reduce power consumption by up to 30%, increase server reliability, offer flexibility to installations, and experience decreased maintenance requirements:

- Lower component count leads to higher system efficiencies, greater reliability, reduced maintenance cost and lower total cost of ownership
- The system is modular and flexible, so it can grow with load requirement
- System front-end components can be located in non-conditioned spaces or on the raised floor near the load
- Busway provides a modular "go-as-you-grow" strategy for dc distribution as rack population changes
- Busway provides a double end-feed feature to permit redundant dc sources at critical loads
- Down-stream static and transfer switches are not required, as the voltage matched DC systems can inherently be coupled together
- DC distribution eliminates harmonics
- The system enables simplified positive grounding or negative grounding

- This DC system has no requirement for a UPS in order to provide high system reliability with utility power outage ride through (a rectifier and Pentadyne flywheel clean energy storage are used instead)

- DC distribution is easily adaptable to green energy alternatives such as solar, wind and fuel cell technologies.
- DC distribution eliminates power factor concerns

These benefits lead to three even greater improvements. The DC systems reduces heat load at server racks by 20-40%, reduces power consumption by up to 30%, and increases server reliability."

DC Power Increases Efficiency and Enhances Reliability

Servers and massive arrays of UPS batteries at today's AC-powered data centers waste energy by producing heat. This sensitive equipment is actually intolerant of the heat they produce and data center designers and managers of these facilities must optimize ventilation, air conditioning units and cooling towers to maintain the equipment and batteries at a precise temperature range. Using DC power and high-speed flywheel energy storage systems would eliminate inefficiencies that generate heat.

In the typical data center, the power distribution system converts 480-volt AC utility power through a transformer that steps it down to 208-volt AC that feeds racks of servers. Individual power supplies (typically these are redundant) within each server unit converts this into a DC voltage appropriate for that unit's needs. These individual power supplies are energy inefficient and generate substantial heat, which the room's air conditioning system must remove at great expense. Heat generation also imposes limits on the number of servers that can be housed in a data center.

There are servers on the market that can run on DC power -- typically at 48 volts DC, which is the standard in the telecommunications industry. The demonstration shows how a DC-powered data center could skip the conversion from 480 VAC to 208 VAC and the DC conversion by individual power supplier. The demonstration DC data center on the Sun Microsystems campus converts 480 VAC utility power directly into DC power at voltages appropriate for data center equipment needs. By skipping or consolidating conversion steps, this approach can save as much as 20 percent of electricity usage while eliminating unnecessary heat generation. Less heat generation and elimination of conversion equipment and backup battery banks results in a significant decrease in floorspace utilization.

According to a recent "High-Tech Means High Efficiency" report by Berkeley Lab, SEMATECH (www.sematech.org) and other industry leaders, data centers, which operate 24 hours a day, 365 days a year, have among the highest-density of energy-consuming equipment of any modern building.

"They can use 100 times the electricity of a typical office building on a square foot basis," says William Tschudi, the Berkeley Lab principal investigator for this project. "Energy costs of $1 million per month are not uncommon in large data centers that require megawatts of electricity."

The Berkeley Lab research team, which consists of project leader William Tschudi, Steve Greenberg, and Evan Mills, conceived the project and provided oversight for the demonstration's planning and design, which is being executed by private-sector firms Ecos Consulting (www.ecosconsulting.com) and EPRI Solutions (www.eprisolutions.com). The partner companies have provided technical advice, equipment and staff to set up the demonstration facility.

Emission reduction estimates are based on the Berkeley Lab's estimated 500-megawatt total data center (4,380,000 megawatt-hours/yr) and the US EPA's Power Profiler national averages, using an estimated 15% average power conservation via DC-powering. The EPA Power Profiler is at:

www.epa.gov/cleanenergy/powerprofiler.htm

Download "High Tech Means High Efficiency" from:

http://eetd.lbl.gov/emills/PUBS/PDF/HT_BusinessCase.pdf

Return Home