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Energy Management Systems to Reduce Electrical Energy Consumption

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Energy Management Systems to Reduce Electrical Energy Consumption
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EXECUTIVE SUMMARY

Project Summary
An energy management system comprises an electrical energy storage element such as a battery, renewable electrical energy sources such as solar and wind, a digital signal processing controller and a solid state power converter to interface the elements together. This hardware demonstration in the lab at the Naval Postgraduate School will focus on solid state power conversion methods to improve the reliability and efficiency of electrical energy consumption by Navy facilities. This is accomplished by peak power shaving, power factor compensation and online standby redundancy. Harvesting renewable energy, especially solar power, will also be investigated.

Background
Energy savings and energy efficiency have become top priorities all around the world, stimulated by the Kyoto protocol and other pressing needs to reduce fossil fuel consumption. In particular, in the United States, the Department of the Navy (DON) has listed its shore energy goals to include a 50% 'ashore energy' consumption reduction by 2020 [1]. Additionally, energy security is a necessity for all DON installations. Shore energy security for the US Navy is "the mitigation of vulnerabilities related to the electrical grid, including outages from natural disaster, accident and physical and cyber attack" [1]. Therefore reducing energy consumption must be accomplished while keeping critical electrical loads serviced at all times.

Findings and Conclusions (to include Process)
The physical layer has been assembled and is being debugged. Several debugging milestones have been achieved. The A/D converters have been calibrated. The digital data acquisition system has been expanded to record four channels of data simultaneously. The overcurrent protection features of the integrated circuits have been tested. Islanding mode to improve electric power reliability has also been demonstrated in the lab.

Recommendations for Further Research
Further research can focus on hybrid energy storage, such as supercapacitors in addition to batteries, so that peak power demands are not serviced by the batteries alone. Alternative control strategies to improve the output power quality, such as

a repetitive controller, can also be explored. The detection of power disturbances and the response by islanding the system is another focus for further work.

[1] US Department of the Navy, "Shore Energy Management", OPNAVINST 4100.5E, 22June 2012, available online at http://greenfleet.dodlive.mil/files/2012/07/OPNAVINST-4100.5E.pdf , September 2013.