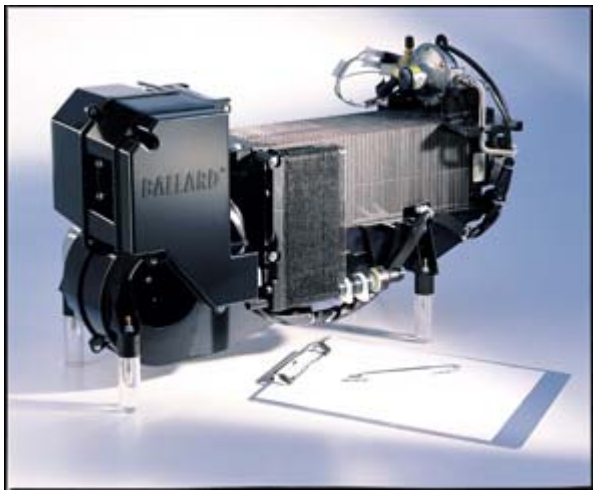
Hybrid Power Management Program Evaluated Fuel Cell/Ultracapacitor Combinations and Developed Other New Applications

In fiscal year 2003, the continuation of the Hybrid Power Management (HPM) Program through NASA Glenn Research Center's Commercial Technology Office resulted in several new successful applications of this pioneering technology. HPM is the innovative integration of diverse, state-of-the-art power devices in an optimal configuration for space and terrestrial applications. The appropriate application and control of the various power devices significantly improves overall system performance and efficiency. The advanced power devices include ultracapacitors, fuel cells, and photovoltaics. HPM has extremely wide potential, with applications from nanowatts to megawatts--including power generation, transportation systems, biotechnology systems, and space power systems. HPM has the potential to significantly alleviate global energy concerns, improve the environment, and stimulate the economy.

Fuel cells provide excellent efficiency and energy density, but do not have good power density. In contrast, ultracapacitors have excellent power density and virtually unlimited cycle life. To improve the power density of the fuel cell, the combination of fuel cells and ultracapacitors was evaluated. The addition of ultra-capacitors significantly improved the power density of the system, thus providing a vastly improved transient response. An ultracapacitor is an excellent energy storage medium for fuel cell systems. Ultracapacitors can easily handle the high charge/discharge currents and have extremely long life in this application.



Hybrid Power Management (HPM) Program--exploring new power applications. Fuel cells tested in conjunction with ultracapacitors.

A typical cordless drill is powered by batteries. The batteries provide reduced performance over time, and eventually they need to be replaced and disposed of. Because batteries are not environmentally friendly, they must be disposed of carefully, and they have a memory that limits the energy that they provide to what was used previously. In contrast, the HPM cordless drill was recharged in 1 min and provided 3 min of continuous operation, or enough power to drive about 30 wood screws. The ultracapacitors provided consistent performance and worked well at low temperatures. In addition, they have no memory and will never need to be replaced.

Cordless drill powered by ultracapacitors.

An electric wheelchair normally is provided with lead acid batteries that require 6 hr to recharge. The range degrades over time, the batteries must be replaced after about 300 charging cycles, and the low-temperature performance of the batteries is greatly reduced. When a wheelchair was tested with ultracapacitors, it could be charged in 5 min and it provided 15 min of operation at full speed. Here too, the ultracapacitors had unlimited life and excellent low-temperature performance.

Electric wheelchair powered by ultracapacitors. Copyright Invacare; used with permission.

A two-wheeled human transportation system also is being evaluated. This vehicle is usually equipped with batteries that take 6 hr to recharge and must be replaced annually under normal use. For HPM, the vehicle is being equipped with maintenance-free ultracapacitors that have unlimited life and can be charged in minutes.

In addition, HPM is being considered for reliable, long-life energy storage systems, essential for space missions, such as the exploration of Mars, and for deep space missions, such as the exploration of the planet Jupiter's moon Europa. The technology also is being considered for various aeronautical electrical system applications.

Bibliography

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