

# JME

## ASYMMETRIC ELECTROCHEMICAL CAPACITORS FOR UTILITY BULK ENERGY STORAGE

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## Capacitor Powered Pure Electric Bus

50 Passenger, 25 km/hr, 15 km range, 15 min. charge time, 190 V



**30 MJ CAPACITOR STORAGE SYSTEM**

## Electrochemical Capacitors

- Often called **Supercapacitor** or **Ultracapacitor**
- Invented by Standard Oil of Ohio in the 1960's
- Product line introduced by NEC in 1978 (SOHIO license)
- Originally used for computer memory backup
- Appreciation of other attractive features since ~1990
  - Very high cycle-life compared with batteries
  - Long, maintenance-free operational life
  - Safe, environmentally friendly technology
- Very large, low-cost systems have now been demonstrated

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**Development work has been ongoing to develop *VERY* large, low-cost electrochemical capacitors**

- **Utility grid off-peak energy storage**
- **Power quality storage**
- **Navy all-electric ship energy storage**
- **Lead-acid battery replacement for UPS applications**
- **Distributed generation storage--wind and solar energy**

## **Characteristics of Asymmetric ECs (aqueous electrolyte)**

- + Relatively high energy density**
- + Cycle life much greater than that of batteries**
- + Tolerant to over-voltage conditions**
- + Voltage self-balance in series strings**
- + Low manufacturing energy costs--electrode drying unnecessary**
- + Low-cost packaging possible--water not contaminant**
- + Very low self-discharge rate is possible**
- + Potentially lowest cost manufactured energy storage component**

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## Asymmetric Electrochemical capacitor

- $\text{PbO}_2/\text{H}_2\text{SO}_4/\text{C}$  design
- Optimized for 5 hour charge-5 hour discharge
- Cells rated at 2.0 V, 790 kF, >5000 cycles (100% DOD)



Source: ESMA presentation 2007 Advanced Capacitor Summit, San Diego.

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## PbO<sub>2</sub>/H<sub>2</sub>SO<sub>4</sub>/C Asymmetric Electrochemical Capacitor

*Universal Supercapacitors, LLC*

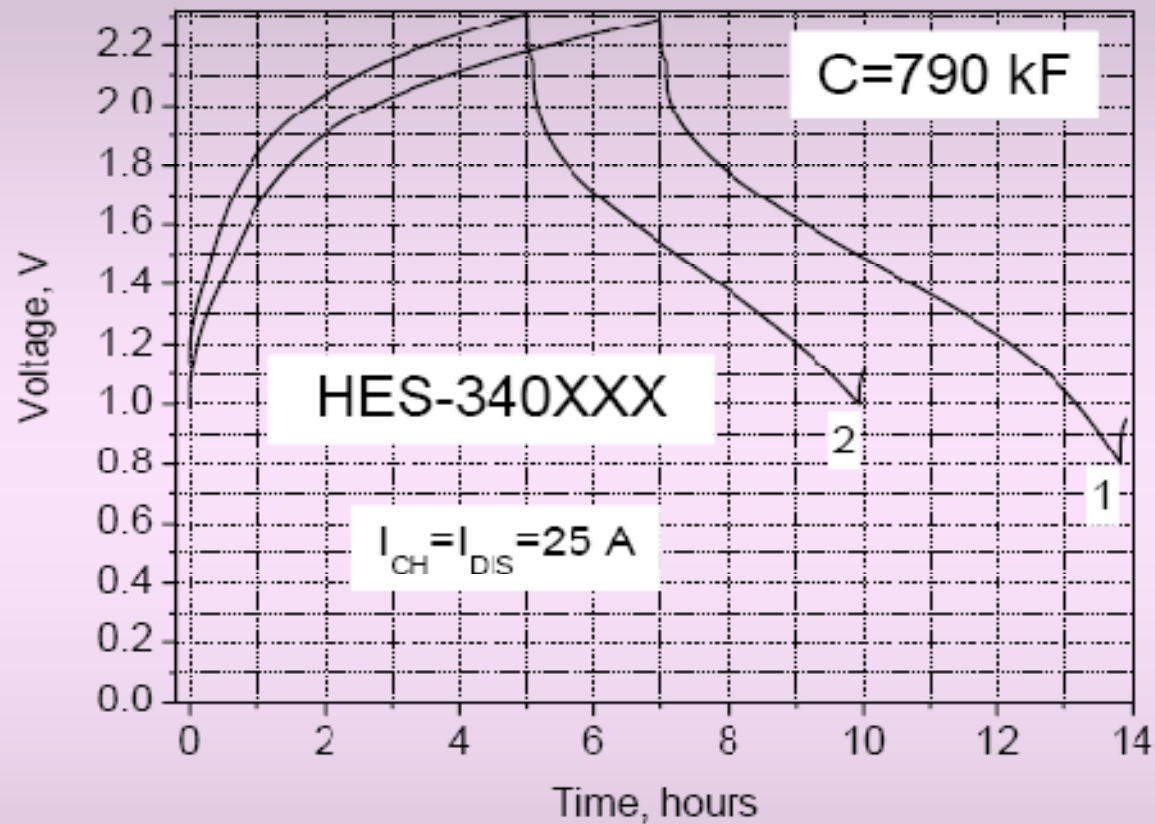


Fig. 5. Time dependence of voltage of a HES-340XXX cell at 7-hour charge and discharge to the voltage of 0.8 V (1) and 5-hour charge and discharge to the voltage of 1.0 V (2) of the cell by 25A constant current.

Source: ESMA presentation 2007 Advanced Capacitor Summit, San Diego.

## $\text{PbO}_2/\text{H}_2\text{SO}_4/\text{C}$ Asymmetric Electrochemical Capacitor

### Development Goals

Commercial scale modules (100 kW, 500 kW, 1 MW):



Source: Imre Gyuk, "Supercapacitors for Electricity Storage, Scope and Projects", Advanced Capacitor World Summit, Washington DC, (7-15-04),

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**Energy Storage  
is a Disruptive Technology whose  
Adoption will Induce a Paradigm Shift  
in the Entire Utility Industry !!!**

IMRE GYUK, "Emerging Storage Applications for the Transmission Grid"  
DOE Program Manager, ENERGY STORAGE RESEARCH  
Senate Committee hearing (July 28, 2008).