

Progress in Electrical Energy Storage

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Without technological breakthroughs in efficient, large scale Energy Storage, it will be difficult to rely on intermittent renewables for much more than 20-30% of our Electricity.

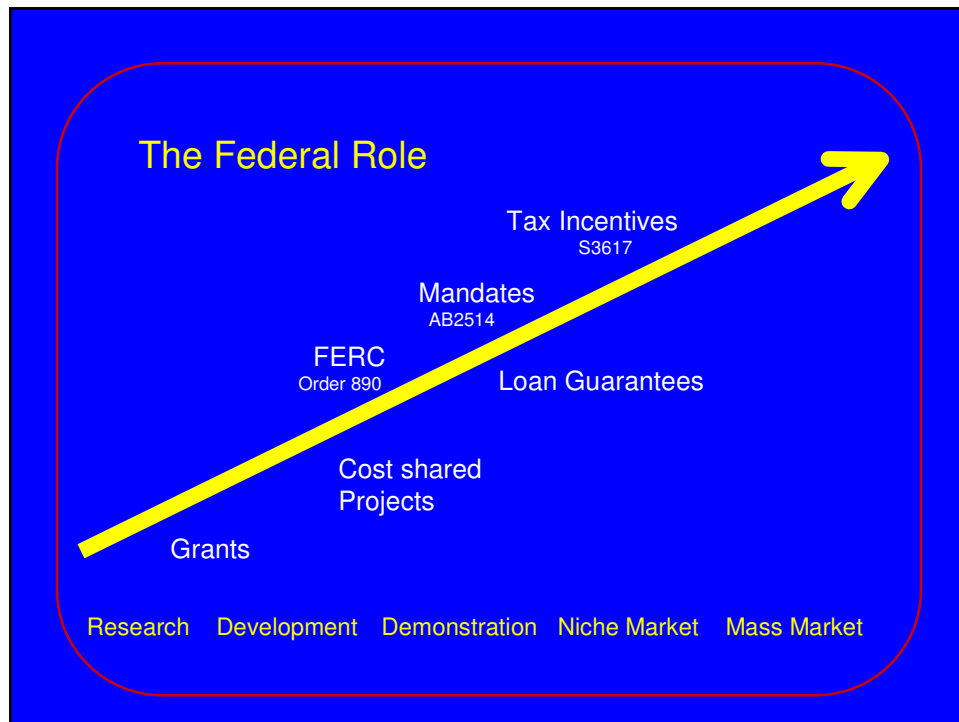
Secretary Chu, Feb. 2010

The need for regulation services can dramatically increase as the amount of variable renewable resources is increased. Local storage is among the best means to ensure we can reliably integrate renewable energy resources into the grid.

Chairman Wellinghoff, FERC, March 2010

Transmission and storage capacity are key issues for energy resource planning. If you like wind power, you have to love transmission and storage.

Terry Boston , CEO, PJM, June 2010



ARRA Stimulus Funding for Storage Demonstration Projects (\$185M)

A ten-fold Increase in Power Scale!

Large Battery System (3 projects, 53MW)

Compressed Air (2 projects, 450MW)

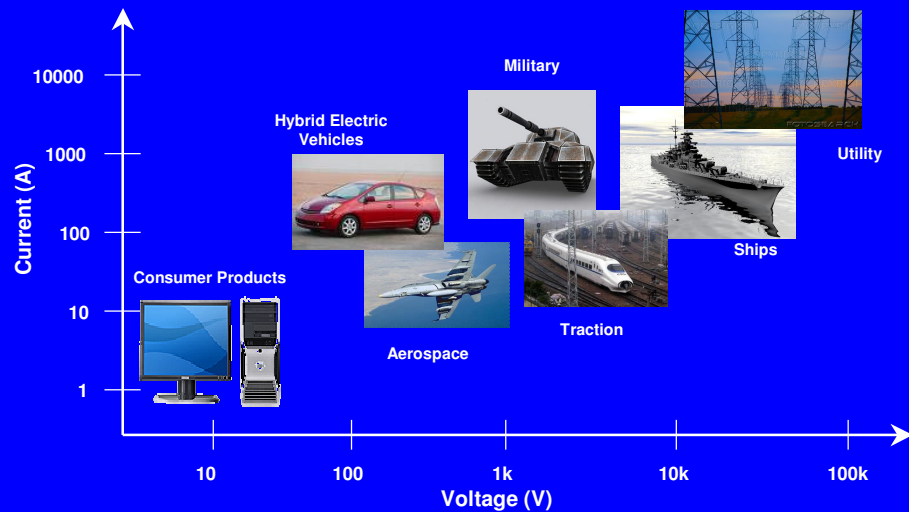
Frequency Regulation (20MW)

Distributed Projects (5 projects, 9MW)

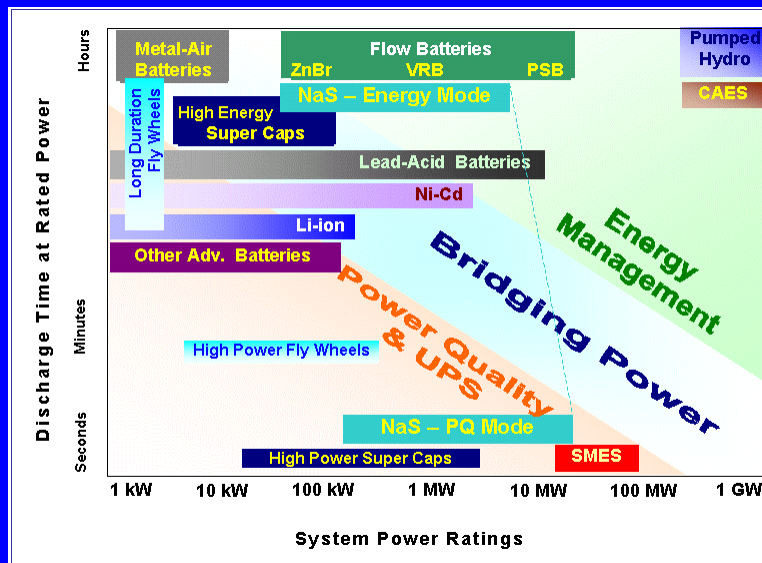
Technology Development (5 projects)

533MW - \$585M Costshare!

Scales of Power



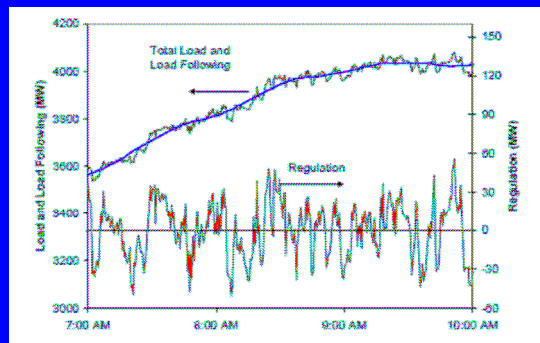
Storage Technologies and Regimes of Application



VOLTAGE and FREQUENCY REGULATION

Market ready

Grid Frequency Regulation with Fast Storage:



Kirby 2004

Current method to balance constantly shifting load fluctuation is to vary the frequency and periodically adjust generation in response to an ISO signal. Fast storage can respond instantaneously!



2x 100kW/15 min Flywheel system Demos

CEC / DOE and NYSERDA / DOE

Regulation by fast storage
may be twice as effective
as gas turbines
(Y. Makarov, PNNL,)

Flywheels yield a 70-80%
Reduction in CO2 emission
over present methods
(Fioravanti, KEMA, 2007)

For 20% wind in CA , Frequency
Regulation needs will double
CAISO



2 x 1MW / 15 min Flywheels
in NE-ISO



4 x 1MW / 15min Li-Ion
in PJM. CA-ISO

**FERC Order 890, requires ISOs to develop tariffs,
market rule, and control algorithms, to open markets
for new technologies to provide ancillary services**

ARRA - Beacon Power:

20MW Flywheel Storage for Frequency Regulation in PJM



20 MW Flywheel System in NY State initiated with DOE Loan Guarantee
2 more 20 MW systems proposed (flywheels and Li-Ion)

DOE Loan Guarantee - Beacon Power:
20MW Flywheel Storage for Frequency Regulation in PJM



DOE Loan Guarantee – AES / A123:
20MW Lithium Ion Battery for Frequency Regulation in NY-ISO



8 MW installed

PEAK SHAVING ENERGY MANAGEMENT UPGRADE DEFERRAL

Near commercial



Charleston, WV Appalachian Power Substation – AEP / DOE Project, June 2006

1.2 MW / 6hr NaS Battery for Substation Support



**3 x 2MW for Substation Support,
and Reliability during 2009**

