



# Implementation of Storage with Renewables – Industry Status

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First International Renewable Energy  
Storage Conference (IRES I)





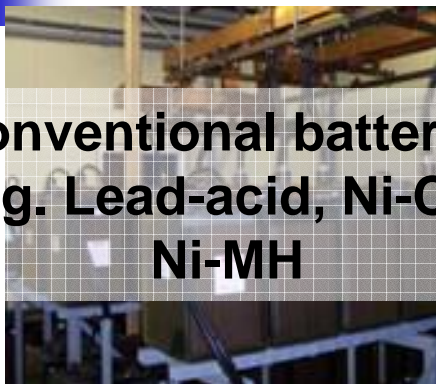
# Electricity Storage Association

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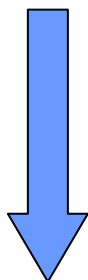
- Formerly the Energy Storage Association
- Trade Association with 60+ members from three continents
- Utilities, suppliers of energy storage equipment and services, research institutions
- Mission: To promote the development and commercialization of competitive and reliable electricity storage delivery systems ...

# Battery technologies

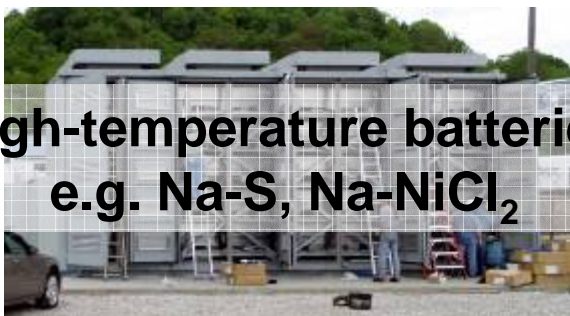
**Conventional batteries**  
e.g. Lead-acid, Ni-Cd,  
Ni-MH



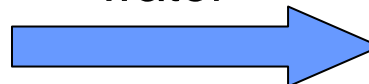
Add  
heat



**High-temperature batteries**  
e.g. Na-S, Na-NiCl<sub>2</sub>



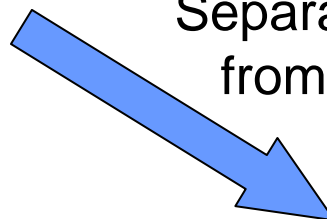
Remove  
water



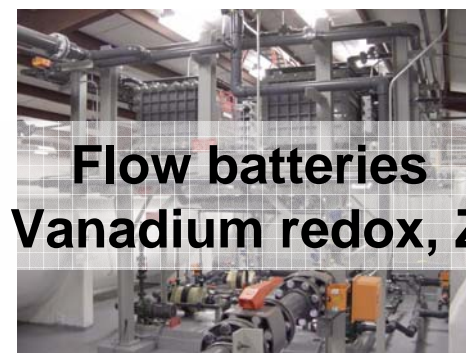
**Lithium batteries**  
e.g. Li-ion, Li-polymer,  
Li-metal polymer, Li-S



Separate power  
from energy



**Flow batteries**  
e.g. Vanadium redox, Zn-Br





# Non-battery technologies

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- Flywheels (conventional & high-speed)
- Electric double-layer capacitors
  - Super / ultra capacitors
  - Symmetric / asymmetric
- Large-scale storage
  - Pumped hydro
  - Compressed air (CAES)
- Superconducting magnetic (SMES)

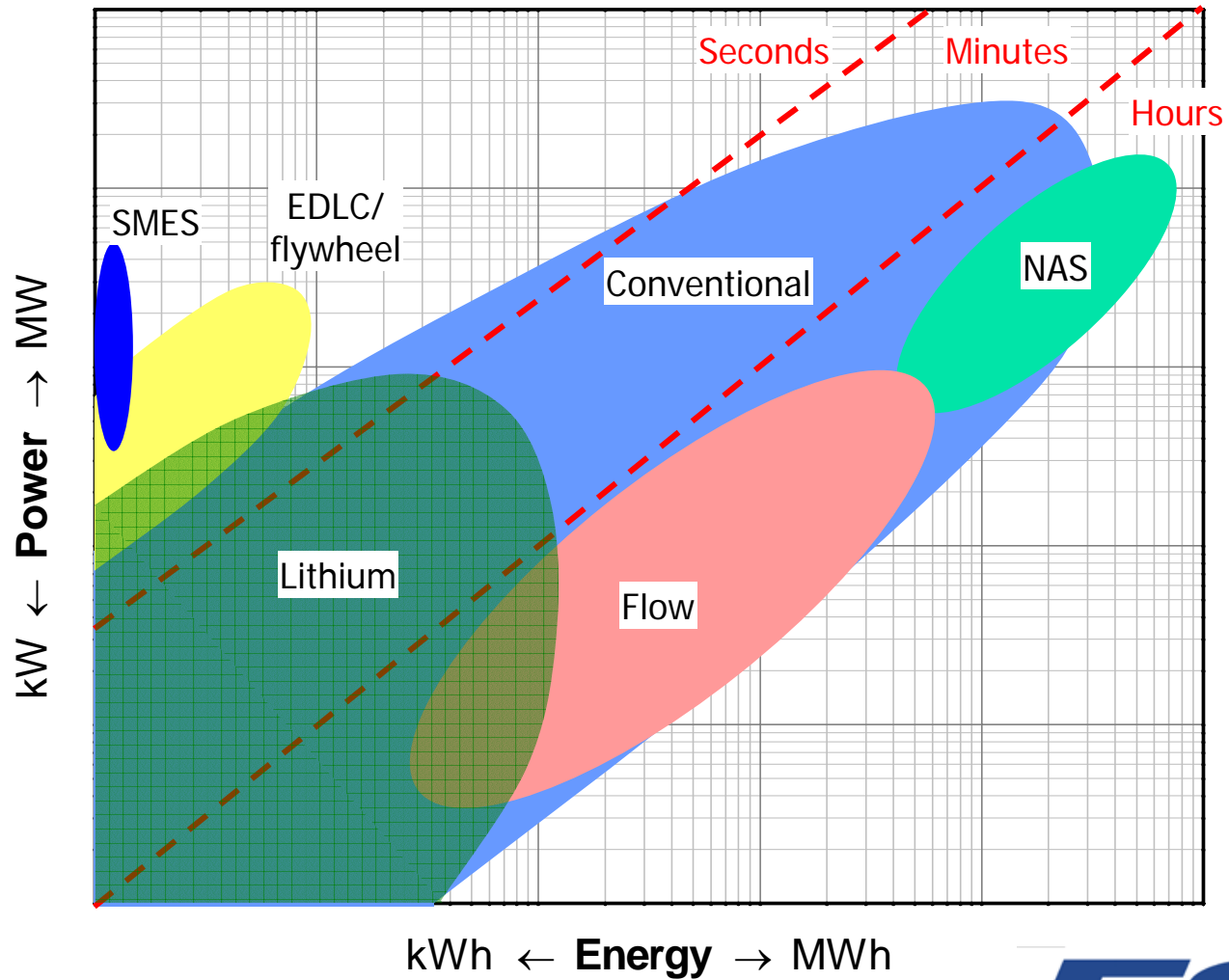


# Application issues

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- Power vs. energy
  - High-power, short-duration discharges
  - High-energy, long-duration discharges
- Scalability
  - kW → MW
  - kWh → MWh
- Cycling capability
  - Electrical
  - Thermal

# Power, Energy & Scale



Approximate information.  
Installed systems as of mid-2006.



# Power & energy with wind power

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- Seconds of discharge
  - Smoothing of wind output
- Minutes of discharge
  - Load following
  - Ramping control
  - Bridging to conventional generation
- Hours of discharge
  - Dispatch and commitment



# Battery storage systems in action

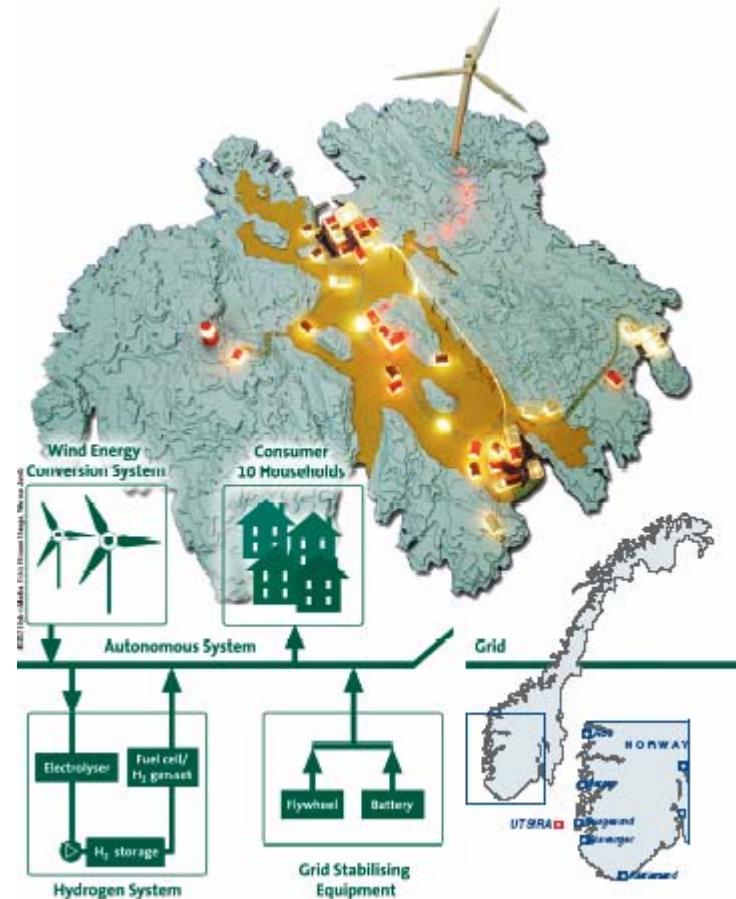
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- Several examples of technical success stories
- Wide application spectrum
  - Seconds / minutes / hours
- Many are also commercially viable, or close to being so



# Seconds, minutes & hours - Utsira

- Norsk Hydro project
- Enercon wind turbines
- Seconds of storage
  - Enercon flywheel
- Minutes of storage
  - Saft Ni-Cd battery
- Hours of storage
  - Electrolyzer
  - Fuel cell
  - Hydrogen ICE generator



Source: Norsk Hydro

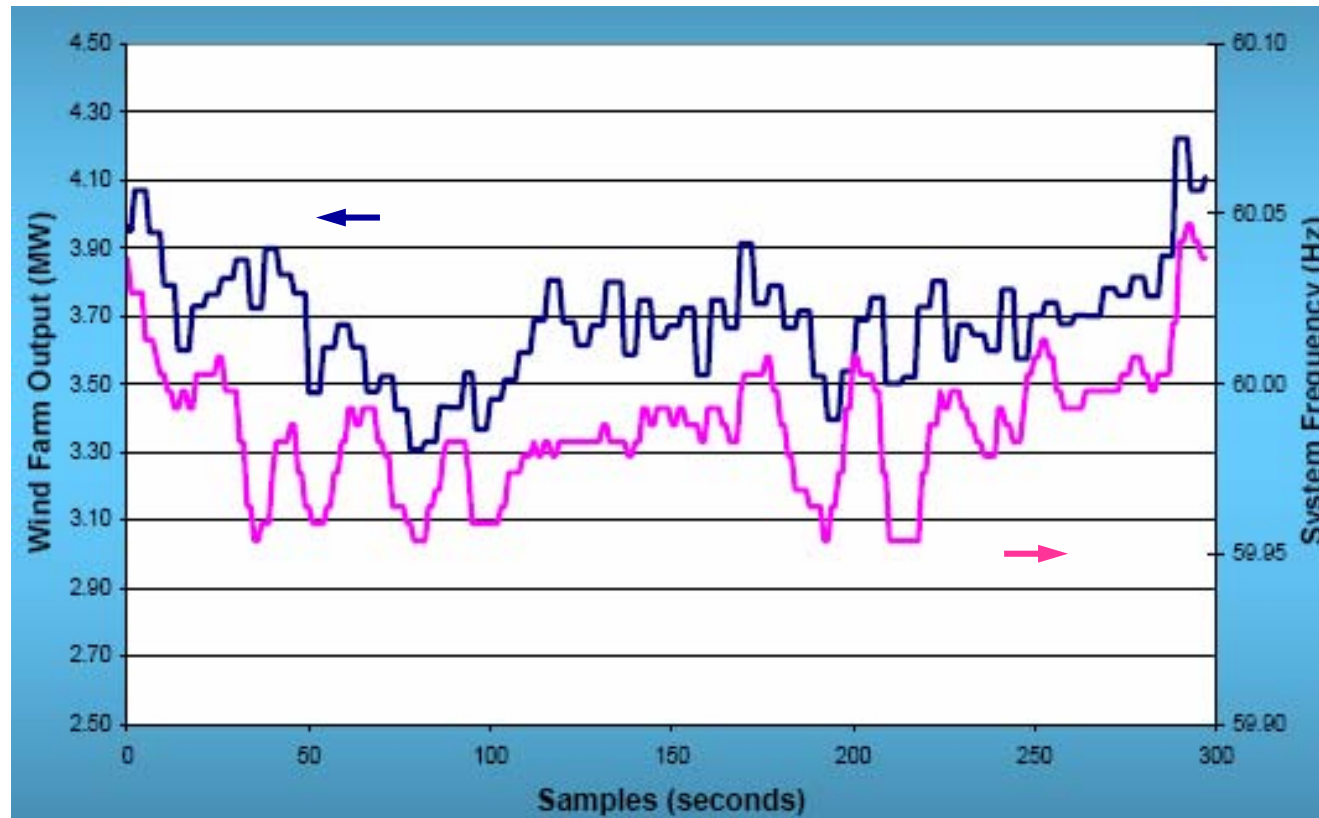
# Seconds – Hawaii “ESA”

- Hawaii Electric Co concept
  - Electronic Shock Absorber
- S&C Electric demonstration project
  - Lalamilo wind farm
  - 40 x 100 kVA wind turbines
  - 2 x 250 kVA converters
- Ultracapacitor storage
  - Maxwell & Epcos
- Stabilizes grid frequency
- Local reactive power support



Source: S&C Electric

# Frequency problems in weak grids



Source: S&C Electric / HECO

# Minutes – remote power grids

- Isolated grids with diesel power
- Solar power station
  - Allows diesels to be turned off
- Short-duration battery system
  - 100's kW / 5 minutes
  - Smoothes solar output
  - Bridges to diesels



Source: Solar Systems Pty Ltd

# Hours – Sorne Hill wind farm

- Tapbury Management
  - 32 MW wind farm
- VRB Power flow battery
  - 1.5 MW / 12 MWh
  - Possible expansion to add 50 MWh
- Economics
  - Better prices for conditioned power
  - Avoiding curtailment

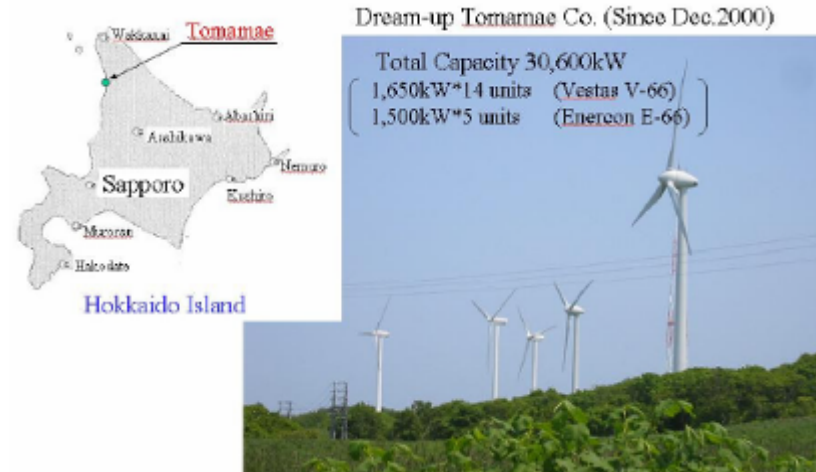


Source: VRB Power



# Hours – Subaru project, Hokkaido

- Tomomae wind farm
  - 30.6 MW rated output
- VRB demonstration system
  - Sumitomo / J-Power
  - 4 MW / 6 MWh
- NEDO funding to optimize control strategy



Source: J-Power

# Hours – Hachijojima Island

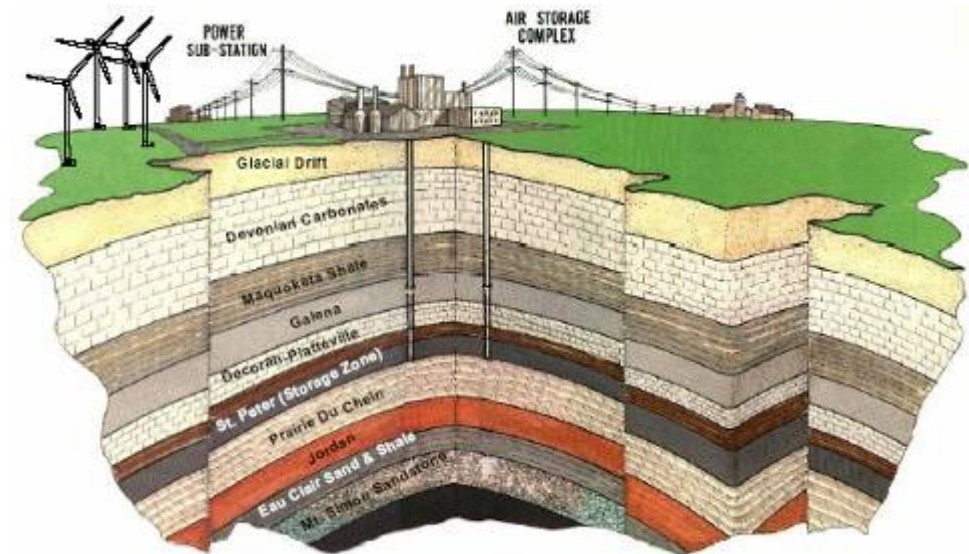
- TEPCO demonstration
  - NEDO sponsored
  - 500 kW wind turbine
  - 400 kW NGK NAS battery
- Largest NAS battery installed to date
  - Hitachi parts plant
  - 8 MW / 7 hours



Source: NGK Insulators

# Weeks – Iowa Stored Energy Park

- Iowa Association of Municipal Utilities
- 25 to 200 MW wind generation
- CAES system
  - Underground aquifer storage of compressed air and natural gas
  - 200 MW x 8 hours, 30 to 45 days
- Estimated to be on-line in 2011







## Gathering momentum...

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- Installation of storage with renewables is accelerating
  - Demonstration systems
  - 'Low-hanging fruit'
- More installations help lower costs
  - Bringing more installations
- The technology is ready...



# Overcoming barriers

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- Barriers still exist
  - Government subsidies
  - Regulatory
  - Tariff-based
  - Cultural
- The storage industry must work with all parties to overcome these barriers
  - Governments
  - Regulators
  - Utilities
  - Operators



## For further information...

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- Any questions:
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- Electricity Storage Association  
[www.electricitystorage.org](http://www.electricitystorage.org)  
(includes links to ESA member companies)