Battery Storage System for Ancillary Services

June 5, 2013

Yutaka Kokai
Hitachi America, Ltd.
Hitachi’s Smart Grid Technology and Solutions

Wide Area Protection System
Advanced SCADA/DMS
AMI, MDM system
HEMS, Demand

Energy Storage System
HVDC
STATCOM
STATCOM for Distribution
EV Charging System

Energy Storage System

© Hitachi, Ltd. 2013. All rights reserved.
Types of Electrical Energy Storage

- **Pumped Hydroelectric**
  - Gen/Motor
  - Flywheel
  - Vacuum
  - Vessel

- **Compressed Air Energy Storage**
  - Gen/Motor
  - Compressor
  - Gas Turbine
  - Combustion
  - Fuel
  - Room for compressed air

- **Superconductive Magnetic Energy Storage**
  - Superconductive magnet
  - Cooling facility
  - PCS
  - Control & Protection

- **Electrochemical Battery**
  - Battery
  - PCS

**Major Batteries**

- NAS (Sodium-sulfur)
- Lead-Acid
- Ni-MH (Nickel metal hydride)
- Lithium-ion, etc.
Deployment of Various Types of Battery

By considering the battery location, purpose, charge/discharge specification, life and cost, optimal battery type, volume and control method should be determined.

**Features of Hitachi’s Batteries**

<table>
<thead>
<tr>
<th>Location</th>
<th>Purpose</th>
<th>Evaluation point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Plant</td>
<td>✅ Suppress WT power fluctuation</td>
<td>Min. design of battery capacity</td>
</tr>
<tr>
<td>Substation (Grid-level app.)</td>
<td>✅ Frequency adjustment, ✅ Surplus energy storage</td>
<td>Charge/discharge schedule control</td>
</tr>
<tr>
<td>Customer (Behind-the-meter app.)</td>
<td>✅ Avoid reverse power flow caused by roof-top PVs, ✅ Suppress Overloading</td>
<td>Distribution line voltage control &amp; Peak shaving</td>
</tr>
</tbody>
</table>

**Lithium-ion Battery**

- LL-1500-W8 (1500Ah, 12kWh)
  - ✅ Large capacity
  - ✅ Long life (17 years)

**Long-life Lead-Acid Battery**

- Battery Module CH75-6 (1.67kWh)
  - ✅ High energy density
  - ✅ Compactness
# Battery at Wind Farm

## Lead-acid battery

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy operation</td>
<td>Operating in ordinary temperature No moving parts (No heater and no pump owing to ordinary temperature operation)</td>
</tr>
</tbody>
</table>
| Large-current charge / discharge | Charge = 0.2C  
Discharge = 0.4C                                      |
| Start-up                 | Starting up instantly owing to no heating process                                                 |
| Easy maintenance         | No need to add electrolyte owing to structure design                                            |
| History for reliability  | Lead battery history is 100 years or more. Many application examples                             |
| Recycle                  | Recycle ratio of lead-acid battery is 100% in Japan. (Out of RoHS regulation)                    |

*Wind power: 1,200kW  
Battery: 800kWh* (Left)  
*Wind power: 600kW  
Battery: 151kWh* (Right)
Lead-acid Battery for Distribution Application

Hitachi’s Lead-acid battery and PCS (Power conditioning system) are used in the US to mitigate power fluctuation caused by renewable energy resources.
Li-ion Battery for Regulation Applications

- **Wind**
- **PV**

Performance Monitoring

FR Signal

Fluctuation Compensation

Frequency Regulation Output

1MW All-in-One Package 40ft Container

Specifications and container design are subject to change.

Battery Charge/Discharge

System Output (20min. Mov. Ave.)

© Hitachi, Ltd. 2013. All rights reserved.
Example of Battery Behavior Simulation

PJM regD Signal of 2012/1/8

C Rate Transition (Absolute Value)

SOC Transition