The Smart Energy System combines our technologies for energy creation (photovoltaic modules), energy storage (rechargeable batteries), and energy saving (efficient energy usage). The system stores electricity generated by photovoltaic modules as well as low-cost late-night power in lithium-ion batteries. By controlling electrical usage in the most efficient way possible, the Smart Energy System reduces facility CO2 emissions and power consumption.

Worldwide Expansion of Storage Battery System Applications

Storage Battery System
Using Lithium-ion Batteries

Utilities / Renewable energy
Offices and schools
Residential
Commercial Buildings

North America (USA, Canada)
SANYO North America Corporation
Solar and Smart Energy Division
email: SmartEnergySystem@us.panasonic.com

Europe
SANYO Component Europe GmbH
Mobile Energy Business Division
Smart Energy Systems Department
email: info.ses@eu.panasonic.com

Other area
SANYO Electric Co., Ltd.
International Sales & Marketing Headquarters
email: info_ses@jp.panasonic.com

The contents of this catalogue are current as of June 2012.
**Smart Energy Storage System:**  
A scalable power storage system for multiple energy storage applications

Based on Panasonic's unique technology development abilities, production technology, and global supply chain, the company has achieved and maintained a major share of the global lithium-ion battery market. Offering an extensive lineup of lithium-ion batteries ranging from small applications such as consumer batteries for laptop computers, to larger applications such as the batteries used in environmental vehicles, Panasonic is a leading company in battery technology for various applications. In addition, Panasonic is a leader in the development and production of photovoltaic modules. Now, based on this foundation, Panasonic has entered the market for Smart Energy Storage Systems, adding a fourth key product area to already established presence in photovoltaic modules, rechargeable batteries, and batteries for electric and hybrid vehicles. Looking forward to future expansion in the renewable energy storage market, Panasonic will use its leading Smart Energy Storage System to maximize customer satisfaction with “coordination and integration” technologies actively tailored to meet customer needs.

### Various applications for rechargeable batteries

- **New Battery Pack**
- **Battery Power (kW)**
- **Total Battery Capacity (kWh)**

### Panasonic's Energy Business

- **Photovoltaic Modules**
  - HIT® Photovoltaic Modules
  - Modules with global top-level conversion efficiency. Unique the biomass offers high performance and high reliability in the harshest outdoor environments as well as better productivity in facilities environments.

- **Rechargeable Batteries**
  - Conventional Rechargeable Batteries
  - Batteries with high performance and reliability have earned a high reputation of Panasonic's energy storage technology. Panasonic has leading share of the global market.

- **Rechargeable Batteries for Environmental Vehicles**
  - Panasonic is developing and expanding the business for rechargeable batteries for electric and hybrid vehicles.

### Large-Scale Battery Systems for Stationary Applications

- **Battery Management System**
  - Battery Protection Unit (BPU) and Battery Protection Module (BPM) for small-scale systems
  - Battery Management Unit (BMU) for mid to large scale
  - Standard battery modules for energy storage

**To realize a low-carbon society of the future**

As utility companies begin the large-scale introduction of renewable energy to the grid, Smart Energy Storage Systems will become a key component. This is because renewable energy sources can cause instability with fluctuations in the power they produce. Acting as a stabilizer for renewable energy, the Smart Energy Storage Systems will serve as an energy storage source and play a critical role in the low-carbon society of the future.

**Scalable solutions for various needs in the utility grid**

Comprised of storage batteries and control units to manage charging and discharging, Panasonic’s Smart Energy Storage System is suitable for various applications (e.g. Residential Energy Storage, Community Energy Storage, Utility scale ancillary services, etc.). Through the unique control method and know-how of managing energy storage, the system can control systems with over 1,000 storage batteries as part of a 1-MWh or greater system.

<table>
<thead>
<tr>
<th>Large-Scale Battery Systems for Stationary Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System Development</strong></td>
</tr>
<tr>
<td><strong>Battery Management System</strong></td>
</tr>
<tr>
<td><strong>Battery Protection Unit (BPU)</strong> and Battery Protection Module (BPM) for small-scale systems**</td>
</tr>
<tr>
<td><strong>Battery Management Unit (BMU)</strong> for mid to large scale**</td>
</tr>
<tr>
<td><strong>Standard battery modules for energy storage</strong></td>
</tr>
</tbody>
</table>

**Peak Cut / Peak Shift / Energy Shift**

- **System Stabilization**
  - **Home and Business**
  - **Community**
  - **Grid Support**

**Solutions**

- **Homes**
  - Small Stores
  - Medium-Sized Stores
  - Large-Scaled Stores (Non-Residential)

- **Buildings**
  - Factories
  - Solar / Wind Power
  - Power Plant{}

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*HIT® is a registered trademark of SANYO Electric Co., Ltd.

**The name “HIT” comes from “Heterojunction with Intrinsic Thin-layer” which is an original technology of SANYO Electric Co., Ltd.*
**Grid Support**

Solutions for the large-scale introduction of renewable energy!
- Solutions for severe power fluctuations
- Solutions for frequency regulation
- Solutions for peak-power demand

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**Employing Smart Energy Storage System for utility scale**

- Power fluctuations caused by renewable energy
- Power stabilization using Smart Energy Storage System

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**Project SIESTORAGE (Siemens Energy Storage)**

Panasonic’s 500 kWh battery system, consisting of 280 battery modules and battery management systems, is being used in field test as an integral part of Siemens’s new SIESTORAGE module energy storage container. The SIESTORAGE is directly connected to the medium voltage grid in South Europe.

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**Stabilizing Power from Renewable Energy Sources**

Fluctuating power and severe output changes from wind and solar energy sources can be stabilized with energy storage, providing high-quality power to the grid.

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**Instant Power Fluctuation Control (Frequency Control)**

Utilizing the high-rate characteristics of lithium-ion batteries

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| Amount of installed Solar (World) |
| Amount of installed Wind (World) |

<table>
<thead>
<tr>
<th>Year</th>
<th>Installed Solar (GW)</th>
<th>Installed Wind (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>170.2</td>
<td>95</td>
</tr>
<tr>
<td>2010</td>
<td>200.1</td>
<td>120</td>
</tr>
<tr>
<td>2011</td>
<td>240.3</td>
<td>150</td>
</tr>
<tr>
<td>2012</td>
<td>300.0</td>
<td>190</td>
</tr>
<tr>
<td>2013</td>
<td>350.0</td>
<td>220</td>
</tr>
<tr>
<td>2014</td>
<td>400.0</td>
<td>250</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Grid Support Capacity/Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>500kWh/1MW</td>
</tr>
</tbody>
</table>

**Application**

This storage system serves as a variety of applications such as Smoothing the natural fluctuations of solar and wind power to stabilize power supply and prevent power outage.
Employing Smart Energy Storage System for a power grid (Community energy storage)

Community Grid

Solutions to minimize capital investment by using distributed energy storage on the grid.

- Solutions for severe power fluctuations
- Solutions to stabilize distribution system's voltage
- Employing Distributed Energy Storage System for a power grid (Community energy storage)

Stable Power Output
Use fluctuating power from wind and solar sources to charge storage batteries, effectively stabilizing power to the grid.

- Solar Power + Storage Battery System
- Power output variation
- Charging
- Discharging
- Smoothed Load
- Original Load
- Demand Shift

Peak Demand Shift
Power generated at night charges the Smart Energy Storage System, and is discharged during the daytime, shifting the peak demand and stabilizing the grid.

- Discharging
- Smoothed Load
- Original Load
- Demand Shift

Backup Power Source during Outages
Power from the battery storage system can also serve as a backup power source in the event of a power outage.

- Discharging
- Smoothed Load
- Original Load
- Demand Shift

Medium-Scale Power System Example
Panasonic is conducting a demonstration project with a University in the United States, where we combine the Smart Energy Storage System with a technology to forecast the output of solar generation. This demonstration project is aiming to contribute to the stable and reliable supply of electricity in an area with high level renewable penetration.

University (USA)

Panasonic is conducting a demonstration project with a University in the United States, where we combine the Smart Energy Storage System with a technology to forecast the output of solar generation. This demonstration project is aiming to contribute to the stable and reliable supply of electricity in an area with high level renewable penetration.
### Industrial/ Commercial

#### Employing Smart Energy Storage System for buildings, factories, and schools

- Reduces electricity bills by reducing contracted power (peak shifting)
- Can be utilized as UPS function
- Also can act as a valuable asset for Energy Arbitrage/Demand response and other applications

*27-kWh System*

#### Peak Demand Shift

Power stored during off-peak, late-night hours in the battery storage system is discharged during daytime peak demand, effectively shifting the peak demand.

#### Backup Power Source during Outages

Power from the storage system can be used as a backup power source in the event of a power outage.

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### Homes and Small Stores

#### Employing Smart Energy Storage System in a home or small store

- Reduces power bills through self-consumption of photovoltaic electricity
- Contributes to the reduction of CO2 emissions
- Serves as an emergency power source in the event of a disaster

*4.0/ 6.8-kWh System*

#### Shifting peak demand usage by combining photovoltaic modules and Smart Energy Storage System; maximizing consumption of photovoltaic module power

Before (Conventional PV)

<table>
<thead>
<tr>
<th>PV generation</th>
<th>PV generation (feed to grid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery (grid)</td>
<td>Battery (grid)</td>
</tr>
</tbody>
</table>

After (PV Plus Battery)

<table>
<thead>
<tr>
<th>PV generation</th>
<th>PV generation (feed to grid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery (grid)</td>
<td>Battery (grid)</td>
</tr>
</tbody>
</table>

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### Facility UPS

When there is a power outage, the lithium-ion battery storage system can operate as a UPS system to bridge the operation of critical systems until the power returns or a backup generator starts.

Installation example:
- TV and radio stations operating during severe weather conditions
- Fire and rescue dispatch systems

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### Storage Battery system

**Residential Storage Battery System Example**

<table>
<thead>
<tr>
<th>Storage Battery Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.05 kWh</td>
</tr>
</tbody>
</table>

**Photovoltaic Modules**

<table>
<thead>
<tr>
<th>Photovoltaic Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.6 kW</td>
</tr>
</tbody>
</table>

**Application**

Storage batteries are used to maximize the use of solar power, which leads to higher self consumption. The stored energy is used during the period without solar radiation.

**Status**

Under operation
In the power storage building at the Kasai Green Energy Park, there are more than 800 standard battery modules, each with an output of 1.6 kWh. Panasonic has developed one of the world’s top level power systems with the Lithium Mega Storage system at the site. Efficiently controlled energy generated from photovoltaic modules, as well as energy provided through off-peak, late-night grid power stored in these storage batteries, is utilized through optimal energy management.

Panasonic’s Kasai Green Energy Park (Japan)

<table>
<thead>
<tr>
<th>Storage Battery Capacity</th>
<th>1.5 MWh / 288 kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photovoltaic Modules</td>
<td>1 MW</td>
</tr>
</tbody>
</table>

Application:
Peak shaving; Store late-night power from the grid and surplus solar power for daytime use in the Kasai Green Energy Park
In operation since October 2010

Accomplishment of average 17% peak shaving in July, 2011

Average peak shaving rate is 17% in Peak hour of electricity demand (13:00 – 16:00)
Annual utility charge reduction effect (preliminary calculation) is about 3.5 million yen

Peak cut ratio for each day

<table>
<thead>
<tr>
<th>Day</th>
<th>Peak cut ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/5</td>
<td>20%</td>
</tr>
<tr>
<td>7/6</td>
<td>18%</td>
</tr>
<tr>
<td>7/7</td>
<td>17%</td>
</tr>
<tr>
<td>7/8</td>
<td>18%</td>
</tr>
<tr>
<td>7/9</td>
<td>19%</td>
</tr>
<tr>
<td>7/10</td>
<td>18%</td>
</tr>
<tr>
<td>7/11</td>
<td>18%</td>
</tr>
<tr>
<td>7/12</td>
<td>19%</td>
</tr>
<tr>
<td>7/13</td>
<td>20%</td>
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<tr>
<td>7/14</td>
<td>17%</td>
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<tr>
<td>7/15</td>
<td>18%</td>
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<tr>
<td>7/16</td>
<td>18%</td>
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<tr>
<td>7/17</td>
<td>16%</td>
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<td>7/18</td>
<td>17%</td>
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<td>7/24</td>
<td>17%</td>
</tr>
<tr>
<td>7/25</td>
<td>16%</td>
</tr>
<tr>
<td>7/26</td>
<td>17%</td>
</tr>
<tr>
<td>7/27</td>
<td>17%</td>
</tr>
</tbody>
</table>

The day in big result of PV
July 19th, 2011 (FRI)

The day in small result of PV
July 15th, 2011 (FRI)