Derwent Top 100 Global Innovator 2020

# **Energy Storage System**



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LS **EnGather** technology supports the entire power system from power generation to transmission, transformation, distribution as well as customers.



## EnGather

Based on advanced power solution technologies that maximize efficiency and stability of power supply, LS has provided a wide range of electric equipment & systems covering both low voltage and ultra-high voltage capacities. Combining its expertise in power and automation, LS has developed an advanced energy story system EnGather



### Why LS?

Building on 40 years of core technologies for the power sector and power electronics in automation, LS has installed energy storage systems (ESS) for different applications, equipping itself with key capabilities in ESS. Its diverse experiences from development of PCS to implementation of turnkey solutions and EPC has allowed efficiency and stable operation of the systems with added customer values. LS is committed to driving smart energy by offering optimal solutions for customers, implementing projects utilizing advanced technology and providing one-stop service with thorough quality control.



## **Product applications**



### Expected benefits by application



#### Smoothing

Renewable energy sources are unpredictable and the availability of renewable energy is not constant, all of which may undermine quality of the grid system.

When connected with ESS, quality electricity can be supplied to the grid system in a stable manner.





**Frequency regulation** 

A gap between power generation and demand on the grid causes the grid frequency to move away from its nominal value, and this can be regulated using ESS to improve quality of electricity.

Deploying ESS can also maximize utilization of coal-fired power plants to reduce power cost.





#### P, Q control for distribution network

As renewable energy is being widely adopted, the existing distribution network will reach its full capacity, requiring investment for capacity expansion. Installing ESS for P/Q control can have same effect of increasing capacity without new capacity installation.







### Load leveling

Time of use electricity pricing has three different pricing for light load, heavy load and maximum load. Electricity is charged during hours of light load and discharged during maximum load to reduce energy charge on your bill.

### Back-up power

In case of blackout, ESS supplies electricity enabling swift response to emergencies.





Peak shaving

When electricity usage goes beyond what is contracted, electricity will be supplied by ESS to prevent demand charge on your bill from going up.





Grid-tied/Stand-alone

A microgrid is a discrete energy system consisting of diesel power generation, renewable energy, ESS, etc. and loads capable of operating in parallel with, or independently from, the main power grid.

ESS helps stabilize the grid system through power smoothing control as well as voltage and frequency regulation.



## ESS total solution by application



## ESS for photovoltaic power generation

ESS is installed in photovoltaic power plants and is charged with power generated during set period of time (10AM to 4PM). Power discharged at other times of the day is eligible for REC weight to generate revenue.

### Policy benefits







### Commercial/Industrial ESS

Special electricity charge discount programs running until 2020 for customers using ESS will allow customers to enjoy more benefits. Customer's usage pattern is analyzed to size up the most optimal system configuration with savings estimation. Various operational modes of PMS, the monitoring and control system of ESS, also enhances system usage.



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## Energy Storage System

## System configuration



**EnGather** analyzes your pattern of electricity demand to estimate optimal ESS/Battery capacity, and the system is designed to suit the local characteristics and usage.









### **PMS** Power Management System

## Commercial / Industrial

Integrated monitoring and control system of ESS provide optimal solutions for commercial and industrial end-users. The operation center allows convenient and effective operation of ESS with simple clicks of a mouse.

- Operation mode
   Schedule-based Load Leveling
   Demand-based peak shaving
   Independent operating substituting diesel generator
  - Main functions
    - Monitoring and control of PCS, battery and other equipment
      - Analysis of operational
      - effectiveness such as cost saving

#### PMS Operation Screen



The energy flow on the grid system is displayed in maptype diagrams to assist intuitive monitoring of ESS operation status.

ESS operation is updated on a real-time basis and is presented in graphs with immediate estimation of costs saved.

## **ESS for distribution**

Operational algorithms are embedded to prevent excessive load on the distribution network.

- Operation mode
  - Active power control : Scheduling, Peak Shaving,
     P Control
  - Reactive power control : Voltage control, Power

#### Main functions

• Unmanned operation in the field integrating remotely controlled communication system with upstream systems of the distribution center





## Modular scalable technology

## **3 level topology PEBB**

The new Modular Scalable PCS is based on 3 level topology power Electronics Building Block (PEBB) and has applied Parallel-Operation Technique up to 16 units.

Modular Scalable PCS allows customers to choose capacity from 125kW up to 2.5MW.

An newly introduced optimal parallel-operation method not only increases the efficiency but also improves the reliability of an overall system.

Maintaining the efficiency over 98%

in the range of 33~100% load condition

Round trip

Charging/ Discharging efficiency

-Max. charging efficiency : 98%

- Max. efficiency : Over 96.4%

- Rated efficiency : Over 96.2%

Discharging efficiency over 98%

Load rate [%]

- 33~100% load condition

-Max, discharging efficiency : 98.3%



### **PEBB** capacity

- Rated power -125kW (@380V)
  - -158kW (@480V)
- AC rated voltage -380/400/440/480V
- DC voltage range -620~1,200V
- PEBB size [mm] -250W x 814H x 822D
- Energy density -945 [kW/m<sup>3</sup>]
- Note
- -Stand-alone operation capability
- -Certified with SGSF test (SGSF : Smart grid standard forum)

## Smart operation mode



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- · Selecting the PEBBs to run depending on the accumulated power processed by each PEBB
- Increasing the longevity of the overall system

### 96.5

Efficiency curve

Dischargi Efficiency

Charging Efficiency

Efficiency [%]

98.0

97.

97.

96.0

33



### Modular Scalable PCS

Up to 16 units of modular PEBB can be connected in parallel to optimize PCS power output (in case of 2MW PCS).

PCS capacity

- 2 units of PEBB : 250kW
- 4 units of PEBB : 500kW
- 6 units of PEBB : 750kW
- 8 units of PEBB : 1MW - 12 units of PEBB : 1.5MW
- 16 units of PEBB : 2MW
- AC voltage
   PEBB capacity

   380V
   125kW

   400V
   131kW

   440V
   145kW

   480V
   158kW

### Sustainable operation



- When PEBB failure occurs, the PCS system can continue to operate by excluding the malfunctioned PEBB
- Minimizing the off time of the overall system by partial operation during the fault
- Simple and quick replacement of a malfunctioned PEBB for maintenance

### Efficiency optimized operation



- Low efficiency in low load conditions due to general characteristics of inverters
- Maintaining each
   PEBB at the optimized
   level of output by
   changing the number
   of running PEBBs
- Improving the overall system Efficiency



## Modular Scalable PCS

## PCS model name







## Recommended battery

Modular Scalable PCS is compatible with batteries of different applications with DC voltage range of 620V to 1200V.

PCS		PCS DC voltage range (1MW, 2MW)	713			1200
Battony	Energy (1C↓)	Company S/Energy/242S Company S/Energy/264S Company K/Energy/133 Company L/Energy/R1000	714	774 845 768	1004	1096 1100
Battery	Power (1C↑)	Company S/Power/242S Company S/Power/264S Company K/Power/133 Company L/Power/R1000	75 72 71	50 818 818 919 919 919 919 919 919 919 919	992 10 1000	)82 1100
PCS		PCS DC voltage range (90k, 250k, 500kW)	620		1000	
	Energy (1C↓)	Company S/Energy/198S Company K/Energy/111 Company L/Energy/R1000	634 640 714	822 83	2 1000	
Battery	Power (1C↑)	Company S/Power/242S Company K/Power/111 Company L/Power/R1000	650 714	750 830	992	
		400	0 600	800	1000	1200 1400

## Specification of Modular Scalable PCS

PCS capacity		90kW	250kW	500kW	750kW	1MW	1.5MW	2MW	
Model name		LSEP-0090G2-DI1T-KR	LSEP-0250G2-DI6-KR	LSEP-0500G2-EI6-KR <sup>1)</sup> LSEP-0500G2-DI6-KR <sup>2)</sup>	LSEP-0750G2-EI6-KR	LSEP-1000G2-EI3-KR <sup>11</sup> LSEP-1000G2-DI3-KR <sup>21</sup>	LSEP-1500G2-EI3-KR	LSEP-2000G2-EI3-KR <sup>1)</sup> LSEP-2000G2-DI3-KR <sup>2)</sup>	
Type of grid connection		3 Phase 4 wire	3 Phase 3 wire						
DC	DC voltage range (V)	530 ~ 1,000	620 ~ 1,000 (@380V) 713 ~ 1,000 (@440V)	620 ~ 1,200 (@380V) <sup>11</sup> 713 ~ 1,200 (@440V) <sup>11</sup> 620 ~ 1,000 (@380V) <sup>21</sup> 713 ~ 1,000 (@440V) <sup>21</sup>	620 ~ 1,200 (@380V) 713 ~ 1,200 (@440V)	713 ~ 1,200	620 ~ 1,200 (@380V) 713 ~ 1,200 (@440V)	713 ~ 1,200	
	Max. DC current (A)	180	420	830	1,240	1,440	2,470	2,870	
	DC disconnection method	Circuit breaker	Circuit breaker	DC Disconnector /Fuse Circuit Breaker	DC Disconnector /Fuse	Disconnector / Fuse <sup>1)</sup> circuit breaker <sup>2)</sup>	DC disconnector /Fuse	Disconnector / Fuse <sup>11</sup> circuit breaker <sup>21</sup>	
	Rated power (kVA)	90	250	500	750	1,000	1,500	2,000	
	Rated voltage (V)	380	380 / 440	380 / 440	380 / 440	440	380 / 440	440	
AC	Nominal AC voltage range (%)	-12%, 10%	-12%, 10%	-12%, 10%	-12%, +10%	-12%, 10%	-12%, +10%	-12%, 10%	
	Nominal current (A)	137	380 (@380V) 328 (@440V)	760 (@380V) 656 (@440V)	1,140 (@380V) 985 (@440V)	1,312	2,280 (@380V) 1,969 (@440V)	2,624	
	Max. AC current (A)	160	440	880	1,330	1,530	2,650	3,050	
	AC frequency (Hz)	50 / 60							
	Max. total harmonic distortion		Total $\langle$ 5%, Individual $\langle$ 3%						
Efficiency		Max. efficiency 〉 97%, Round trip(Max.) 〉 94%	Max. efficiency > 98%, Round trip{Max.} > 95%						
5 1	Dimensions (W×D×H, mm)	730 x 880 x 2,205	1,330 x 880 x 2,205	2,030 x 880 x 2,205	2,330 x 880 x 2,205	2,630 x 880 x 2,205 <sup>1)</sup> 2,930 x 980 x 2,205 <sup>2)</sup>	3,230 x 880 x 2,205	3,830 x 880 x 2,205 <sup>1)</sup> 4,130 x 980 x 2,205 <sup>2)</sup>	
Lifetosure	Weight (Ton, Packing excluded)	0.6	0.9	1.7	2.1	2.6	3.8	4.2	
	Cooling system	Forced air							
	IP	IP21	IP21	IP21	IP21	IP21	IP21	IP21	
Environment	Temperature (°C)	-20 ~ 50							
	Relative humidity (%)	0 ~ 95 (Non-condensing)							
User	НМІ	8.4 inch touch LCD							
interface	Communication	Modbus TCP, DNP 3.0 (Option)							
Compliance to standards	Korean standard	SGSF-025-4[Ed2.0: 2016-12] * 750kW, 1.5MW(SGSF Ed3.0(SPS-SGSF-025-4-1972 : 2019])							
	International standard	CE (2MW product: LSEP-2000G2-EI3)							
	Safety	IEC 62477-1, IEC 62477-2, IEC 62103							
	EMC	90kW ~ 2MW(KN 62040-2) 750kW, 1.5MW(KN 11, KN 61000-6-2)							

## Quality control system

### Major ESS testing equipment

LS has built a systematic research and development process within its R&D headquarters and has a separate reliability center to secure product liablity from the R&D stage. It has also established testing facilities and quality verification process that are most optimal for ESS based on years of experience obtained from a number of ESS projects. Quality control is practiced in a thorough manner from production to final shipping.



- Rated Circulation Testing Equipment
- Capacity: 2.5MVA
- Purpose:
- Product reliability test for long-hour operation
- Performance Testing Equipment
  Capacity: 500kW
- Constant Temperature and Humidity
   Chamber
- Capacity: Enough for housing MW-level PCS
   Purpose
- Ambient temperature and humidity setup

## Korea's first testing agency accredited by UL for ESS testing

LS Power Testing & Technology Institute (PT&T) is the first international accredited testing institute in the country's private sector. PT&T currently has 2000MVA short-circuit testing equipment, high-voltage testing equipment, and reliability testing equipment. As an international testing and calibration institute certified by KOLAS, PT&T is qualified to carry out quality management and testing for electric equipment and systems. PT&T has established strategic alliances with world-class certification institutes such as US on ESS testing, and now UL testing can be performed domestically.



### One-stop turn-key service

One-stop service covering consulting, sizing, installation and warranty is available for customers interested in ESS to ensure customer convenience and satisfaction.



## Project management

The project team is staffed with Project Managers (PM) with ample amount of project experience. Clearly defined project management processes ensure successful project implementation while PMs are evaluated on project management maturity (PMM) and are trained with professional programs to further enhance project management capabilities.



## Track record

### Grid stability

### KEPCO shinchungju substation

- Shinchungju, Korea
- Frequency regulation (Autonomous)
- 16MW / 6MWh li-ion kokam battery
- LS scope: 16MW PCS, PMS, Engineering and installation

#### **KEPCO** seoansung substation

- Soeansaung, Korea
- Frequency regulation (Autonomous)
- 16MW / 5.4MWh li-ion kokam battery
- LS scope: 16MW PCS and PMS, Engineering and installation

### **KEPCO** ulsan substation

- Ulsan, Korea
- Frequency regulation (Autonomous)
- 32MW / 12MWh li-ion samsung SDI battery
- LS scope: 32MW PCS and PMS, engineering and installation

### **KEPCO** distribution project

- Nep island, wando-gun, Korea
- P, Q control for distribution network
- 3MW / 6MWh li-ion samsung SDI battery
- LS scope: 3MW PCS and PMS, Engineering and installation

### KEPRI demonstration & distribution project

- Jeongeup-si, Korea
- P, Q control for distribution network
- 250kW / 500kWh li-ion kokam battery 8sets
- LS scope: 250kW PCS and PMS





















## Track record (Overseas projects)

### Chesapeake college

- State of maryland, USA
- Frequency regulation (AGC)
- 1 MW / 720 kWh samsung SDI battery
- LS scope: 1MW PCS, Switchgear, Engineering and installation

#### Shin-Chitose Kashiwadai

- Hokkaido, Japan
- Photovoltaic power generation with ESS
- 17MW / 13.7MWh samsung SDI battery
- LS scope: EPC, 0&M (PV and ESS)









## **Commercial & industrial**

### LS R&D anyang campus

- Anyang, Korea
- Peak shaving, Load leveling & back-up power
- 1MW / 1MWh LG chem. battery
- LS scope: 1MW PCS and PMS, Engineering and installation

### LS-Nikko Copper

• Ulsan, Korea

- Peak shaving, Load leveling
- 6MW/ 36MWh
- LS Scope : 6MW PCS, PMS, Engineering and installation

### SeAH besteel

- Gyeongsangnam-do, Korea
- Peak shaving, Load leveling

Peak Shaving, Load Leveling

- · 2MW/8MWh
- LS Scope : 2MW PCS, PMS, Engineering and installation

#### SeAH Coated Metal

- Jeollabuk-do, Korea
- 2MW/ 9MWh
- LS Scope : 2MW PCS, PMS, Engineering and Installation













## Renewable integration

### Busan hwamyeong purification plant

- Hwamyeong, Busan, Korea
- Photovoltaic Power generation with ESS
- Photovoltaic 997kW / ESS 1MW / 3MWh samsung SDI battery
- · LS scope: PV 1MW (Module, PCU)/ ESS 1MW (PCS, PMS) EPC, 0&M

#### LS busan factory

- Hwajeon-dong, Busan, Korea
- Photovoltaic Power Generation with ESS
- Photovoltaic 911kW / ESS 1MW / 2.7MWh Samsung SDI Battery
- · LS scope: PV 1MW (Module, PCU)/ ESS 1MW (PCS, PMS) EPC, 0&M

### LS cheongju factory

- Cheongju, Korea
- Photovoltaic power generation with ESS
- 1MW / 1MWh samsung SDI battery
- LS scope: 1MW PCS and PMS, Engineering and installation

#### **Daemyung GEC**

- Youngam, Korea
- Wind power smoothing
- 4MW/14MWh samsung SDI battery
- · LS scope: 4MW PCS, EMS, Switchgear, Engineering and installation















## Memo











· For your safety, please read user's manual thoroughly before operating.

- · Contact the nearest authorized service facility for examination, repair, or adjustment.
- Please contact qualified service technician when you need maintenance.
   Do not disassemble or repair by yourself!
- Any maintenance and inspection shall be performed by the personnel having expertise concerned.



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· According to The WEEE Directive, please do not discard the device with your household waste.



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