

Energy Storage System



LSIS

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LS group is a leader of key industries and the 14th largest group in Korea.

- No. of executives/employees: approx. 13,000
- Revenue: 19 billion USD
- Total assets: 18.9 billion USD (as of 2016; excluding assets of overseas affiliates)
- No. of affiliates: 45 companies
- Operating profits: 652 million USD



LS IS

LS Cable & System

LS-Nikko copper

LS Mtron

LS Networks

G2ON

E1

yesco

Leading company and total solution provider in the field of electric power systems and automation solutions.

LSIS, the leader of Korea's electric power industry, provides smart convergence solutions with ICT and DC technologies.

Energy Storage System (ESS)

A system improves the quality of the energy supply by storing energy and supplying stored energy in required situations such as lowering power rates or responding to blackout

Smart Building Energy Management System (BEMS)

A 'green building' system that maximizes energy consumption efficiency by collecting and analyzing the energy consumption information of a building

One-Stop Solution For Photovoltaic Power Generation

The first one-stop solution in Korea that can be installed in any space including salt pans and water surfaces with the components required for photovoltaic systems (e.g. photovoltaic cells and installation system)

Energy Management System (EMS)

A system designed to optimally control the operation of power generation systems and manage the power supply

Smart campus MG system

A system that supplies stable high-quality power to campuses, and manages energy adequate for properties of buildings through energy analysis and consumption prediction

Smart Factory Energy Management System (FEMS)

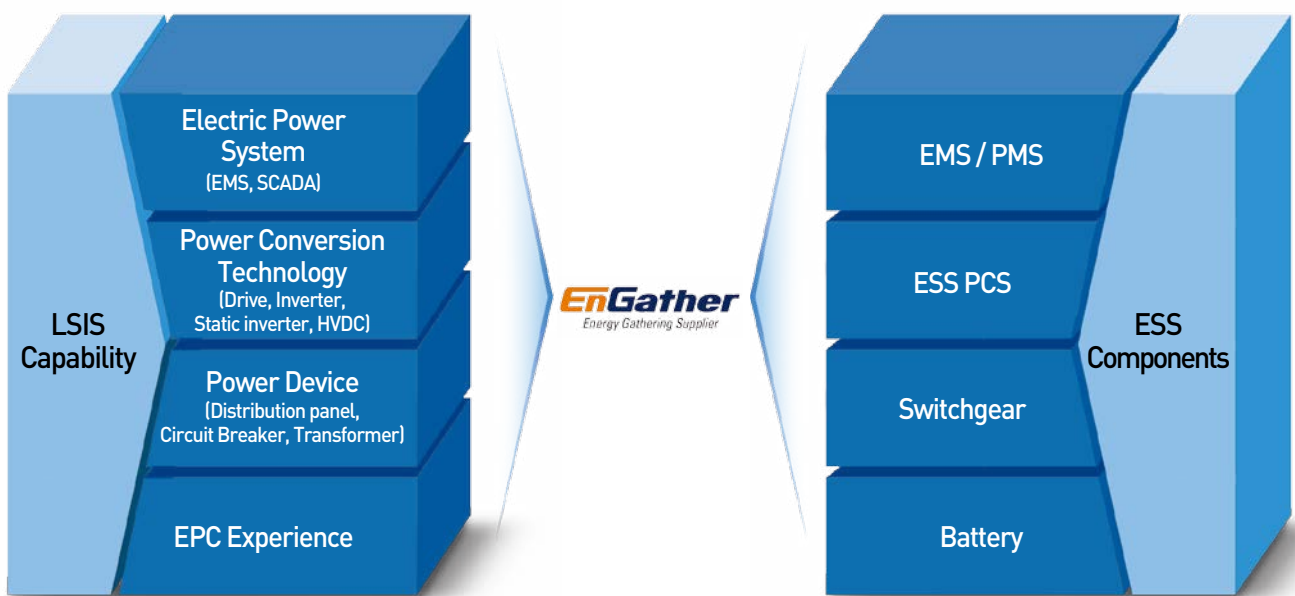
A green factory system for maximizing energy consumption efficiency by collecting and analyzing production line energy consumption information in real time

Smart Home Energy Management System (HEMS)

A system designed for easy monitoring and management of household energy consumption at home at anytime from anywhere

Overview - EnGather

LSIS **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, LSIS 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, LSIS has developed an advanced energy storage system **EnGather**



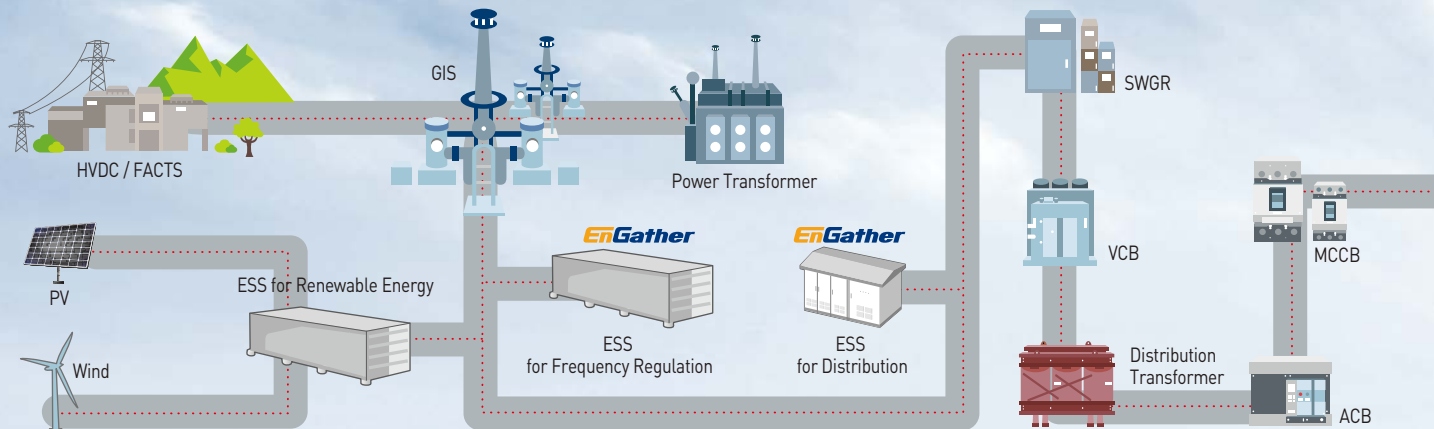
Why LSIS?

Building on 40 years of core technologies for the power sector and power electronics in automation, LSIS 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. LSIS 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.

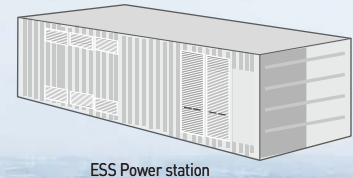
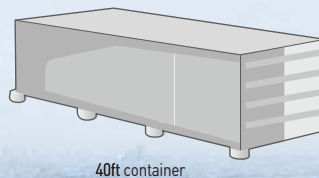


Product Applications

Power Generation, Power Transmission and Transformation



EnGather



Expected Benefits by Application

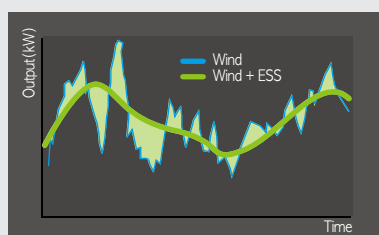
Renewable Energy



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.



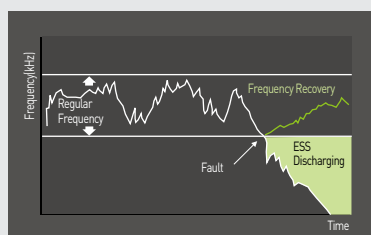
Frequency Regulation



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.

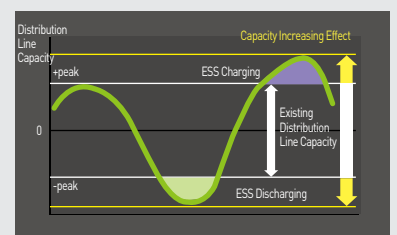


Distribution

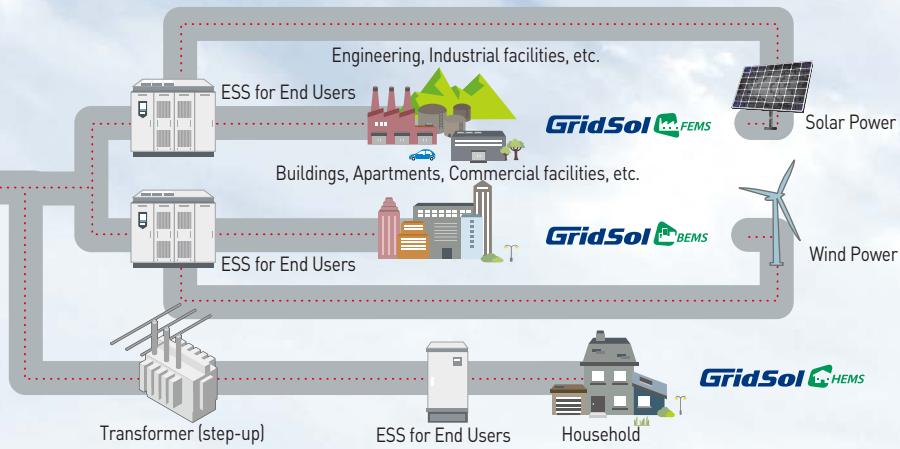


P, Q Control for Distribution Network

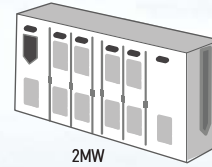
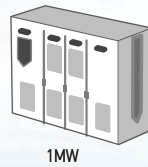
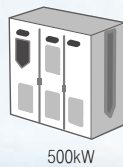
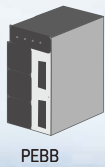
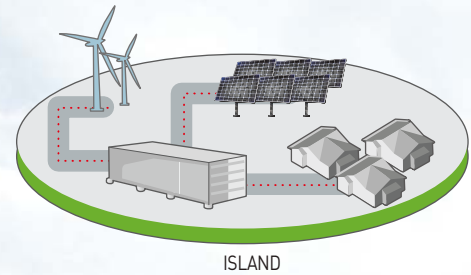
As renewable energy is being widely adopted, the existing distribution network will reach its full capacity, requiring investment for capacity expansion. Installing ESS for P/Q control can have same effect of increasing capacity without new capacity installation.



End Users



Microgrid



Commercial

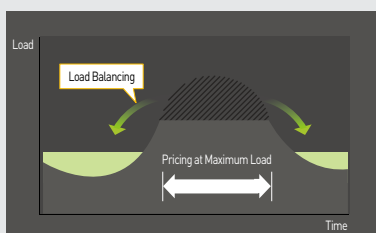


Load Leveling

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.

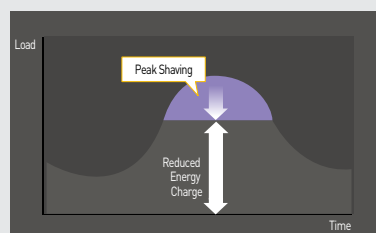


Industrial



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.



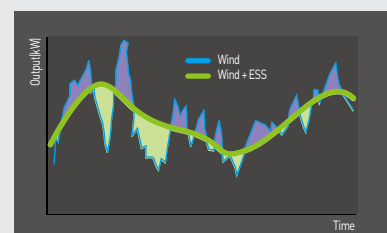
Microgrid



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.



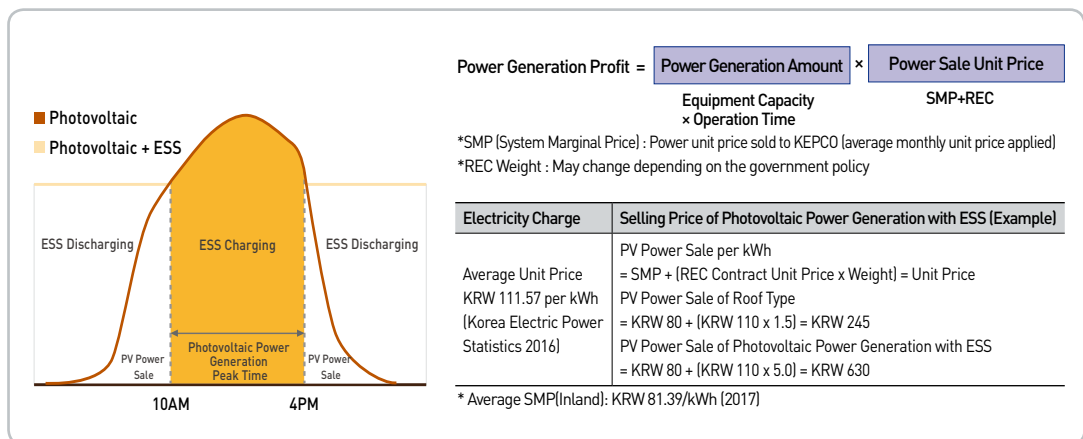
ESS Total Solution by Application



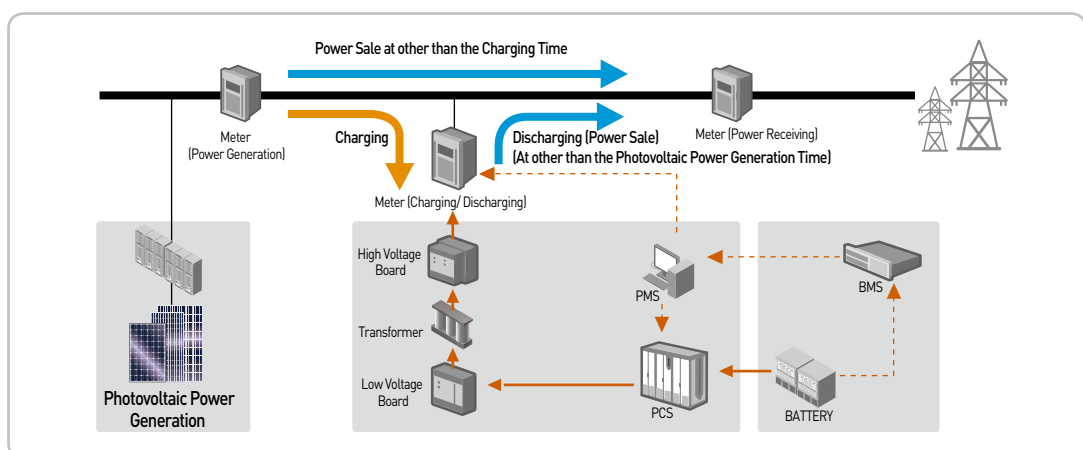
ESS for Photovoltaic Power Generation

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



System Configuration

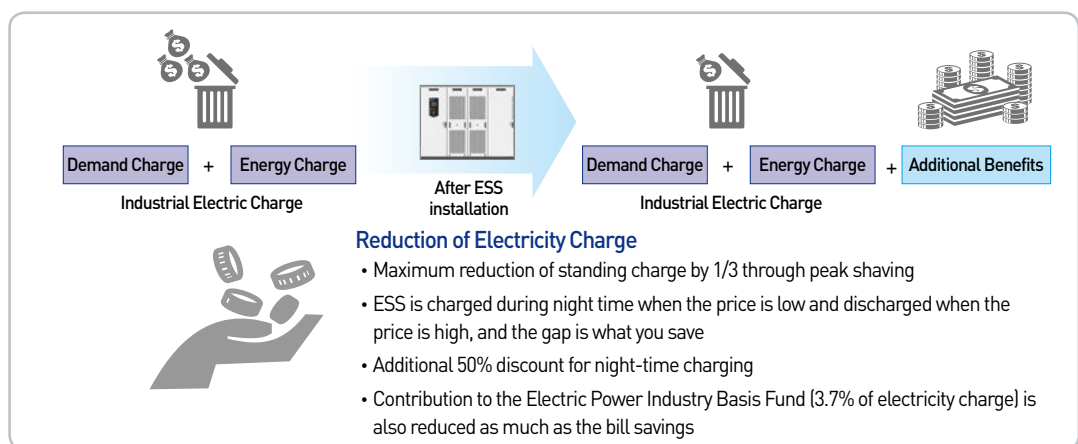




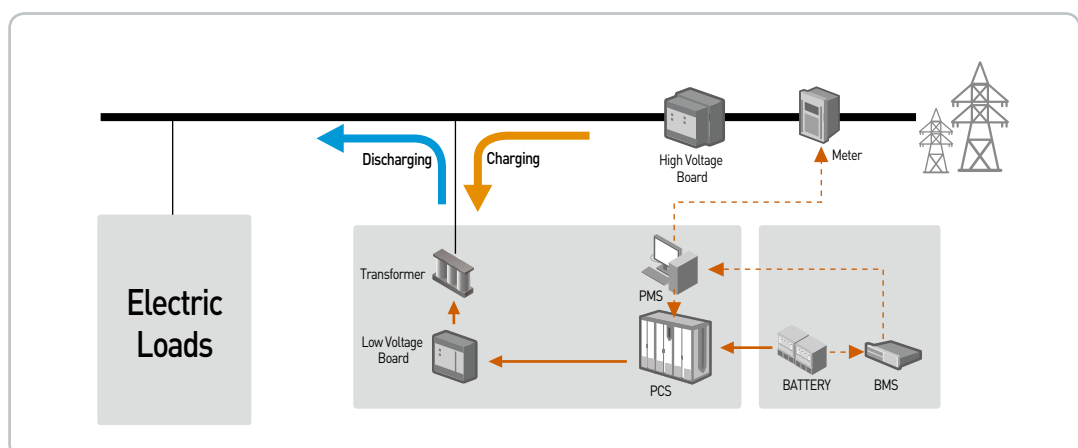
Commercial/Industrial ESS

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.

Expected Benefits

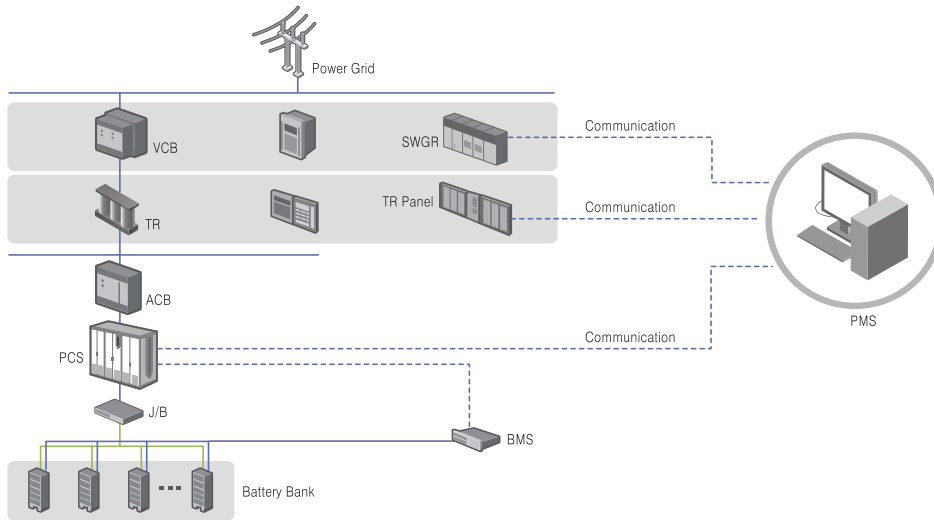


System Configuration



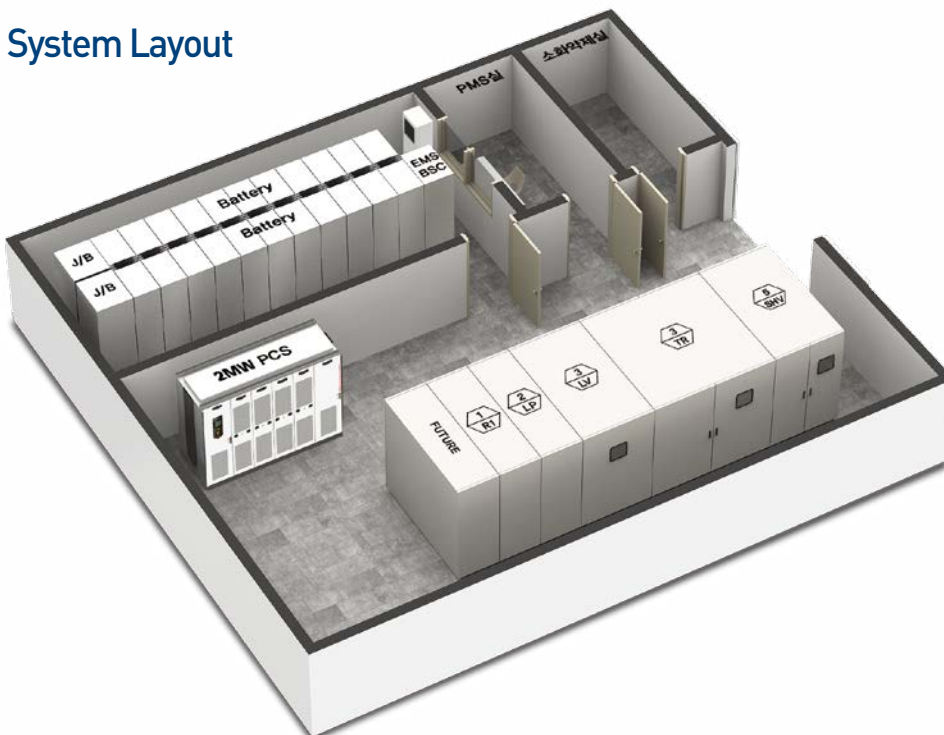
Energy Storage System

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.

System Layout



Indoor ESS Configuration : PMS, PCS, Battery, Switchgear

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 map-type diagrams to assist intuitive monitoring of ESS operation status.



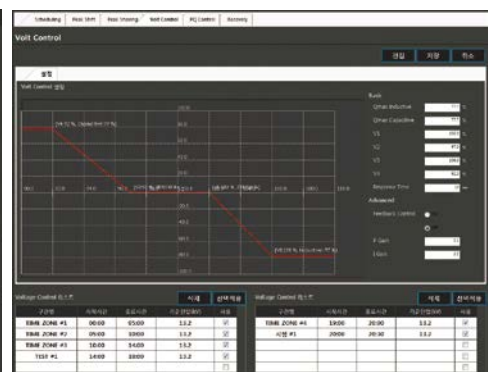
ESS operation is updated on a real-time basis and is presented in graphs with immediate estimation of costs saved.

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

■ PMS Operation Screen



Modular Scalable Technology

3 Level Topology PEBB

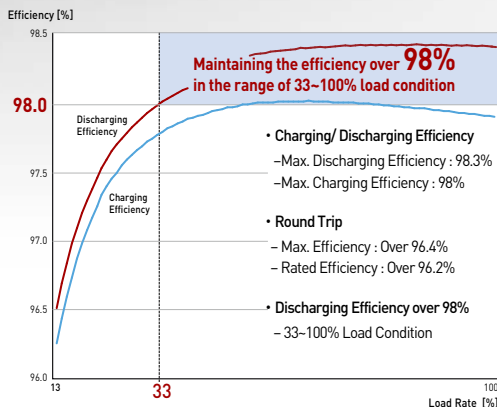
The new Modular Scalable PCS is based on 3 Level Topology Power Electronics Building Block (PEBB) and has applied Parallel-Operation Technique up to 16 units.

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.



Efficiency Curve



PEBB Capacity

- Rated power
 - 125kW (R380V)
 - 158kW (R480V)
- Energy Density
 - 945 [kW/m³]
- Note
 - Stand-Alone Operation Capability
 - Certified with SGSF Test [SGSF : Smart Grid Standard Forum]
- AC Rated Voltage
 - 380/400/440/480V
- DC Voltage Range
 - 620~1,200V
- PEBB size [mm]
 - 250W x 814H x 822D

LSIS' Smart Operation Mode

Load Follow Operation

25% Load	
50% Load	
100% Load	

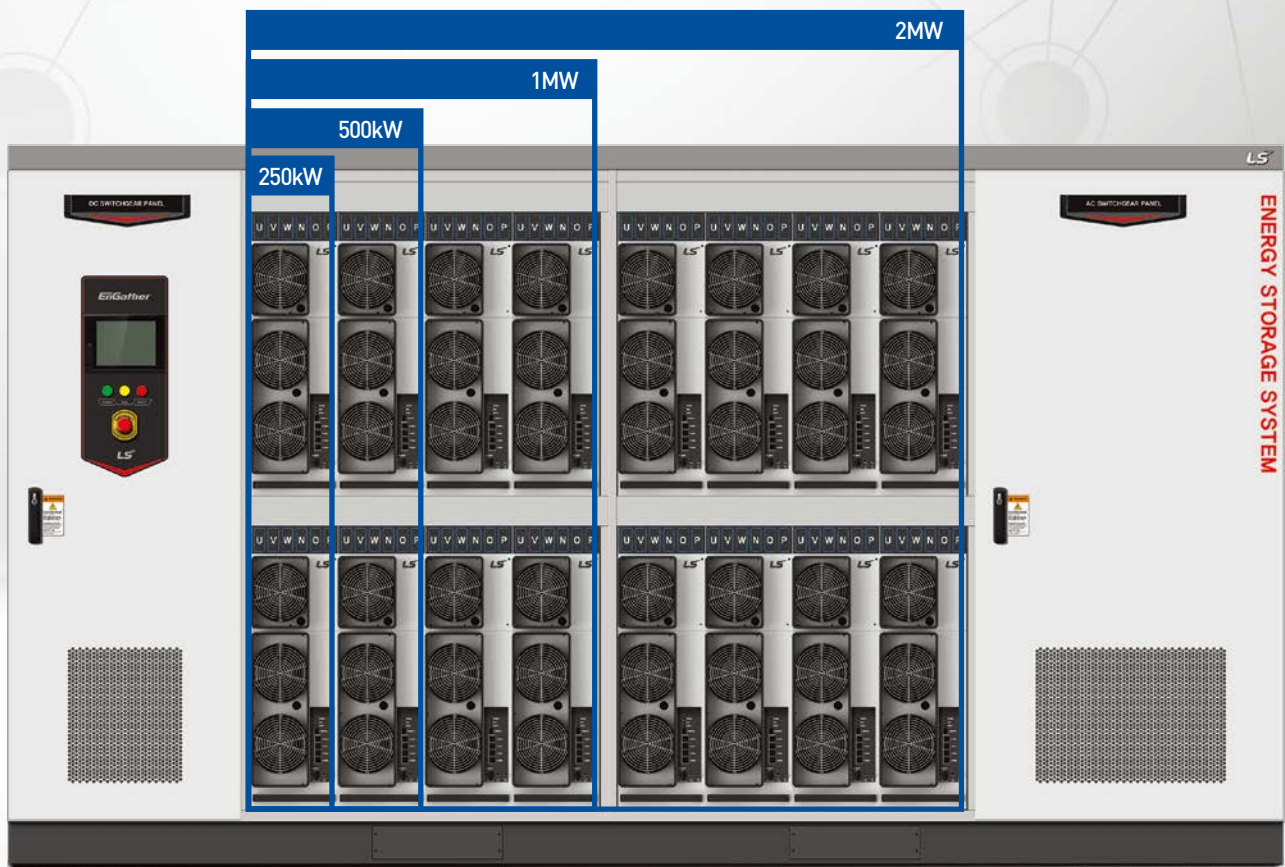
● : Run ● : Stop ● : Fault

- Determining of PEBBs depending on load conditions
 - In case of 25% Load, only 25% PEBBs are running
 - Running all PEBB during 100% of load In case of 100% load

Durable Operation

1 st Run	
2 nd Run	
3 rd Run	

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



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	- 8 units of PEBB : 1MW
- 4 units of PEBB : 500kW	- 16 units of PEBB : 2MW

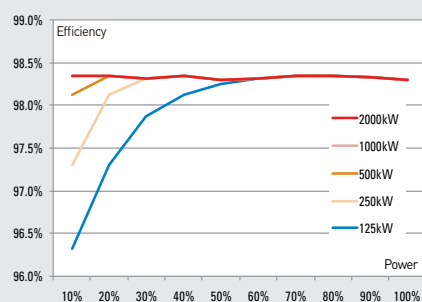
AC Voltage	PEBB Capacity
380V	125kW
400V	131kW
440V	145kW
480V	158kW

Sustainable Operation

PEBB Normal Operation	
PEBB Fault	

- 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

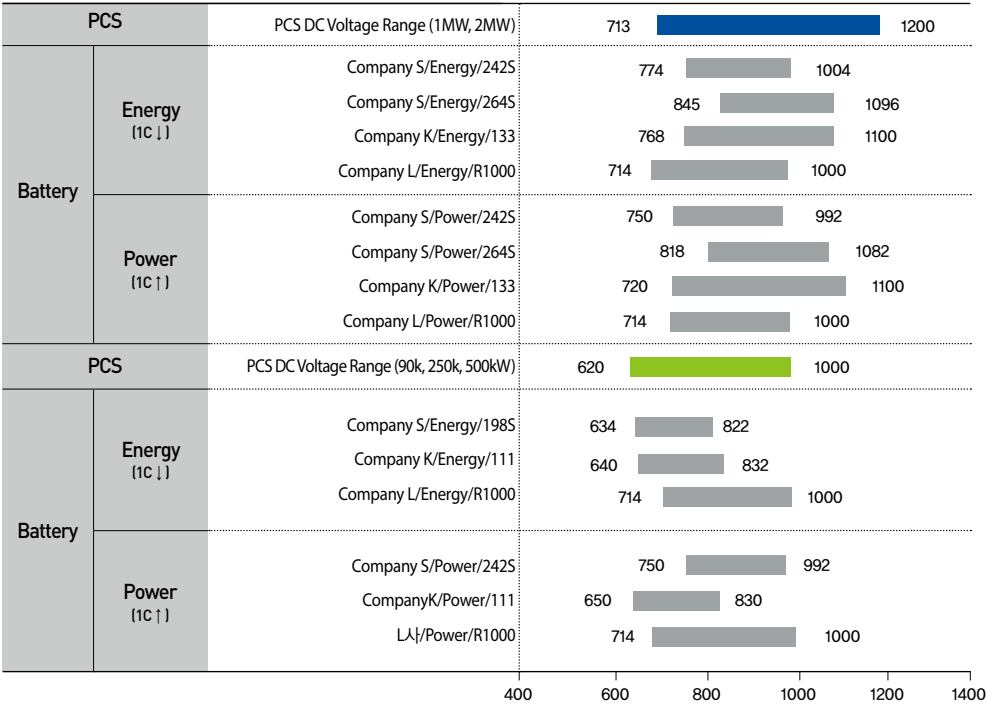
LSEP	-	2000	G	2	-	E	0	1	T	-	KR
LSIS Energy Storage System PCS		PCS Capacity		PEBB Capacity		Enclosure		Transformer			Standard
		0100 : 100kW 0250 : 250kW 0500 : 500kW 1000 : 1MW 2000 : 2MW		1 : 1MW Power Stack 2 : 125kW PEBB		I : Indoor O : Outdoor		Blank : None T : Transformer Built-In			KR : SGSF CE UL
			Grid-tied (Type of Grid-Tied)		Type of DC Connection		AC Rated Voltage				
					D : DC Circuit Breaker E : DC Disconnecter/Fuse		1 : 380V 2 : 400V 3 : 440V 4 : 480V 5 : 690V 6 : 380/440V				



Indoor Type PCS			
250kW	500kW	1MW	2MW

Recommended Battery

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



PCS Capacity		250kW	500kW	1MW	2MW
Model Name		LSEP-0250G2-DI6-KR	LSEP-0500G2-DI6-KR	LSEP-1000G2-EI3-KR ¹⁾ LSEP-1000G2-DI3-KR ²⁾	LSEP-2000G2-EI3-KR ¹⁾ LSEP-2000G2-DI3-KR ²⁾
Type of Grid Connection		3 Phase 3 Wire			
DC	DC Voltage Range (V)	620 ~ 1,000 (@380V) 713 ~ 1,000 (@440V)	620 ~ 1,000 (@380V) 713 ~ 1,000 (@440V)	713 ~ 1,200	713 ~ 1,200
	Max. DC Current (A)	420	830	1,440	2,870
	DC Disconnection Method	Circuit Breaker	Circuit Breaker	Disconnecter / Fuse ¹⁾ Circuit Breaker ²⁾	Disconnecter / Fuse ¹⁾ Circuit Breaker ²⁾
AC	Rated Power (kVA)	250	500	1,000	2,000
	Rated Voltage (V)	380 / 440	380 / 440	440	440
	Nominal AC Voltage Range (%)	-12%, 10%	-12%, 10%	-12%, 10%	-12%, 10%
	Nominal Current (A)	388 (@380V) 335 (@440V)	775 (@380V) 669 (@440V)	1,339	2,678
	Max. AC Current (A)	440	880	1,530	3,050
	AC Frequency (Hz)	60			
	Max. Total Harmonic Distortion	Total < 3%, Individual < 1.5%			
Efficiency		Max. Efficiency > 98%, Round Trip > 95%			
Enclosure	Dimensions (WDH, mm)	1,330 x 880 x 2,205	2,030 x 880 x 2,205	2,630 x 880 x 2,205 ¹⁾ 2,930 x 980 x 2,205 ²⁾	3,830 x 880 x 2,205 ¹⁾ 4,130 x 980 x 2,205 ²⁾
	Weight (ton, Packing Excluded)	0.9	1.7	2.6	4.2
	Cooling System	Forced Air			
	IP	IP21	IP21	IP21	IP21
Environment	Temperature (°C)	-20 ~ 50			
	Relative Humidity (%)	0 ~ 95 (Non-condensing)			
User Interface	HMI	8.4 inch Touch LCD			
	Communication	Modbus TCP, DNP 3.0 (Option)			
Compliance to Standards	Korean Standard	SGSF-025-4 (Ed 2.0:2015-12)			
	Safety	IEC 62477-1, IEC 62477-2, IEC 62103			
	EMC	EN 61000-6-2, EN 61000-6-4			

Quality Control System

Major ESS Testing Equipment

LSIS has built a systematic research and development process within its R&D headquarters and has a separate reliability center to secure product liability 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

LSIS's 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.



[UL Certificate of Qualification]

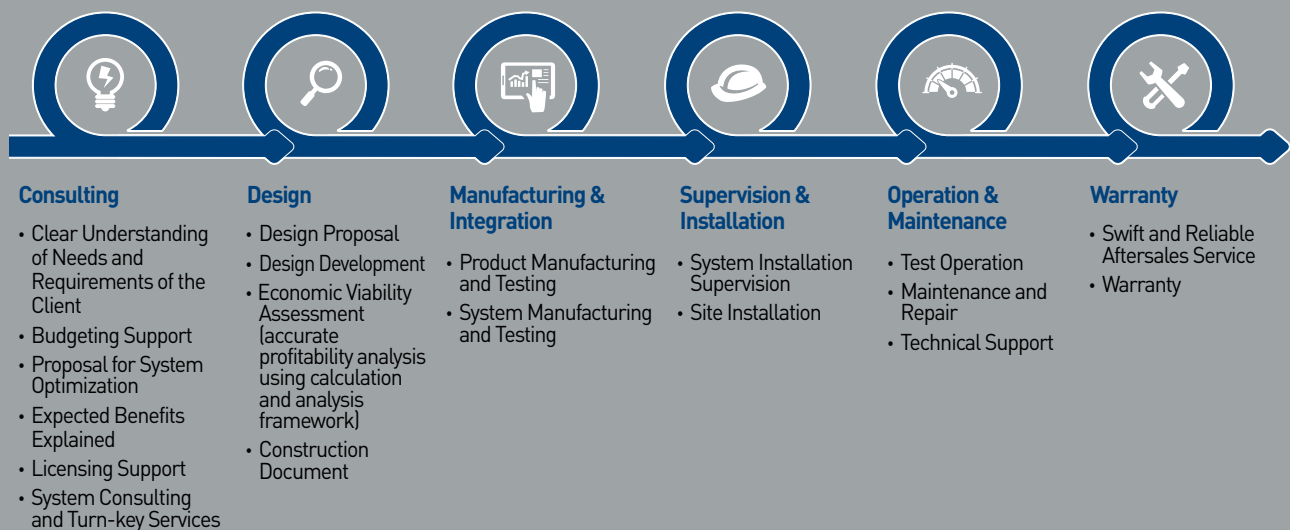
PT&T became the first Korean testing agency accredited by UL in February 2015.
UL certification : UL 9540, UL 1741, IEEE 1547.1

[Power Testing & Technology Institute
(PT&T), Cheongju, Korea]



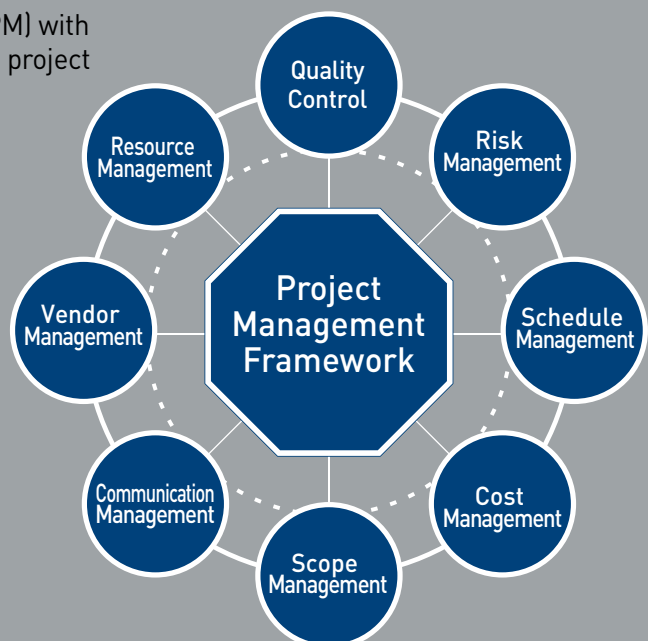
One-Stop Turn-key Service

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
- 2016.07
- LSIS scope: 16MW PCS, PMS, Engineering and Installation



Honam Coal Plant

- Yeosu, Korea
- Frequency Regulation (AGC & Autonomous)
- 4MW / 2MWh Li-ion LG Chem. Battery
- 2016.04
- LSIS scope: 4MW PCS and PMS, Engineering and Installation



KEPCO Seoansung Substation

- Soeansaug, Korea
- Frequency Regulation (Autonomous)
- 16MW / 5.4MWh Li-ion Kokam Battery
- 2015.07
- LSIS scope: 16MW PCS and PMS, Engineering and Installation



KEPCO Ulsan Substation

- Ulsan, Korea
- Frequency Regulation (Autonomous)
- 32MW / 12MWh Li-ion Samsung SDI Battery
- 2017.07
- LSIS 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
- 2017.08
- LSIS 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
- 2017.07
- LSIS 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
- 2017.08
- LSIS scope: 1MW PCS, Switchgear, Engineering and Installation



Shin-Chitose Kashiwadai

- Hokkaido, Japan
- Photovoltaic Power Generation with ESS
- 17MW / 13.7MWh Samsung SDI Battery
- 2017.09
- LSIS scope: EPC, O&M (PV and ESS)



Commercial & Industrial

LSIS R&D Anyang Campus

- Anyang, Korea
- Peak Shaving, Load Leveling & Back-up Power
- 1MW / 1MWh LG Chem. Battery • 2015.03
- LSIS scope: 1MW PCS and PMS, Engineering and Installation



Samsung SDI CheonAn Factory

- CheonAn, Korea • Peak Shaving & Load Leveling
- 2.5MW / 7MWh Samsung SDI Battery • 2014.08
- LSIS scope: 2.5MW PCS and PMS, Engineering and Installation



Samsung SDI Ulsan Factory

- Ulsan, Korea • Peak Shaving & Load Leveling
- 2MW / 4MWh Samsung SDI Battery • 2014.08
- LSIS scope: 2MW PCS and PMS, Engineering and Installation

Renewable Integration

Busan Hwamyeong Purification Plant

- Hwamyeong, Busan, Korea
- Photovoltaic Power Generation with ESS • 2017.12
- Photovoltaic 997kW / ESS 1MW / 3MWh Samsung SDI Battery
- LSIS scope: PV 1MW (Module, PCU) / ESS 1MW (PCS, PMS) EPC, O&M



LSIS Busan Factory

- Hwajeon-dong, Busan, Korea
- Photovoltaic Power Generation with ESS • 2018.01
- Photovoltaic 911kW / ESS 1MW / 2.7MWh Samsung SDI Battery
- LSIS scope: PV 1MW (Module, PCU) / ESS 1MW (PCS, PMS) EPC, O&M



LSIS Cheongju Factory

- Cheongju, Korea
- Photovoltaic Power Generation with ESS • 2015.06
- 1MW / 1MWh Samsung SDI Battery
- LSIS scope: 1MW PCS and PMS, Engineering and Installation



Daemyung GEC

- Youngam, Korea • Wind Power Smoothing
- 4MW/14MWh Samsung SDI Battery • 2016.01
- LSIS scope: 4MW PCS, EMS, Switchgear, Engineering and Installation



KOSPŌ Jeju Island

- Jeju Island, Korea • Wind Power Smoothing
- 2MW / 8MWh Samsung SDI Battery • 2015.11
- LSIS scope: 2MW PCS, EMS, Switchgear, Engineering and Installation



KEPRI Bigeum Island

- Bigeum Island, Korea • Wind Power Smoothing, Power Quality
- 500kW / 250kWh LG Chem Battery • 2014.06
- LSIS scope: 500kW PCS, 1MVA STATCOM and EMS, Engineering and Installation





Safety Instructions

- 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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