

Introducing LS

- LS, a leader in Korea, is ranked 13th among domestic businesses
- \$18.6 billion in assets and \$22.7 billion in revenues (2014)
 - 12,700 employees, 100 international affiliates and branches in 25 countries, including the US, China, Europe, and Middle East
 - Over 80 years of electric industry experience (founded in 1936)
 - Spun out of LG in 2003 as a separate company
 - Key affiliates: LSIS, LS Cable & System, LS-Nikko Copper, LS Mtron, Yesco, Gaon Cable, and E1



LSIS headquarters: LS Tower Anyang-si, Gyeonggi-do, Korea

Overall Business Portfolio of LSIS

Full range of Electric Power Solutions/ Automation Solutions/Drive Solutions/Wire Cables/ Metal Pipe/ Transportation Systems/ Wireless Telecomm./ Green Businesses (Smart Grid, Energy Storage, PCS, AMI, etc.)

Electric Power Products – Many Supporting Energy Storage



Smart Power Transmission

- Transformer
- Gas Insulated Switchgear
- Low & Medium Voltage Switchgear
- Bus Duct System
- Power equipment Diagnosis/ Preventive Maintenance
- HVDC/FACTS
(High Voltage Direct Current/ Flexible AC Transmission Systems)
- Smart Grid
- Photovoltaic Solution
- Railway System



Smart Power Distribution

- Low Voltage Equipment
 - Miniature Circuit Breakers
 - Molded Case Circuit Breakers
 - Air Circuit Breakers
 - Contactor & Relay
 - Manual Motor Starter
 - Surge Protective Device
- Medium Voltage Equipment
 - Vacuum Circuit Breakers
 - Vacuum Contactors
 - Ring Main Unit
 - Vacuum Interrupters
- Protection & Measurement
 - X-GIPAM Series
- Metering



Smart Industrial Automation

- Programmable Logic Controller
- Distributed I/O
(Input/Output)
- Servo Motor/Servo Drive
- Human Machine Interface
- AC Drive
- Industrial Integration System
- Distributed Control System
- Factory Automation System

High-quality Products from Eight Plants around the World

- Korea: 5 Plants (Cheongju 1 & 2, Cheonan, Busan, Busan HVDC)
- Overseas: 3 Plants (China: Dalian, Wuxi / Vietnam: Hanoi)



Research & Development and Testing



Cheonan

- Four R&D centers (3 Korea, 1 China)
 - Support core technologies and work closely with business units
 - Build base for new products and businesses



PT&T

- Power Testing & Technology Institute (PT&T)
 - First private international accredited testing institute in Korea
 - Over \$50 million invested
 - High-power, high-voltage, reliability testing, and calibration laboratories
 - Qualified to conduct quality management and testing for electric equipment and systems
 - Strategic alliances with world-class certification institutes such as UL on ESS testing, and can now perform UL testing

Energy Storage System Testing Capabilities

From renewable energy to energy storage, LSIS has a depth of experience in ESS & PV inverter testing, ensuring energy storage technologies meet performance, reliability and safety criteria



Long duration reliability testing
Capacity: 1MW / 2MW

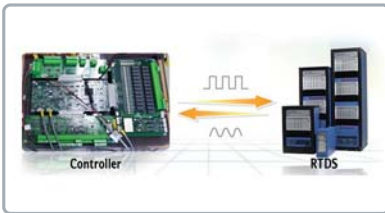


Performance/protective/transient testing
Capacity: 250kW



Control algorithm verification
Capacity: 22kW

PV, battery & inverter modeling and simulation makes it possible to analyze a large number of operating conditions and design parameters for battery, PCS, ESS, and PV hardware, software and system optimization



Real Time Digital Simulator (RTDS) for system simulations



Electromagnetic compatibility testing



Temperature and humidity chamber



LSIS, named in Top 100 Global Innovators for five consecutive years by Thomson Reuters!

Proven Innovation

LSIS, a leader in the power and automation fields in Korea was named once again to Thomson Reuters' list of Top 100 Global Innovators in 2015. This is the 5th consecutive year that LSIS has received this honor along with other leading global companies.

LSIS Co., Ltd.

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LSIS Power Conditioning System (PCS)

MW-level bi-directional inverters for energy storage applications.

Excellent dynamic characteristics and stable charging/discharging control between the grid and high energy-density batteries. Integrated power control algorithms.

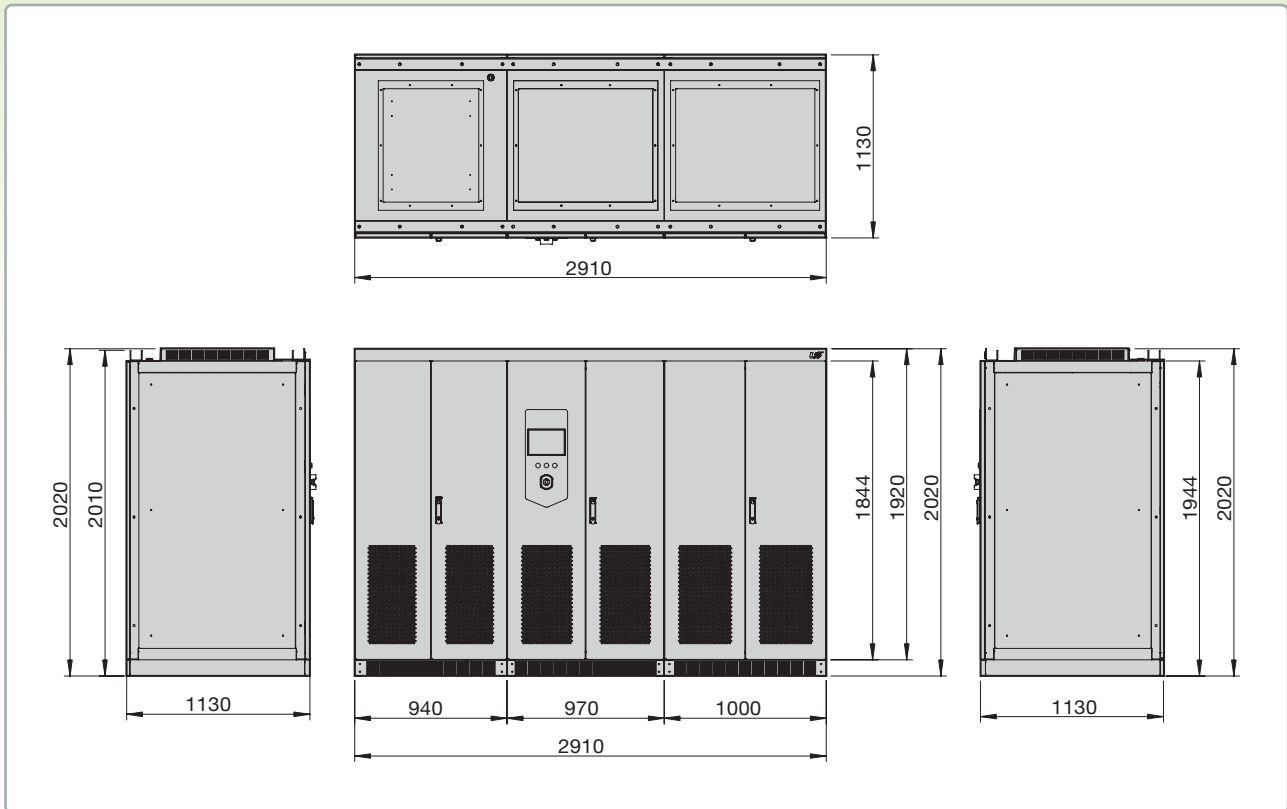
Configured with modular inverter stacks for easy maintenance and highly reliability in demanding storage applications (frequency regulation, peak shaving, emergency generator, load shifting, PV and wind smoothing, etc.).

- MW-level power control
- Bi-directional power conversion
- Quick response
- High efficiency
- Active and reactive power control
- Easy maintenance



Items		Specification	
Model		LSEP-1000G1(KOR)	LSEP-1000L1(KOR)
Electrical	Number of Phases		3 Phase
	DC Input	Input Voltage	588 to 830Vdc
		Maximum Input Current	1,700Adc
		DC Breaker	2000V/2600A, 71kA short circuit capacity (EN50123-2)
	AC Output	Rated Capacity	1MW
		Rated Voltage	380Vac
		Frequency	60Hz
		Nominal Output Current	1,519Arms
		Current Harmonics	THD : total 5%, individual 3%
		Power Factor	≥0.99 steady state
		Efficiency	Max. 98%, >96% (at rated power, discharging efficiency)
		Ancillary and Cooling System Losses	Max. 2.0kW
		AC Breaker	690V/2500A, 65kA short circuit capacity (IEC 60947-2)
		Control Method	Active Power, Reactive Power
System Spec.	Dimensions (WxHxD)		2,910 x 2,020 x 1,130 mm
	Weight		~ 3,300 kg
	Cooling System		Forced air
	Enclosure Protection		IP20/ IP21
Environmental Spec.	Ambient Operating Temperature		-10℃ to 40℃
	Relative Humidity		Up to 85% RH
	Elevation		Up to 1,000m
User Interface	HMI		IXP50 Touch Panel (8.4inch)
	Communications		Modbus TCP, DNP3.0
Standards	System		SGSF-04-2012-07
Reference		Samsung SDI 6MW	Young-am 4MW, LSIS 2MW, Jeju island 2MW, KEPCO 16MW

Dimensions (in millimeters)



HMI (Human Machine Interface) Display

Mounted on the PCS panel.

Operator can monitor and control PCS operation via HMI or remotely

- Touch-panel 8.4" color LCD screen
- Real-time monitoring and diagnosis
- Pre-installed operating modes

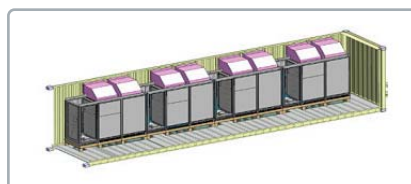


40ft Container Packaging

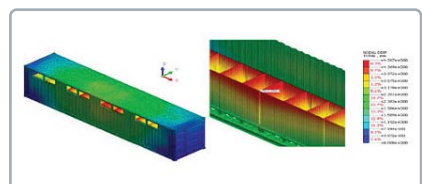
If no indoor space for installation, standard 40ft containers can be used to package the equipment for outdoor use



Internal configuration (4MW per 40ft container)



Seismic analysis



Heat flow analysis

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LSIS Power Conditioning System (PCS) Operating Experience and Track Record

Summary

- Over 60MW of LSIS PCS equipment in operation. Expected to reach 120MW by the end of 2016
- Supporting over 60MW and 52MWh of battery installations
 - Lithium ion from Samsung SDI, LG Chem and Kokam
 - Vanadium redox flow
- Control systems developed and provided for frequency regulation, commercial & industrial, microgrid and renewable integration
- Wide range of scopes performed from PCS-only to full project design, engineering, integration and installation

Grid Stability

KEPCO Shinchungju Substation

- Shinchungju, Korea
- Frequency regulation (autonomous)
- 16MW / 6MWh Li-ion Kokam battery
- Constructed July 2016
- LSIS scope: 16MW PCS and power management system (PMS), engineering and installation



Honam Coal Plant

- Yeosu, Korea
- Frequency regulation (AGC & autonomous)
- 4MW / 2MWh Li-ion LG Chem battery
- Commissioned April 2016
- LSIS scope: 4MW PCS and PMS, engineering and installation



KEPCO Seoansung Substation

- Soeansaug, Korea
- Frequency regulation (autonomous)
- 16MW / 5.4MWh Li-ion Kokam battery
- Commissioned July 2015
- LSIS scope: 16MW PCS and PMS, engineering and installation



KEPCO Ulsan Substation

- Ulsan, Korea
- Frequency regulation (autonomous)
- 32MW / 12MWh Samsung SDI battery
- Commissioning expected July 2017
- LSIS scope: 32MW PCS and PMS, engineering and installation



Commercial & Industrial

LSIS R&D Anyang Campus

- Anyang, Korea
- Peak shaving, load leveling & back-up power
- 1MW / 1MWh LG Chem battery • Commissioned March 2015
- LSIS scope: 1MW PCS and PMS, engineering and installation



LSIS Cheongju Factory

- Cheongju, Korea
- Peak shaving, load leveling & solar integration
- 1MW / 1MWh Samsung SDI battery • Commissioned June 2015
- 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 • Commissioned August 2014
- 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 • Commissioned August 2014
- LSIS scope: 2MW PCS and PMS, engineering and installation



Smart grid demonstration project

- Busan Dongrae Market, Korea
- Peak shaving & load leveling
- 100kW / 224kWh LG Chem battery • Commissioned December 2013
- LSIS scope: 100kW PCS and PMS, engineering and installation



Smart grid demonstration project

- Busan Industrial Supplies Market, Korea
- Peak shaving & load leveling
- 500kW / 806kWh LG Chem battery • Commissioned December 2013
- LSIS scope: 500kW PCS and PMS, engineering and installation



Renewable Integration

Daemyung GEC

- Youngam, Korea
- Wind power smoothing
- 4MW/14MWh Samsung SDI battery • Constructed January 2016
- LSIS scope: 4MW PCS, power distribution and energy management system (EMS), engineering and installation



KOSPO Jeju Island

- Jeju Island, Korea
- Wind power smoothing
- 2MW / 8MWh Samsung SDI battery • Commissioned November 2015
- LSIS scope: 2MW PCS, power distribution and EMS, engineering and installation



KEPRI Bigeum Island

- Bigeum Island, Korea
- Wind power smoothing, power quality
- 500kW / 250kWh LG Chem battery • Commissioned June 2014
- LSIS scope: 500kW PCS, 1MVA STATCOM and EMS, engineering and installation



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