KEPCO ESS

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Dominant player in Korea (Monopolistic position in the T&D sector)

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Major business

Korean Government

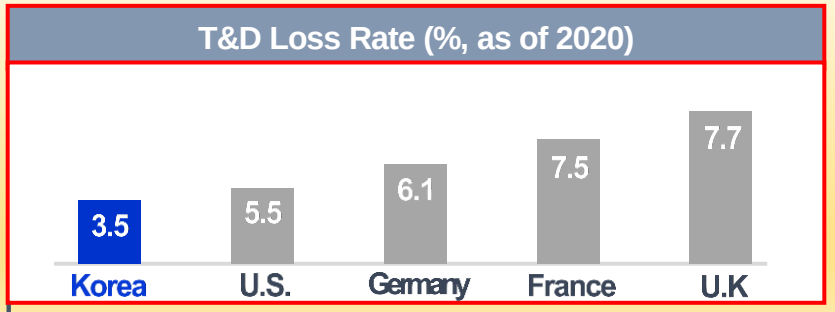
(51%)

KEPCO

Transmission & distribution

100% market share in Korean power market

	Moody's	S&P	Fitch
Government	Aa2	AA	AA-
KEPCO	Aa2	AA	AA-



(100%) (100%) (100%) (100%) (100%) (100%)

Generation

64.9% of total capacity in Korea

KHNP	KOEN	KOMIPO	WP	KOSPO	EWP
Nuclear & hydro	Thermal & renewable	Thermal & renewable	Thermal & renewable	Thermal & renewable	Thermal & renewable
Assets: KRW61.9trn Revenues: KRW9.9trn	Assets: KRW10.9trn Revenues: KRW4.3trn	Assets: KRW13.0trn Revenues: KRW4.3trn	Assets: KRW10.4trn Revenues: KRW3.6trn	Assets: KRW10.7trn Revenues: KRW4.0trn	Assets: KRW9.6trn Revenues: KRW4.2trn

Others

KEPCO E&C	(65.8%)	Engineering service	KEPCO KDN	(100%)	Electric power IT service
KEPCO KPS	(51.0%)	Maintenance & repair	KEPCO NF	(96.4%)	Nuclear fuel
KEPID	(29.0%)	Retail metering	KOGAS	(20.5%)	Import & supply of LNG

KEPCO's Global Projects

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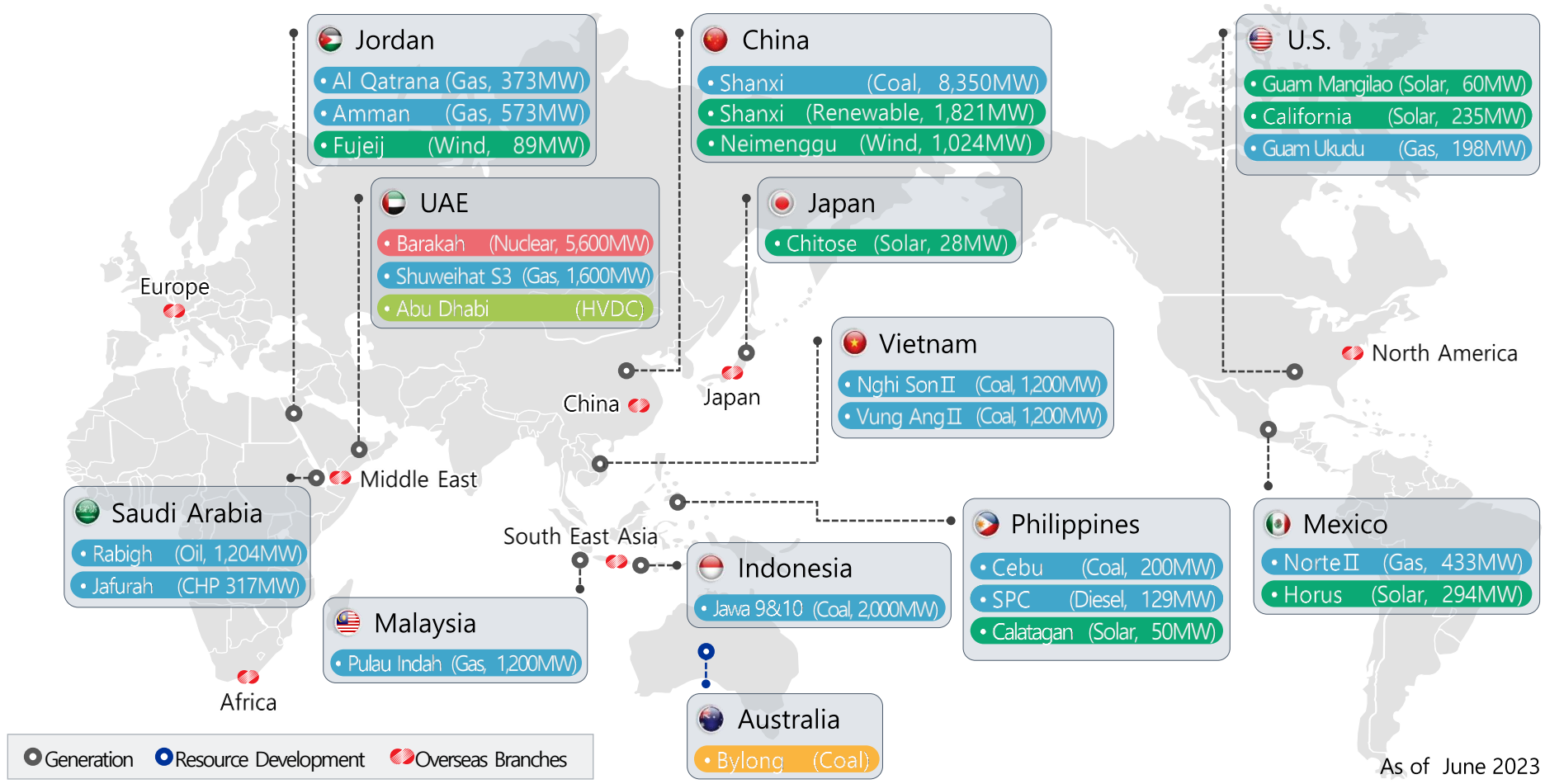
37 Projects in 18 Countries

- **Thermal** — 14 Projects in 10 Countries
- **Renewable** — 7 Projects in 6 Countries
- **Grid Solution** — 14 Projects in 7 Countries
- **Natural Resources** — 1 Project in Australia
- **Nuclear** — 1 Project in UAE



As of June 2023

KEPCO's initial ESS: FR(Frequency Regulation) ESS

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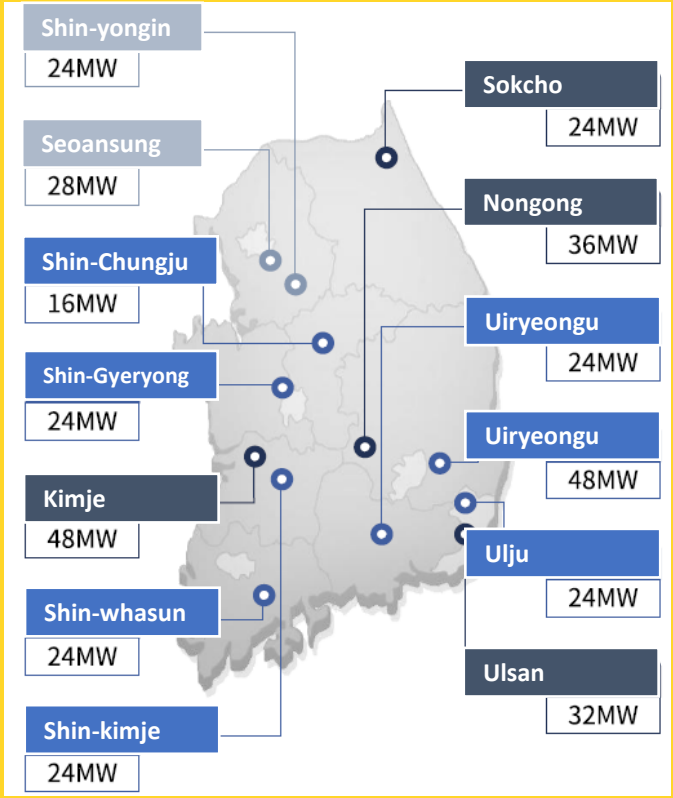
Domestic FR ESS Installation(376MW/154MWh, 13 sites)

Shin-yongin(24MW)

Seoansung(28MW)

Shin-Chungju(16MW)

Shin-gyeryong(24MW)



Kimje(48MW)

Shin-whasun(24MW)

Uiryeong(24MW)

Kyeongsan(48MW)

Ulju(24MW)

Shin-kimje(24MW)

Lessons Learned from ESS operation

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Fire Hazard

- Need to prevent the thermal runaway battery causing fire

(e.g., limiting the maximum charging rate to 80%)

Single Source of Responsibility

- Components (PCS, battery, PMS, etc.) are manufactured by different manufacturers, hindering swift incident resolution and clear identification of the cause. Need to consider binding one entity to take general responsibility.

External Environment

- ESS exposed to the natural elements are likely to suffer deterioration, such as corrosion. Need to consider relocating the ESS placed outdoor to indoor environment - component by component, if necessary.

Stronger Quality Assurance

- KEPCO is accumulating field experience and know-how related to manufacturing the PCS for large-capacity ESS and operating ESS better. Need to establish standardized specifications and test & certification methods.

Mid-to-long-term Expectations

- Use of ESS will reduce the investment in new facilities as the availabilities of generation, transmission and distribution assets will be improved and cost of purchasing electricity can be reduced.
- Curtailment imposed to the generation assets can be alleviated by a better frequency management during the grid failure.
- Large scale blackout can be avoided by being able to respond to frequency fluctuation better.

Lessons Learned from ESS operation

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Preventative Measures

Recommendations by the Government

1. Protection from electrical failure: Install the overvoltage protector and the ground fault protector.
2. Emergency stop: Install the emergency stop switch in and/or outside the container.
3. Battery overcharge prevention: Do not charge more than 80% (indoor) or 90% (outdoor).
4. Environment management: Monitor and comply with the manufacturer's recommended temperature and humidity standards at all times.
5. Data blackbox: Store all operational data separately for at least 3 years.

KEPCO's additional steps

1. [illegible]he timestamps of PCS and battery.
2. OS upgrade: Implemented alarms related to electric protection devices.
3. Magnetic switch replacement: Replaced all switches with the ones with stronger insulation performance.
4. Additional fire extinguishing system: Installed additional fire extinguishers for the Samsung and LG batteries.

Current Practice: Grid Stabilization ESS

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Grid Stabilization ESS

Purpose

▣ **Stabilize the grid by alleviating the curtailment caused by delayed transmission line construction**

Purpose	Frequency Regulation (for existing facilities)	FR + Alleviation of Curtailment
Description	○ Used only for FR ※Replaces the frequency regulation function of general generators to a degree	○ Used to stabilize the grid ※ FR + curtailment alleviation + response to RE volatility
Charging Rate	65%	65%
Duration	15 minutes	30 minutes

Overview

▣ **Capacity: 1.4GW (12 locations, including Young-ju S/S)**

	Grid Stabilization Phase 1	Grid Stabilization Phase 2	Total
Capacity in MW	500 (7 locations)	900 (5 locations)	1,400 (12 locations)
Year of completion	2023	2024~	USD 856.bn

Outlook (Research Plan)

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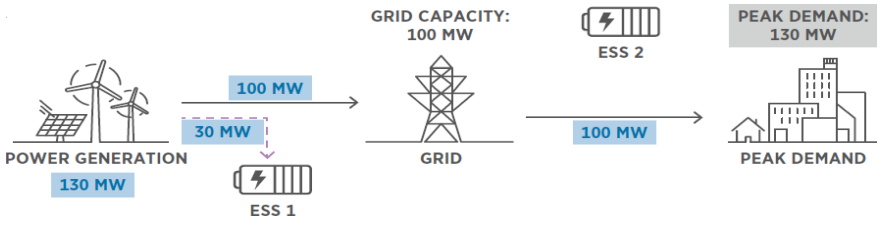
Research

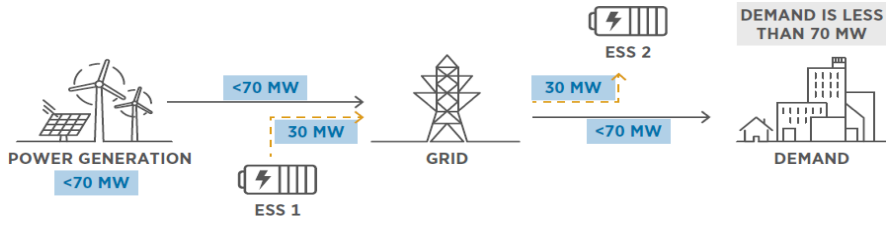
- Frequency Regulation by Super-Capacitor ESS ⇒ Replace Lithium Battery
- NTAs(Non-Transmission Alternatives)

- ESS NTAs Operation



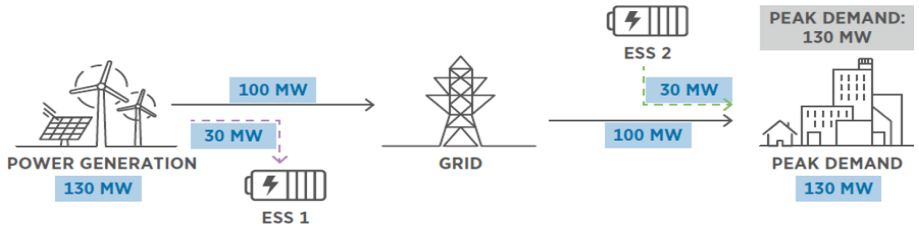
STEP ① : Charging
- When the renewable energy generation exceeds the capacity

of the power grid, the ESS1 is used to charge excess energy



STEP ② : Transmitting
- When there is spare capacity in the grid, the ESS2 is charged

through the ESS1 discharge



STEP ③ : Discharging
- During peak demand, ESS2 is discharged without causing congestion

in the power grid.

Thank you!

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