The role of battery energy storage to support Indonesia's energy transition

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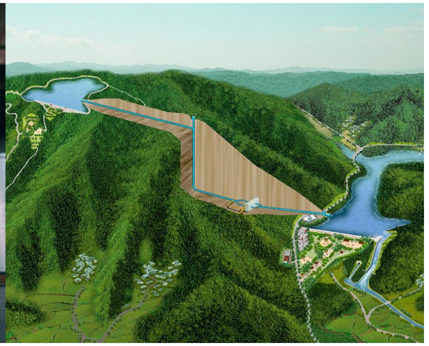
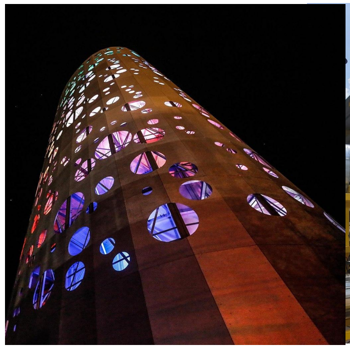
Energy storage technologies

Mechanical



Thermal

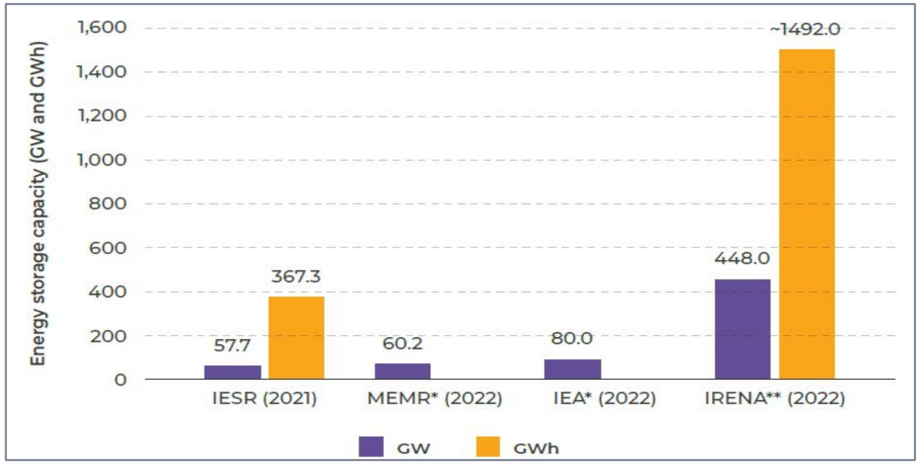


Electro-chemical

- The estimated total power capacity of the global ESS is more than 160 GW by the end of 2021 and is expected to continue to grow along with the increasing commitment of several countries in achieving the NZE target (IEA, 2022)
- Around 90% of all ESS capacity comes from mechanical PHS, the most mature ESS technology.
- The growth of **PHS capacity could be outpaced by electrochemical batteries ESS** which is projected to have 387 GW/1,143 GWh of new ESS installed by 2030 (BloombergNEF, 2022)

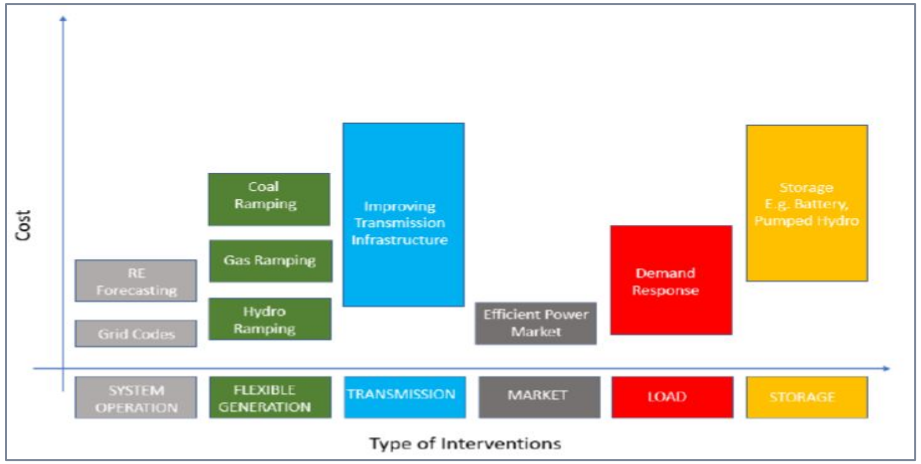
Why ESS adoption is necessary to achieve NZE?

Indonesia energy storage capacity demand to achieve NZE target (IESR, 2022)

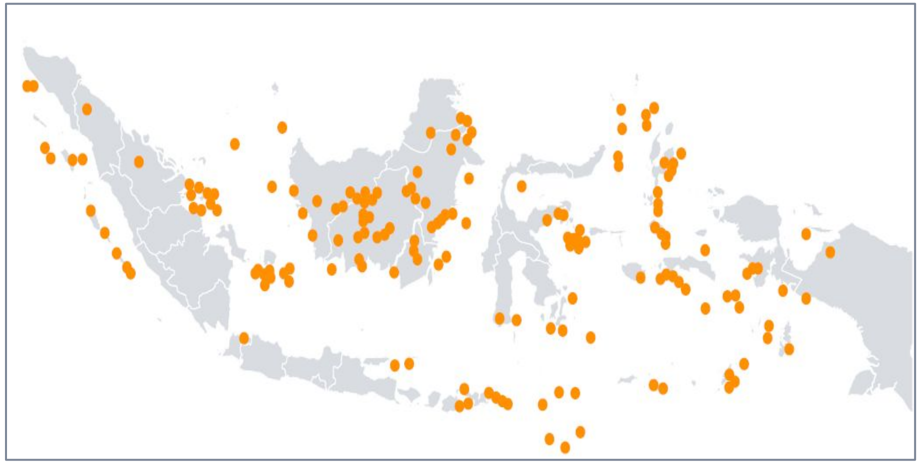


- ESS could enable VRE penetration that is expected to grow in capacity
- Geographical condition, causing several systems reach a higher RE development phase earlier (and require ESS)

Flexibility options interventions and costs (DEA & MEMR, 2021)

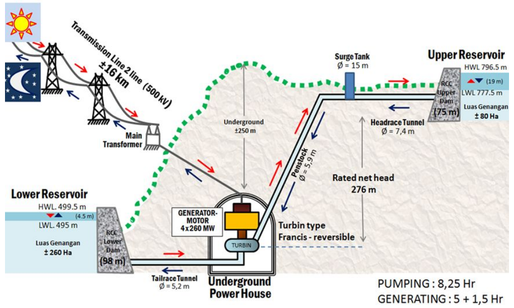


Locations of Phase 1 Diesel Power Generators Conversion Program (IESR, 2021)



Battery Energy Storage System (BESS) application in Indonesia is still limited to the off-grid system

Notable ESS projects



Upper Cisokan PHES, West Java

- 4 x 260 MW
- Groundbreaking in 2022, expected COD in 2027
- JVB system peaker, and possibly spinning reserve

Selayar Island Hybrid System, South Sulawesi

- 876 kWh Li-ion
- Operational since 2022
- Support 1.3 MWp solar PV

Nusa Penida Island Hybrid System, Bali

- 1,82 MWh BESS
- Operational since 2022
- Support 3.5 MWac solar PV

Mining Industry Microgrid, East Kalimantan

- 2MW / 2MWh
- Operational since 2020
- PV generation smoothing, hybrid system stability, and spinning reserve.

Upcoming projects

Status	Capacity	Notes
Tender won	Undisclosed	ESS for 100 MW Lampung ground-mounted PV
Tender phase 1	1.8 GWh	GWh ESS in scattered locations (PLN de-dieselization program), expected COD by 2025
Planning	24 GWh	Storage for two PV projects in Riau Islands

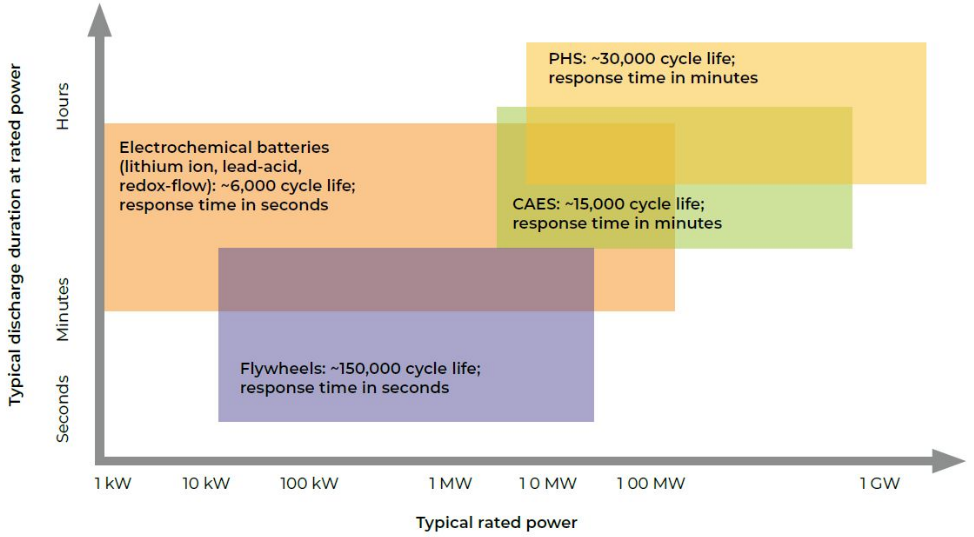
ESS technology options should be identified for various potential uses, particularly VRE integration.

Different energy storage applications and technical requirements

	Primary response	Secondary response	Peaker replacement	Energy trade	Power reliability	Long-duration storage
Minimum response time	<10 seconds	No specific requirement	No specific requirement	No specific requirement	<10 seconds	No specific requirement
Power scale (MW)	1 – 100	10 – 100	1 – 100	1 – 100	1 – 10	1 – 100
Duration (hours)	0.25 – 1	0.25 – 10	2 - 6	2 - 10	2 - 10	100h
Application annual cycle	15,000	1,000	350	350	365	40

Source: IESR analysis and Schmidt et al., 2019

Typical characteristics of energy storage technologies



- Each ESS technology possesses different merits and limitations.
- To decide the most appropriate type of ESS for one or multiple applications in a power system, the technical requirements should be first evaluated.
- An ESS technology can have different cost depending on the type of application in the power system.

Application-specific LCOS of various ESS technologies

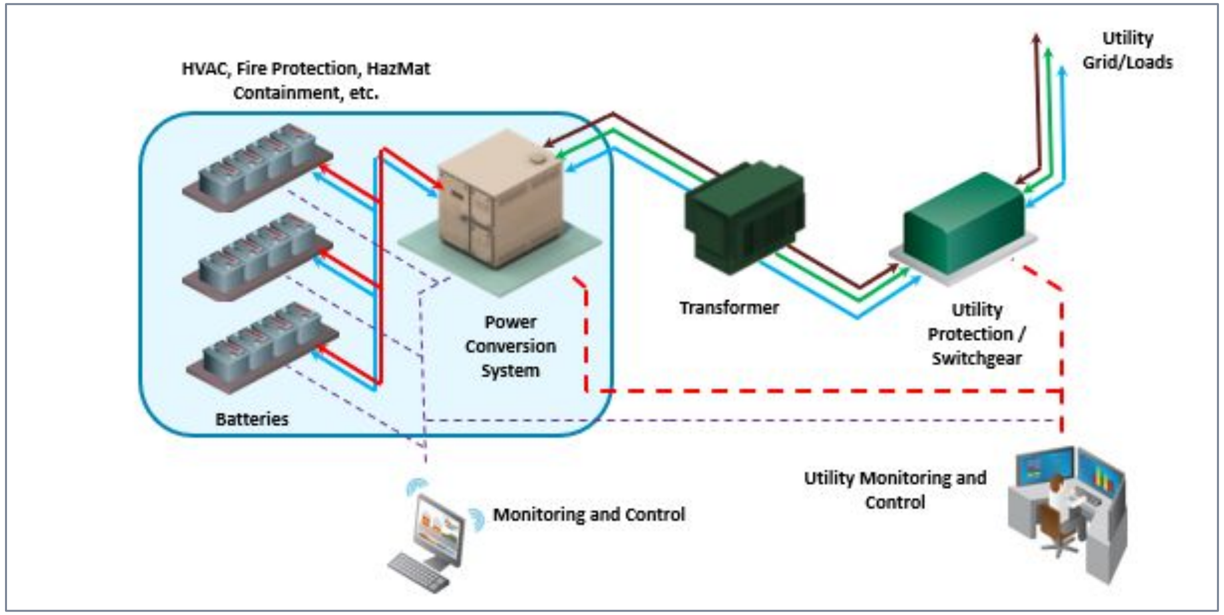
Applications (Scale)	Technology	Duration	LCOS (USD¢/kWh)
Primary response (100 MW)	Flywheels	0.25 hour	14.82
	LIB (LFP)		19.28
	LIB (NCM)		21.11
	VRFB		30.48
Secondary response (100 MW)	LIB (LFP)	4 hours	12.61
	LIB (NCM)		14.22
	VRFB		14.40
	PHS		8.65
Peaker replacement (100 MW)	LIB (LFP)		20.94
	LIB (NCM)		25.95
	VRFB		28.84
	PHS		23.89
Energy trade (100 MW)	LIB (LFP)	10 hours	22.85
	LIB (NCM)		27.63
	VRFB		26.03
	PHS		15.82
Power reliability (10 MW)	LIB (LFP)	10 hours	19.62
	LIB (NCM)		24.51
	VRFB		22.30
	Lead-acid		57.12
Long-duration storage (100 MW)	LIB (LFP)	100 hours	158.41
	LIB (NCM)		197.64
	VRFB		159.13
	PHS		35.47
	CAES		19.99

Source: IESR, 2023

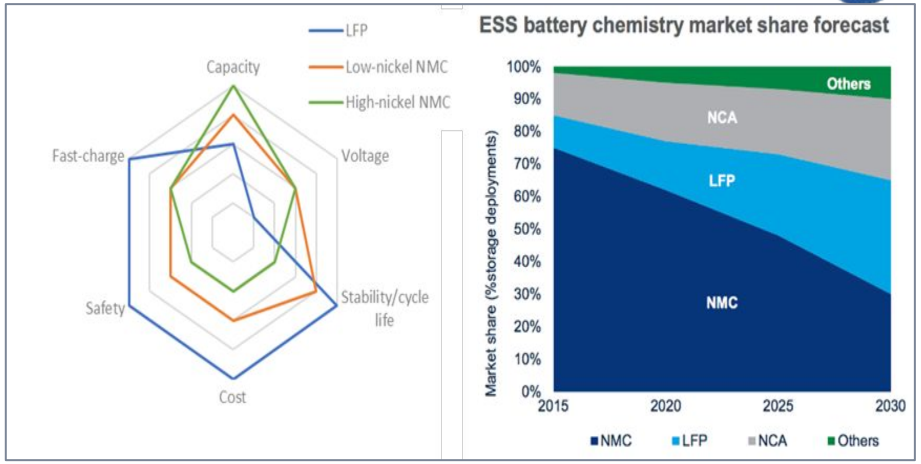
- Flywheels is the least-cost option for an application that requires more than 8,500 cycles/year (i.e., primary response).
- For applications that require moderate annual cycle and duration (i.e., secondary response and peaker replacement), the choices are between batteries and PHS.
- PHS and CAES are superior in applications with a duration longer than 10 hours, except for power reliability applications that mandate distributed energy storage systems (i.e., BESS).

BESS are not just batteries, and batteries is not always nickel

The major components of an energy storage system (EPRI, 2021)

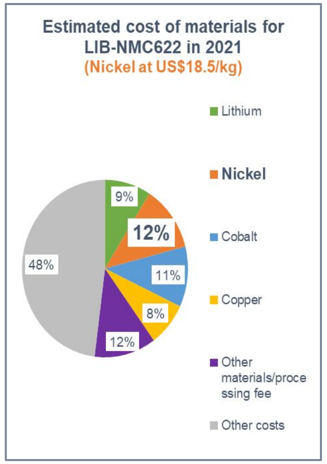


Popular battery chemistry performance and market share forecast



Source: (1) IDTechEx Research, 2020 (reproduced); (2) WoodMackenzie, 2020

- In 1 MW scale 4-hour (LFP) LIB, battery (and BoS) component share only about 50% the total cost.
- Low cost chemistry batteries are suitable for stationary applications
- Rapid energy storage technology research and innovation may offer new options



Source: BofA Global Research; IESR

Beyond LIB technology

What is needed (Including, enabling, valuing)

- Identifying potential uses, quantifying needs, establishing development plans
- Prepare regulatory framework
- Project initiatives
- Business cases to increase BESS demand and stimulate domestic industry

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