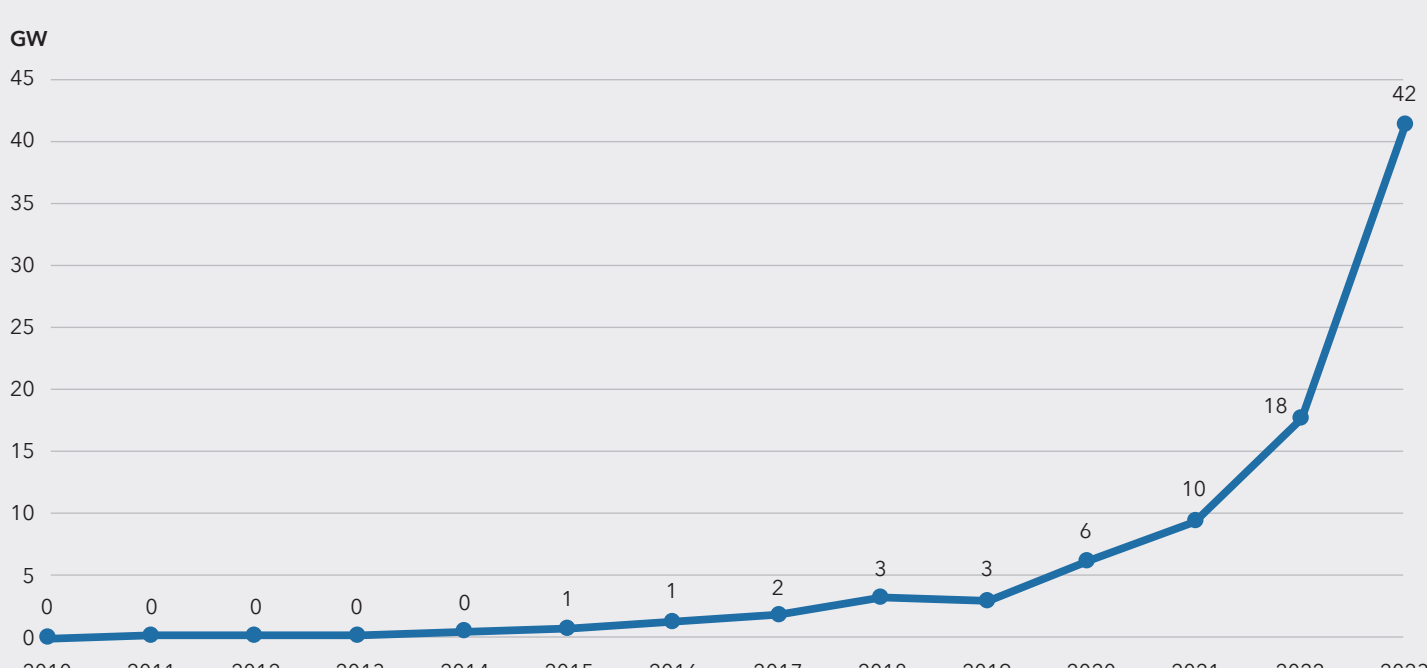


Batteries, which have become an essential component of the global energy transition, are among the fastest growing and most attractive technologies in the energy sector, thanks to the recent technological development and cost reductions. According to the International Energy Agency (IEA), a total of 42 GW of new battery energy storage system capacity was installed in the electricity sector in 2023, which adds up to a total of 86 GW in terms of global energy storage capacity. The additional 42 GW capacity consists of grid-scale batteries, as well as behind-the-meter batteries, mini-grids and batteries integrated into solar rooftop power plants.

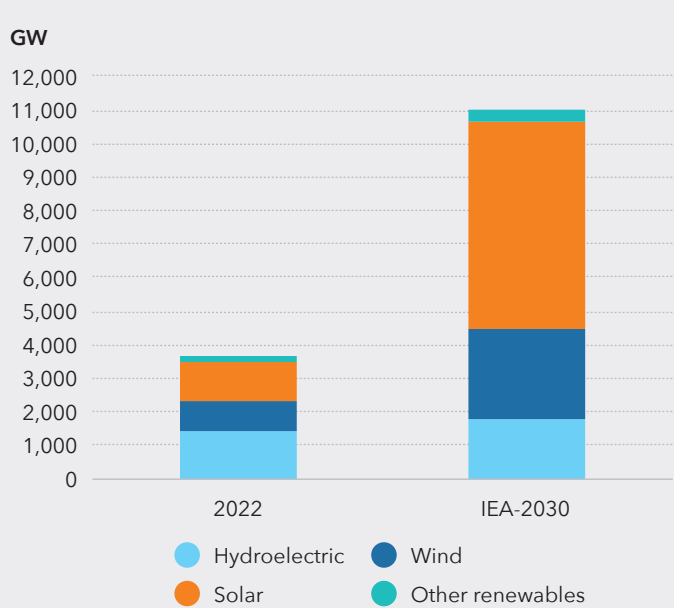
Annual global battery capacity additions (GW)



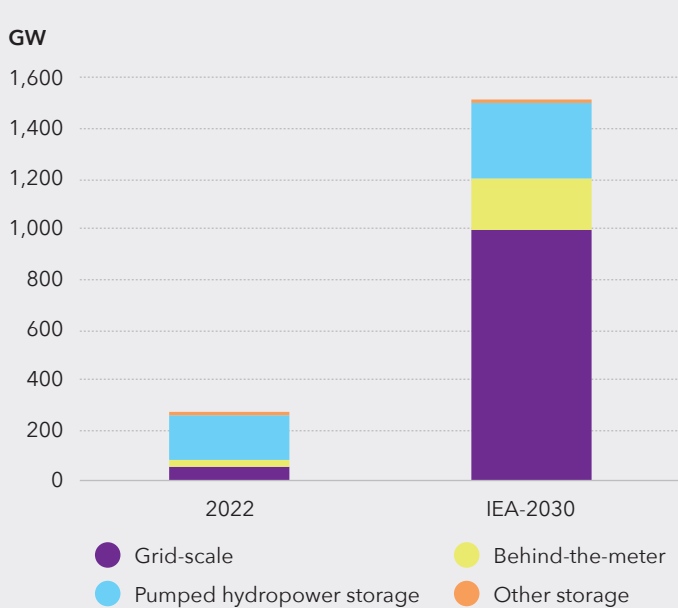
Source: IEA (2024)

In the transition to a net-zero emissions economy, batteries play a key role in increasing electrification, accelerating the integration of renewable energy into the system thus supporting grid stability and facilitating grid operation. According to the IEA's analysis, a six-fold increase in energy storage capacity is required to ensure grid security while meeting the 2030 renewable energy target. In other words, 176 GW of new energy storage capacity needs to be commissioned globally every year until 2030.

Global renewable energy installed capacity (GW) 2023-2030



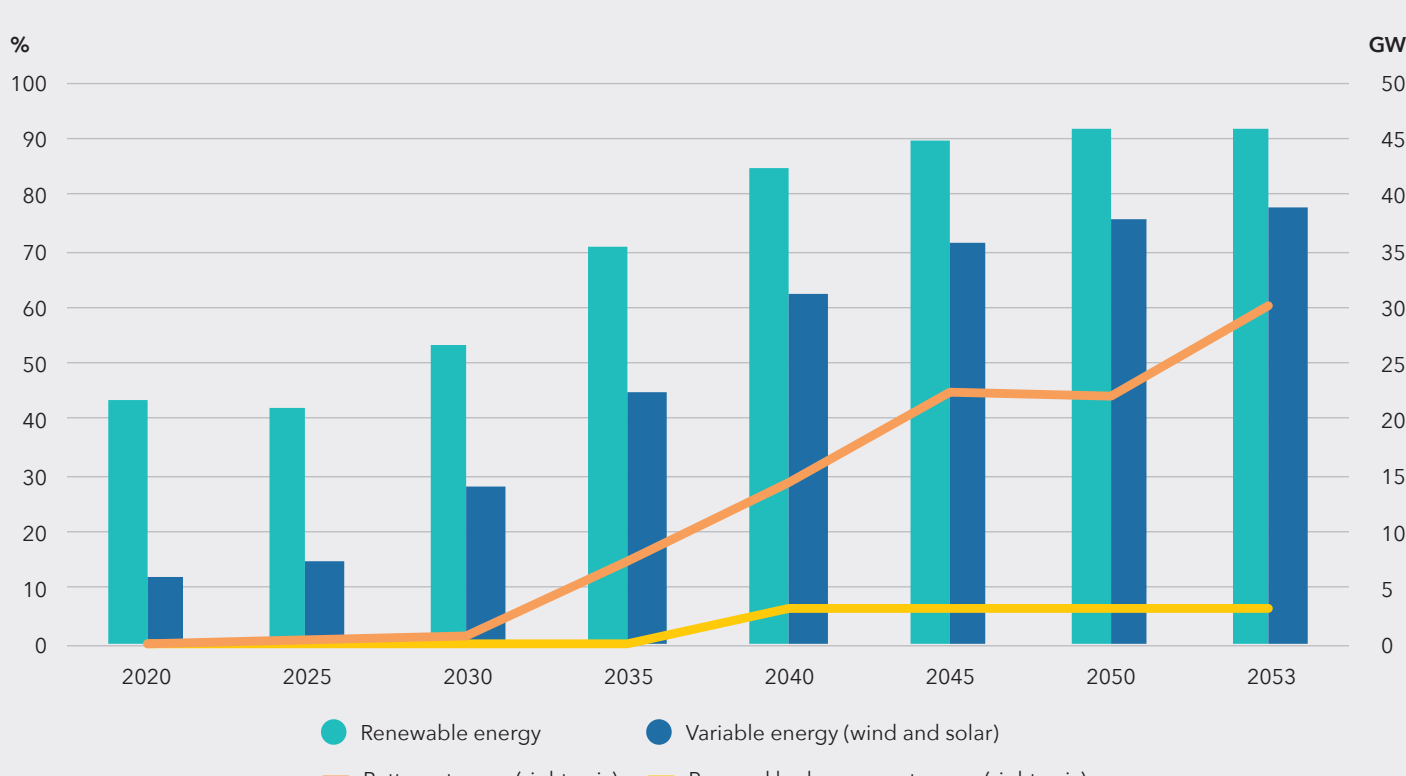
Global energy storage installed capacity (GW) 2023-2030



Source: IEA (2024)

According to SHURA's net-zero carbon pathway, which focuses on the Turkish electricity sector, renewables' share in total electricity generation will be 54% by 2030 and go up to over 90% by 2053. The share of variable energy (from wind and solar) production will reach 78% by 2053. The growth of variable energy generation will increase the need for grid flexibility. It is estimated in the model that 30 GW/120 GWh battery and 3.2 GW of pumped hydropower storage capacity will be required by 2053.

Share of renewable and variable renewable power generation versus installed storage capacity (right-axis) in Türkiye according to SHURA's net zero carbon pathway study

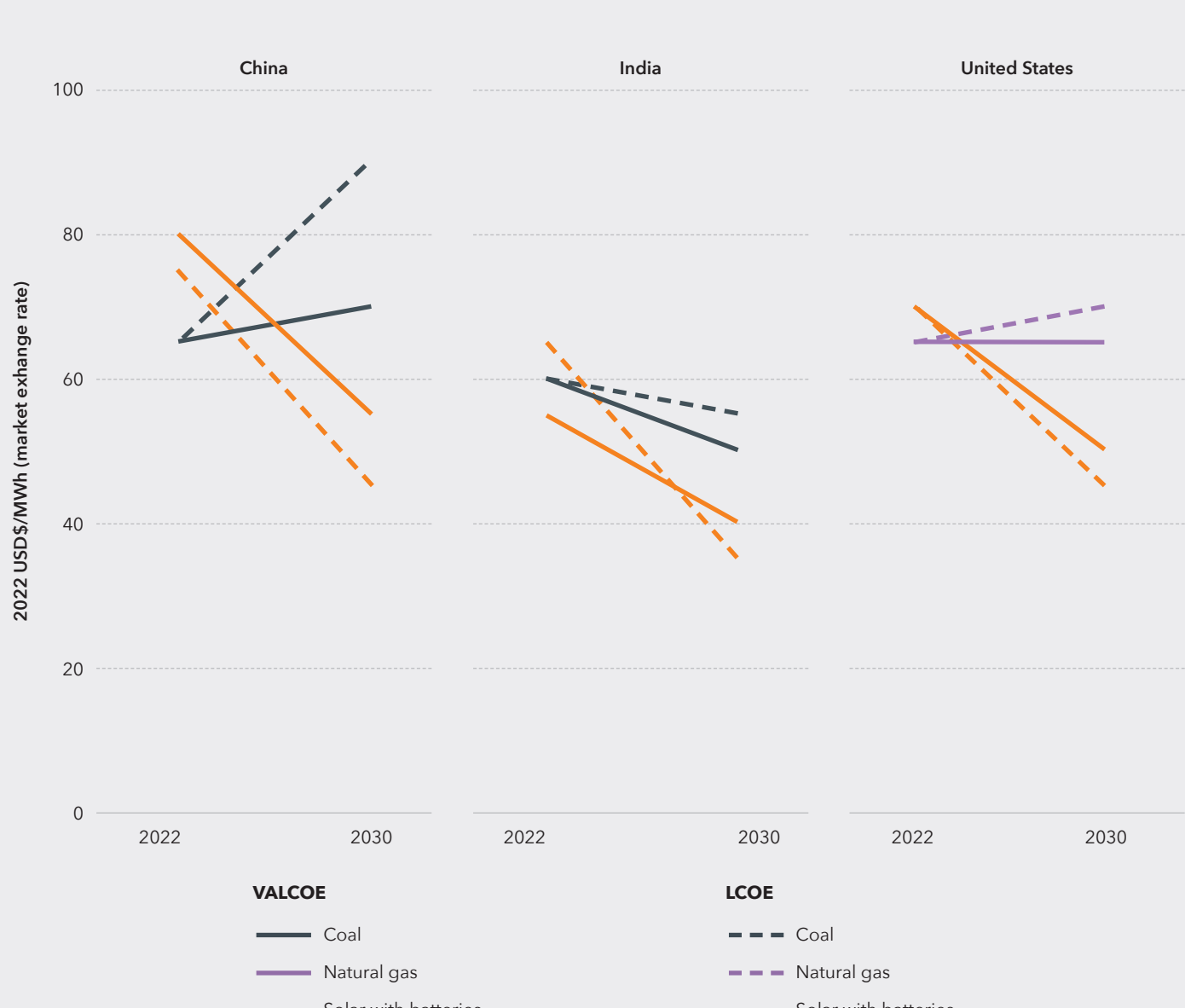


According to the analysis results, the increasing production of hydrogen and its derivatives reduces the required capacity for battery storage as they can be used to store energy.

Source: SHURA (2023)

Batteries respond quickly in line with the market signals and contribute to the reliable operation of the grid. Lithium-ion batteries, whose costs have decreased by 90% since 2010 (from US\$ 1,400/kWh to US\$ 140/kWh), has dominated the grid-scale battery market. In addition to technological developments, economies of scale in production contributed greatly to the cost reduction. According to the IEA analysis, grid-scale solar power plants with battery storage are currently competitive with new coal power plants in India. It is estimated that solar power plants with batteries will be competitive with new coal power plants in China and new natural gas power plants in the USA in the next few years. With advances in battery chemistry and innovations in production, lithium-ion battery costs are predicted to decrease by 40% in 2030 compared to 2023.

Levelized cost of electricity (LCOE) and value-adjusted LCOE (VALCOE) of solar power plants with batteries versus coal and natural gas power plants in selected regions according to IEA's Announced Policies Scenario, 2022-2030



LCOE: Levelized cost of electricity is a parameter that takes into account the direct costs of a power plant such as investment, maintenance and operation, financing, fuel and carbon price. LCOE does not consider costs associated to the integration of the power plant to the grid and other indirect costs.

VALCOE: It is a parameter that takes into account both the costs of a power plant and the value provided to the electricity system.

Source: IEA (2024)

- Battery installations integrated with solar power plants are becoming competitive with fossil fuel power plants. This contributes greatly in supporting the reliability of electricity systems to achieve the global net-zero emission goals.
- Batteries have multiple benefits in the transition to a net-zero emission economy. Especially in developing economies such as Türkiye, creating roadmaps can accelerate the growth of batteries. Such battery development roadmaps should specify the required capacities, optimized locations, and the services that battery energy storage systems could deliver on a sectoral basis.
- Along with the roadmaps, it will be beneficial to detail the legislation on a service basis and define financial incentives to encourage the installation of batteries at a sufficient level.