Long term battery storage

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As the world considers how to establish a path toward limiting the rise in global temperatures by curbing emissions of greenhouse gases, it is widely recognized that the power-generation sector has a central role to play. Responsible for one-third of total global carbon emissions, the sector"s role is, in fact, doubly crucial, since decarbonizing the rest of the economy vitally depends on the growing demand for renewable electricity (for example in electric vehicles and residential heating).

This article is a collaborative effort by Alberto Bettoli, Martin Linder, Tomas Naucl?r, Jesse Noffsinger, Suvojoy Sengupta, Humayun Tai, and Godart van Gendt, representing views from McKinsey"s Electric Power & Natural Gas Sustainability Practices, and the Battery Accelerator Team.

Most projections suggest that in order for the world"s climate goals to be attained, the power sector needs to decarbonize fully by 2040. And the good news is that the global power industry is making giant strides toward reducing emissions by switching from fossil-fuel-fired power generation to predominantly wind and solar photovoltaic (PV) power.

However, the rising share of renewables in the power mix brings with it new challenges. Not least of these are the structural strains on existing power-generation, transmission, and distribution infrastructure created by new flows of electricity and by the inherent variability of renewables, including potential imbalances in supply and demand, changes in transmission flow patterns, and the potential for greater system instability.

The various novel LDES technologies are at different levels of maturity and market readiness, but they are attracting unprecedented interest from governments, utilities, and transmission operators, and investment in the sector is rising fast: more than five gigawatts (GW) and 65 gigawatt-hours (GWh) of LDES capacity has been announced or is already operational.

This is only a start: McKinsey modeling for the study suggests that by 2040, LDES has the potential to deploy 1.5 to 2.5 terawatts (TW) of power capacity--or eight to 15 times the total energy-storage capacity deployed today--globally. Likewise, it could deploy 85 to 140 terawatt-hours (TWh) of energy capacity by 2040 and store up to 10 percent of all electricity consumed. This corresponds to a cumulative investment of $1.5 trillion to $3 trillion (Exhibit 2).

We estimate that by 2040, LDES deployment could result in the avoidance of 1.5 to 2.3 gigatons of CO2 equivalent per year, or around 10 to 15 percent of today"s power sector emissions. In the United States alone, LDES could reduce the overall cost of achieving a fully decarbonized power system by around $35 billion annually by 2040.

The scale of these numbers reflects the multiple use cases for LDES technologies and the central role they can

play in balancing the power system and making it more efficient. These include support for system stability, firming corporate power-purchase agreements, and optimization of energy for industries with remote or unreliable grids. But by far the largest proportion of deployment is expected to be related to the central tasks of energy shifting, capacity provision, and transmission and distribution (T& D) optimization in bulk power systems (see Exhibit 2).

As a result, while novel LDES technologies are still nascent, deployment could accelerate rapidly in the next few years. Our modeling projects installation of 30 to 40 GW power capacity and one TWh energy capacity by 2025 under a fast decarbonization scenario.

A key milestone for LDES is reached when renewable energy (RE) reaches 60 to 70 percent market share in bulk power systems, which many countries with high climate ambitions aim to reach between 2025 and 2035. This would likely include the United Kingdom, the United States, and many other developed countries which have made net-zero commitments prior to the COP26 Climate Change Conference in Glasgow in November. This RE penetration catalyzes widespread deployment of LDES as the lowest-cost flexibility solution.

Hitting these targets requires significant reductions in the cost of LDES technologies. But projections provided by LDES Council member companies show these are achievable and in line with learning curves experienced in other nascent energy technologies in the recent past, including solar PV and wind power. In turn, cost reductions will be dependent on improvements in R& D, volumes deployed, and scale efficiencies in manufacturing. Similarly, total LDES deployment is closely tied to the rate of decarbonization of the power sector and the deployment of variable RE generation.

Together, these measures will ultimately help ensure that the energy transition is achieved at the lowest societal cost. The projections in the study show that with early deployments and a supportive market ecosystem, LDES applications can achieve internal rates of return (IRRs) well above investor hurdle rates by 2025--comparable with benchmarked IRRs of current mature energy projects.