

LONG-DURATION ENERGY STORAGE: POLICY RECOMMENDATIONS TO UNLOCK THE VALUE OF LDES (FACTSHEET)



In November 2023, C2ES launched a long-duration energy storage (LDES) technology working group – one of four technology working groups focused on developing policy solutions that will enable the deployment and commercialization of critical-path technologies. This group convenes leading voices across the power sector ecosystem, including utilities, inter-day and multi-day LDES providers, Independent System Operators/Regional Transmission Organizations (ISOs/RTOs), financiers, members of C2ES’s Business Environmental Leadership Council (BELC), and other key stakeholders. Storage technologies in scope for the first year are mechanical and electrochemical LDES with a duration of dispatch greater than ten hours. Informed by working group discussions, C2ES has published a shortlist of high-impact federal and state-level policy recommendations.

BACKGROUND

LDES will play an increasingly important role in decarbonizing the power sector as more variable renewable electricity is added to the electric power grid. LDES is defined by the U.S. Department of Energy (DOE) as any system that can store and discharge energy for ten or more hours. It is a diverse technology class with a range of potential system forms, including electrochemical, mechanical, chemical, and thermal energy storage. While shorter duration lithium-ion batteries (typically 0 to 4 hours) will continue to address near-term storage needs, LDES will be critical to enabling widespread deployment of renewables, enhancing grid reliability and resilience, reducing use of natural gas peaker plants, avoiding variable renewable overbuild, and diversifying the domestic energy storage supply chain. Federal policy and several recent state-level procurement announcements include support for the deployment of LDES, but more policies and actions will be needed to accelerate the widespread and coordinated deployment and commercialization of LDES technologies. Our policy recommendations are intended to remove barriers to deployment, unlock value drivers, and accelerate private sector demand for LDES technologies.

1. RESOURCE ADEQUACY REFORMS

ISOs/RTOs and electric utilities should shift to a resource adequacy (RA) evaluation framework that focuses on year-round adequacy (“energy adequacy”) instead of peak-load targeted needs (“capacity adequacy”). Doing so necessitates adopting more comprehensive and nuanced RA modeling and accreditation approaches to better evaluate the evolving needs of a decarbonizing power system and the potential role for LDES in a changing climate.

Resource adequacy measures whether a power system has enough capacity and reserves to balance supply and demand—even under challenging conditions of low supply or exceptionally high demand. Today’s power systems are characterized by greater variability in both supply (due to weather-dependent and inverter-based resource generation like wind and solar) and demand (due to flexible loads and distributed generation resources). Climate change is also increasing grid stress events, which diminish grid resiliency and lead to extended power outages. Lastly, the attributes and capabilities of storage and LDES technologies are unique and warrant consideration of new modeling tools that can effectively capture their value to grid reliability. New modeling approaches and metrics will need to be evaluated and developed to accurately determine how LDES can contribute to RA.

As a starting point, ISOs/RTOs and electric utilities should prioritize metrics that better express energy adequacy needs, including expected unserved energy (EUE) and informed by other metrics, such as loss of load hours (LOLH), and away from planning frameworks primarily based on loss of load expectation (LOLE). Doing so should better capture hourly, seasonal, and annual adequacy needs and help grid operators identify where LDES can be used to address gaps. Capacity accreditation—a measure of the individual contributions different resources make to meeting resource adequacy needs—will also require newer methods as a more diverse suite of energy and storage technologies becomes available. For RA accreditation approaches, grid operators will need to make adjustments to ensure that their current accreditation methods better reflect and compensate for the reliability contributions of LDES and all other resource types. This will likely necessitate using new accreditation approaches altogether, or thoughtfully pairing existing methods like effective load carrying capability (ELCC), marginal reliability impact (MRI) derating, or supply tightness, with new approaches that are actively being researched and developed. Long term reforms of RA programs and near-term changes to accreditation approaches will help increase the accuracy of LDES contributions to reliability by better expressing system reliability needs and by better valuing LDES with respect to resource adequacy.

2. OPERATIONAL FLEXIBILITY VALUATION AND REFORMS

ISOs/RTOs should support and expand ongoing reforms to increase system flexibility through increased megawatt (MW) and megawatt hour (MWh) requirements for existing operating reserves in the short-term. ISOs/RTOs should also introduce new ancillary services and energy market reforms in the medium-term to address increasing uncertainty from variable renewable output, extreme weather, and other drivers.

These are examples of incremental reforms that can be done within the existing market paradigm to help unlock the value-stream for LDES technologies, which are well-suited to providing the services needed to manage increasing supply/demand imbalances due to their fast response times and long-duration charge/discharge capabilities.

Additionally, ISOs/RTOs should revise market mechanisms so that LDES technologies can participate in multiple markets (e.g., capacity, ancillary, energy markets) within an ISO/RTO or provide multiple services simultaneously within a state. The more markets or services LDES can participate in or provide without compromising its ability to fulfill RA obligations, the more valuable it will become and the more rapidly it will be deployed.

A prerequisite to the success of these operational flexibility and market reforms is the more effective coordination of planning practices between individual states and regional entities such as ISOs/RTOs. Without first establishing consistency between the ISO/RTO market rules and what is happening in the states within that region, the impact of these reforms will be limited.

3. SETTING CLEAR AND DISTINCT STATE LDES PROCUREMENT TARGETS

State legislators and regulators should set clear and distinct procurement targets for LDES deployment.

As of October 2024, eleven states have established energy storage procurement mandates, targets, or goals, but only California and New York include clear and distinct targets for LDES. The policy design used by these two states can serve as a useful guide for how other states could approach an LDES procurement target or mandate. State LDES procurement targets should encourage utilities, developers, and other power system stakeholders to consider a range of durations (e.g., inter-day and multi-day) and LDES forms (e.g., electrochemical, mechanical, chemical, and thermal) so they can choose the LDES technology that will work best for their specific regions and needs.

State LDES procurement targets should also align with the DOE's definition of LDES, which is ten hours or longer. By setting a distinct LDES procurement target, states can provide LDES technologies with the long-term market certainty needed to catalyze public and private sector investment. This will be one of the most effective ways to accelerate uptake of LDES by utilities and level the playing field with other shorter duration storage technologies. We recommend that PUCs or other state agencies consider several design structures for LDES procurement programs to help share costs with utilities, enable price discovery, and manage costs to both taxpayers and ratepayers. These structures could include a price floor with procurement programs, reverse auctions, and clean transition tariffs (CTTs) or accelerating clean energy (ACE) tariffs.

4. NATIONAL COORDINATION AND ACCELERATION OF LDES DEMONSTRATION PROJECTS

The Department of Energy and the LDES National Consortium should collaborate with state government entities to review, assess, and fill gaps in the national suite of LDES pilot and demonstration projects.

Growing federal and state investments and initiatives on LDES provide a solid foundation for this effort to be built upon. A coordinated national initiative can help produce the key insights and best practices necessary to enable effective demonstration, grid integration, and market compensation of LDES technologies. The effort should encompass diverse LDES technologies that range in duration, storage form, and use cases. Demonstration projects should also account for regional and market differences across the United States. Financial assistance may be offered directly to project developers by federal and state agencies through grants, low-cost debt financing or guarantees, investment tax breaks, or other funding mechanisms such as regulated clean energy revenue riders. Operating revenue could also be bolstered and assured through public procurement and innovative financing mechanisms like clean transition tariffs. Project developers that receive benefits from these public policies should be required to disclose and validate data that can be used by utility resource planners and project developers to enable follow-on investments.

5. FEDERAL ECONOMY-WIDE CARBON PRICING

The administration and Congress should examine options and work toward enacting an economy-wide market-based carbon pricing program that could contribute to the achievement of net-zero emissions by 2050.

Setting a price on carbon—whether through a carbon tax or a cap-and-invest program—confers a clear market value to emissions reductions that is commensurate with the environmental, societal, and economic benefits that reducing global greenhouse gas pollution provides. This market signal will better align clean energy policy goals with costs of currently available technology and enable greater uptake of cleaner LDES technologies over heavier-emitting alternatives, like natural gas peaker plants. Revenue from the carbon pricing program could be used to foster technology innovation (e.g., supporting the development and deployment of nascent LDES technologies) or for other purposes such as lowering government deficits or reducing distortionary taxes.

Please click [here](#) to explore the full brief of C2ES's LDES policy recommendations, developed by C2ES in consultation with more than **25 companies across the power sector**.

<https://www.c2es.org/document/policy-recommendations-to-unlock-the-value-of-long-duration-energy-storage/>



The Center for Climate and Energy Solutions (C2ES) is an independent, nonpartisan, nonprofit organization working to secure a safe and stable climate by accelerating the global transition to net-zero greenhouse gas emissions and a thriving, just, and resilient economy.