

Energy Storage Program Report

Submitted to the General Assembly and Governor
Pursuant to Section 16-135 of the
Illinois Public Utilities Act



Illinois Commerce Commission
527 East Capitol Avenue
Springfield, Illinois 62701

May 25, 2022



STATE OF ILLINOIS

ILLINOIS COMMERCE COMMISSION

527 East Capitol Avenue
Springfield, Illinois 62701

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Chicago, Illinois 60601

May 25, 2022

The Honorable JB Pritzker
Governor

The Honorable Members of the General Assembly

Dear Governor Pritzker and Members of the General Assembly,

The Illinois Commerce Commission submits the Energy Storage Program Report in accordance with 220 ILCS 5/16-135(d) of the Illinois Public Utilities Act.

Section 16-135 directs the Illinois Commerce Commission, in consultation with the Illinois Power Agency, to initiate a proceeding to examine specific programs, mechanisms, and policies that could support the deployment of energy storage systems. No later than May 31, 2022, the Commission shall submit to the General Assembly and the Governor any "recommendations for additional legislative, regulatory, or executive actions based on the findings of the proceeding."

Should you have any questions regarding the attached report, please contact Sarah Ryan, Director of Governmental Affairs, at (312) 965-5454, or by email at sarah.ryan@illinois.gov.

Sincerely,

A handwritten signature in blue ink, appearing to read "Carrie Zalewski".

Carrie Zalewski
Chairman

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I. Introduction

Section 16-135 of the Illinois Public Utilities Act (“Act”), which was added to the Act by Illinois Public Act 102-0662, directs the Illinois Commerce Commission (“Commission” or “ICC”), in consultation with the Illinois Power Agency (“IPA”), to initiate a proceeding to examine specific programs, mechanisms, and policies that could support the deployment of energy storage systems. No later than May 31, 2022, the Commission is to submit to the General Assembly and the Governor any “recommendations for additional legislative, regulatory, or executive actions based on the findings of the proceeding.” 220 ILCS 5/16-135(d). The Commission is also directed to consider and recommend to the Governor and General Assembly energy storage deployment targets, if any, for each electric utility that serves more than 200,000 customers to be achieved by December 31, 2032, including recommended interim targets.

In order to facilitate development of programs, mechanisms, and policies that could support the deployment of energy storage systems, the Staff of the Commission (“Staff”) held a series of webinars and a series of workshops on energy storage systems. The energy storage system webinars were presented in collaboration with the United States Department of Energy (“U.S. DOE”) Office of Electricity Energy Storage Program and Sandia National Laboratories. Experts from the national labs, regional agencies and other organizations and institutions provided energy storage system content through a series of six webinars held between November 2021 and January 2022. Topics included an introduction to energy storage, other state’s approaches, engineering details, energy storage benefit cost analysis & valuation, battery storage for generation, transmission, and distribution deferral, and decarbonation & energy storage. The Commission thanks Dr. Imre Gyuk, who directs the Electrical Energy Storage Research Program in the Office of Electricity at the U.S. DOE for supporting this webinar series; Dr. Howard Passell, Will McNamara, and Marisa Montes, of Sandia National Lab, for organizing and leading the webinar sessions; and the many experts who shared their time and expertise on energy storage system issues with ICC Staff and Stakeholders.

Additionally, Staff hosted four workshops between December 2021 and February 2022. Topics included: a review of Public Act 102-0662’s provisions concerning the Energy Storage Program; the framework to identify and measure the potential costs and benefits that deployment of energy storage can produce; barriers to realizing the benefits of energy storage systems; analyzing and estimating the impacts of deployment of energy storage systems; and programs, mechanisms, and policies that could support the deployment of energy storage systems. Staff additionally solicited several sets of comments on these issues. The workshop and comment process provided a forum and opportunities for stakeholders to provide information and opinions regarding programs,

mechanisms, and policies that could support the deployment of energy storage systems. The Commission thanks stakeholders for their participation and input in these workshops and for their subsequent comments.

The entirety of the materials shared during the webinar series and the Staff workshops can be found on the Commission's website here: <https://www.icc.illinois.gov/informal-processes/energy-storage-program>. This includes video recordings of the webinars and workshops, agendas, presentations, and written comments. In order to keep this summary report at a reasonable length, the report is not intended to be an exhaustive recollection of every presentation or comment received during the webinars and workshops.

After considering the information shared during the workshops, as well as the comments of various participants, this report makes the following recommendations:

- A. That the Commission decline at this time to recommend specific energy storage deployment targets for any electric utility that serves more than 200,000 customers. Section 16-135(e) contemplates any deployment target address energy storage achievable by 2032; as discussed in detail below, there are numerous proceedings that will take place in the next two years that may profoundly impact any recommended storage targets, not the least of which is submission and approval of multi-year integrated grid plans by utilities pursuant to section 16-105.17(f). Consideration of the conclusions reached in those docketed proceedings, as well as others, will provide the Commission with significantly more information that may inform prospective energy storage targets; see Section VI.C., below.
- B. That the General Assembly provide appropriation authority that will address the Commission's costs of engaging a technical consultant to, among other things, evaluate the future role of storage in Illinois relative to PJM and MISO; run a generation expansion optimization model and a production cost model that will calculate a range of front of the meter utility-scale resource additions that would optimally serve projected load; ensure reliable and resilient service; and meet state decarbonization targets and manage the analysis and collection of stakeholder input in this respect.
- C. That the Commission consider one or more energy storage pilot projects allowable under existing legislative authority in order to gather additional information about the costs and benefits of energy storage to enable it to better analyze what future regulatory, legislative or executive actions are necessary to further advance the implementation of energy storage in Illinois; see Section VI.D., below.
- D. That the Commission consider additional energy storage programs that may further energy storage goals that are not possible under existing legislative

authority and identify the legislative changes necessary to authorize the implementation of such programs; see Section VII.C., below.

II. Background: Energy Storage Types

Section 16-135 of the Act defines an energy storage system as a technology that is capable of absorbing zero-carbon energy, storing it for a period of time, and redelivering that energy after it has been stored in order to provide direct or indirect benefits to the broader electricity system. The term includes, but is not limited to, electrochemical, thermal, and electromechanical technologies. There are several types of energy storage systems either currently in operation or in development. Examples of energy storage technologies, including those identified by Dr. Howard Passell of Sandia National Laboratories in the Commission's webinar series, are provided below.

A. Mechanical Energy Storage Systems

1. *Flywheel Energy Storage Systems*

Flywheel energy storage systems use energy produced by motors to rotate low-friction, low-resistance flywheels at very high speeds. Energy is released when inertia allows the rotor to continue spinning and drives the motors in reverse. Flywheels are very useful in terms of ancillary benefits associated with energy storage. They are a high-quality device that can quickly provide real and reactive power. This makes them ideal for helping balance variable power generated from wind or solar farms. The balancing helps improve grid power quality and stabilize voltage levels in the local distribution system. The benefits of flywheels are that they have high power capacity, high cycle life (millions of rotations), fast response time (milliseconds), 80% round trip efficiency, and are applied in many ways at many different scales. The disadvantages of flywheels are that they provide short term storage with limited grid applications (frequency and voltage regulation, transient stability, and stopping and starting electric trains), and they are relatively expensive.

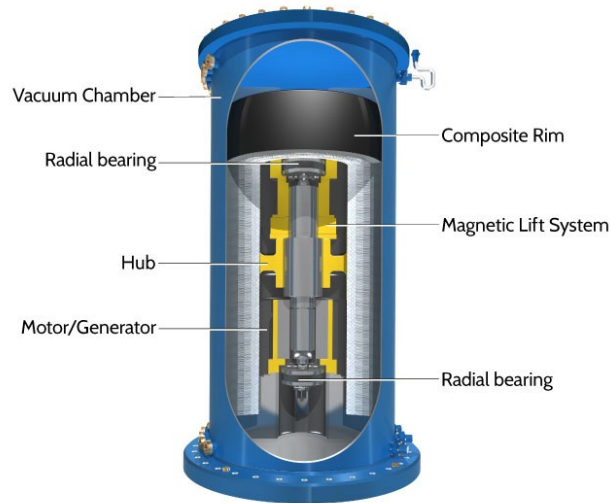


Diagram of a Flywheel Energy Storage System [1]

2. Compressed Air Energy Storage Systems

Compressed air storage systems use energy to power rotary compressors to compress and store air in underground chambers. Energy is released when the stored high-pressure air returns to the surface and is used to power or assist in powering turbines. Currently, there are only three large scale applications of compressed air storage systems in the world, but many efforts have been made at small scale applications. Benefits include long life (40 years), high power capacity, broad applicability, and potentially long duration. Disadvantages include low round trip efficiency (50-80%), low energy density, slower response time (seconds), and high initial and ongoing costs.

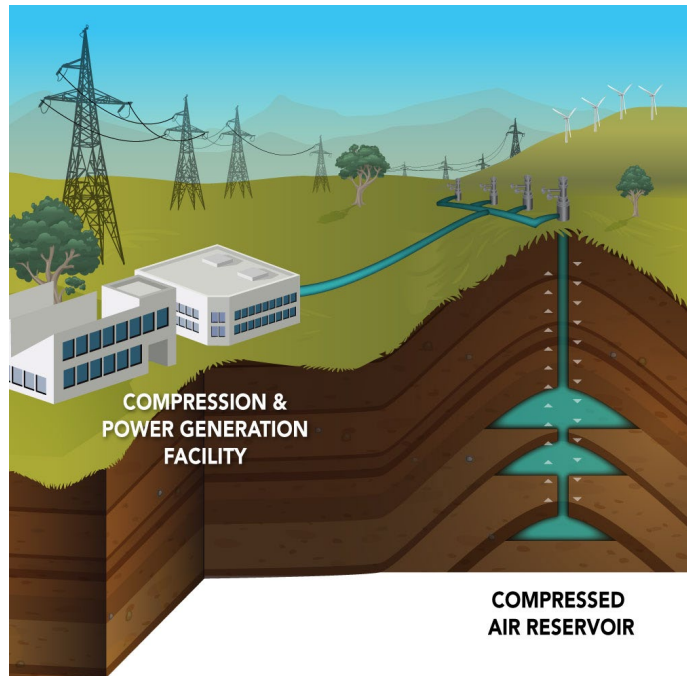


Diagram of a Compressed Air Energy Storage System [2]

B. Gravity Based Energy Storage Systems

1. Pumped Hydroelectric Energy Storage Systems

Pumped hydroelectric energy storage (“PHS”) systems make up roughly 90 percent of all utility-scale energy storage in the United States. The system works by using energy to pump water from a lower elevation reservoir to a higher elevation reservoir. After the water is in the higher elevation reservoir, the system waits until there is a supply gap or demand response before discharging. A PHS system discharges by allowing the water to flow back to the lower reservoir. The kinetic energy of the water is used to spin a turbine generator converting the mechanical, kinetic energy into electrical energy. A continuous, naturally flowing stream, referred to as an open loop system, is not required for a PHS system. The system can function with two non-flowing closed-in bodies of water, also known as a closed loop. Elevation is the most important factor as the difference in elevation between the upper and lower reservoirs is directly proportional to the potential energy of the system. PHS is relatively inexpensive to operate and the least-cost energy storage in terms of cost per capacity, however, PHS requires suitable topography and has a high initial construction cost. Water availability, dam construction, and other environmental concerns may limit the construction of PHS systems. The expected lifetime of this system is more than 40 years for the equipment and 100 years for the dam.

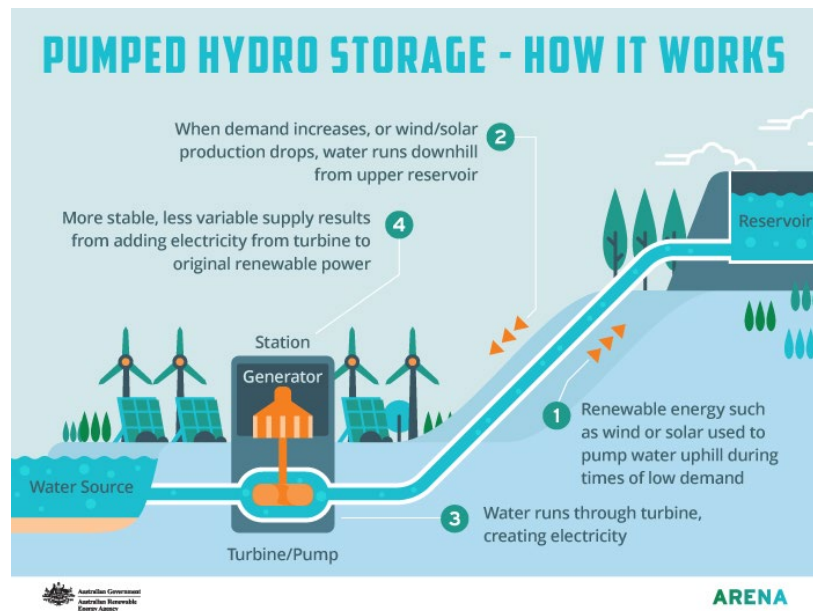


Diagram of Pumped Hydroelectric Energy Storage System [3]

2. Vault or Tower Energy Storage Systems

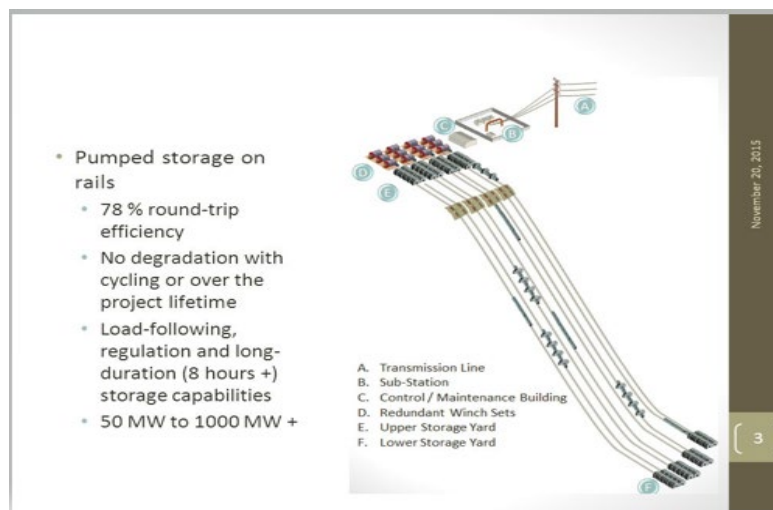
Vault or tower energy storage systems utilize motors to lift a weight (e.g., bricks or concrete blocks). When storing energy, electrical energy is converted into mechanical energy to raise the weights to a desired height. Once the weights have reached the specified height, the electrical energy is fully converted into potential energy and the system can stop absorbing power. The potential energy of the system is directly proportional to height and mass of the weight. To release energy, the weight is lowered, converting potential energy into kinetic energy. This kinetic (mechanical) energy is used to power a generator to convert potential energy back to electrical energy. Vault or tower energy storage also provides a use for solid waste materials. The weights that are used can be made from soil, sand, and waste materials, such as byproducts and materials used in fossil fuel production (e.g., coal, ash, other end of life energy components) or even shredded wind turbine blades. The system itself has a high efficiency (80-90% round trip) as well as an expected operational lifetime of 30 to 40 years.



Demonstration of how energy is charged (left) and discharged (right) in Vault (Tower) Energy System [4]

3. Rail Energy Storage Systems

Rail energy storage systems utilize tracks and mass cars to store energy. The system is comprised of a lower elevation area (discharged area) and a higher elevation area (charged area) connected by a slope (charging and discharging). To store energy, motors absorb electrical energy to lift the mass cars up the slope (charging). Once the cars have reached the charged area, absorbed electrical energy has finished converting into potential energy and the system stops absorbing energy from the grid. The energy stored is proportional to the vertical rise and the number of cars on each rail (weight). Energy is released when the rail cars are allowed to roll downhill, causing the motors to generate electricity on the grid. The rate of descent can be controlled by regenerative braking, which also generates electricity. Due to the nature of the design, the system can be expanded easily by adding more rails. This system has a service life of over 40 years and has approximately a 70% round trip efficiency.

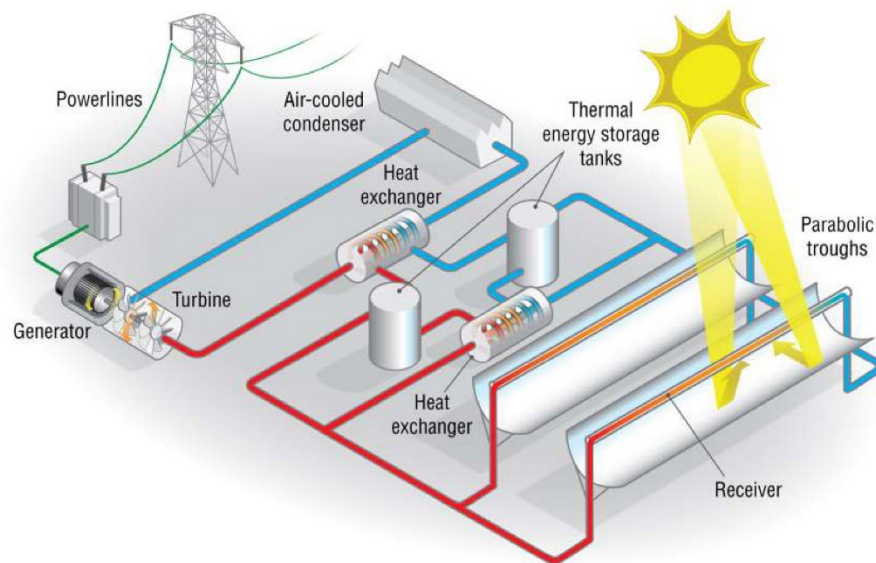


Example of rail energy storage developed by Advanced Rail Energy Storage. To clarify, E represents the charged area, F represents the discharged area. [5]

C. Thermal Based Energy Storage Systems

1. Concentrating Solar Power Energy Storage Systems

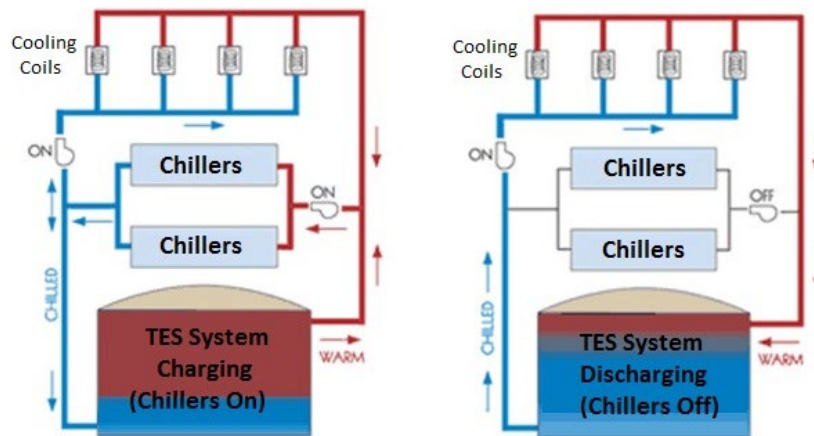
Concentrating solar power (“CSP”) systems use receivers (towers, dishes, linear mirrors, and troughs) to reflect heat from the sun’s rays onto a receiver filled with a fluid or solid (e.g., silica sand). A heat exchanger filled with water is connected to the system which allows for the material within the receiver to transfer heat. The thermal energy (heat) is converted into steam. The steam is used to power a turbine, allowing the thermal energy to be converted into mechanical energy, which is then converted into electrical energy. Afterwards, steam is cooled, condensed, and recycled while the fluid is returned into the tank to be reused. Where CSP systems fall short is efficiency. This is due to energy being converted multiple times per cycle. As of now, CSP storage has an efficiency between 7 and 25 percent, however, the initial construction cost of the system is very low. The system has a service life of 35 years.



Model of a Concentrating Solar Power System. [6]

2. Thermal Energy Storage Systems

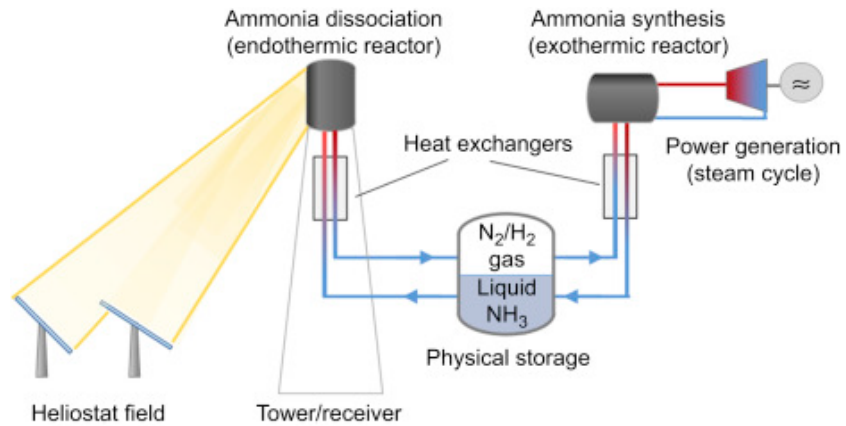
Thermal energy storage (“TES”) systems use energy to heat or cool a fluid (e.g., water). During off peak hours, most of the fluid will be heated, or cooled depending on the season and temperature demand, and stored. The stored energy can be used to power heating and cooling networks during peak demands and reduce or replace the need for fossil fuels to power HVAC systems. Using a buffer tank, energy can be stored longer, and the heat collected over the warm summer months can be stored and used during the winter and vice versa. Thermal energy storage provides renewable energy, is non-polluting, and low maintenance. The expected life of a thermal energy storage system is 20 years.



Picture of TES system charging (left) and discharging (right). [7]

3. Thermochemical Energy Storage Systems

Thermochemical energy storage systems store energy in endothermic chemical reactions, where energy is used to split a thermochemical material into separate components in order to store energy. Energy is retrieved by facilitating the reverse, exothermic reaction during which the components are re-combined and thermal energy, in the form of heat from the reaction, is released. The chemicals are charged and discharged in a self-contained system, allowing the thermochemical material to be stored and reused. The system is suitable for seasonal, long-term, energy storage, high energy density, and highly compact energy storage. While the basic principles of thermochemical energy storage are simple to understand, the system itself can be technically complex. Such systems are still being refined; therefore, there is limited data on efficiency. However, initial estimates indicate the cost will be low relative to some of the other energy storage types.



Model of Thermochemical Energy Storage.

In this case, Ammonia (NH₃) is used as the thermochemical material. [8]

D. Electrochemical Energy Storage Systems

1. *Electrochemical Battery Energy Storage Systems*

Electrochemical Battery Energy Storage Systems rely on stored chemical energy. Chemical reactions convert stored chemical energy into electrical energy. Examples of chemicals used in such batteries include, among others, alkaline (zinc-manganese dioxide), lithium-ion, nickel-cadmium, nickel-metal hydride, lead-acid, nickel-iron, iron-air, and zinc-carbon.

- Lithium ion batteries have high energy density, a high life cycle, fast response time, and a life span of 10-15 years. While their use is widespread, there are a number of issues that arise from the use of lithium. These include the mining needed to extract battery components from the earth, the scarcity of the battery material, as well as safety and recycling concerns.
- Lithium-Aluminum Oxide batteries are the highest in energy density (which have a higher potential risk as more energy is packed into a small space), these batteries are often used in Tesla cars.
- Sodium-Sulfur Batteries are high in energy density and have a life span of about 15 years. They operate at a very high temperature, and this results in a need for systems that can tolerate very high temperature. There are inherent dangers associated with the high temperatures.
- Lead Acid Batteries are the most commonly used batteries in the world. They have a shorter life span of about five years and are lower in energy density. However, these batteries are recyclable.
- Zinc Manganese Oxide Batteries are traditionally primary batteries, and are ubiquitous. They have the lowest materials costs and manufacturing capital expenses. They don't have temperature limitations like that of Li-ion or Pb-acid. They have a round trip efficiency of about 75% and a lifespan of about ten years. They are environmentally benign – EPA certified for landfill disposal.
- Reversible Rust Batteries use a form of iron that is produced globally and manufactured in the United States. Iron is placed in a liquid electrolyte, like a battery, and is put through a cycle of rusting and conversion back to metallic iron. When the iron pellets rust, they are discharging, and then when a current is applied it reverses the process. Rust batteries are the lowest cost for rechargeable battery chemistry at approximately 1/10th the cost of lithium-ion batteries. These batteries have no flammable aqueous electrolytes, no heavy metals, and no risk of thermal runaway.

2. Electrochemical Capacitor Energy Storage Systems

Electrochemical Capacitor Energy Storage Systems (supercapacitors or ultracapacitors) use energy to create differences in electric charges between conductive plates or electrodes separated by insulators. Energy is delivered when the electrodes are connected by an external path and the current flows until the electric charges return to balance. The benefits to these super capacitors are they have a high cycle life, fast discharge, and high round trip efficiency (95%). They are used in many applications, including laptops, buses, and trains. Some negatives to capacitors are that they have a very low energy capacity, due to a low per cell voltage, and are unable to produce a slow, constant voltage when discharging, potentially leading to poor power quality. A battery, on the other hand, has a mostly constant voltage output and a higher energy capacity per unit weight.

3. Fuel Cell Energy Storage Systems

Fuel cell energy storage systems use fuel fed to an anode (e.g., hydrogen) and to a cathode (air) surrounding an electrolyte. When a catalyst separates them at the anode, protons and electrons take different paths to the cathode. Electrons flow through external circuits to produce electricity while the protons flow through the electrolyte to produce water and heat.

- Flow Batteries – A specific type of fuel cells called flow batteries use a cathode tank and an anode tank, and when both are run through a system involving a fuel cell, it produces electricity. To control the amount of electricity stored, one just needs to modify the size of the tanks. Resizing flow batteries is very easy because tank sizes can be adjusted without adding new racks or controllers. Flow batteries have a wide range of chemistries available, including vanadium, zinc bromine, and iron chromium. They also have a wide range of applications.

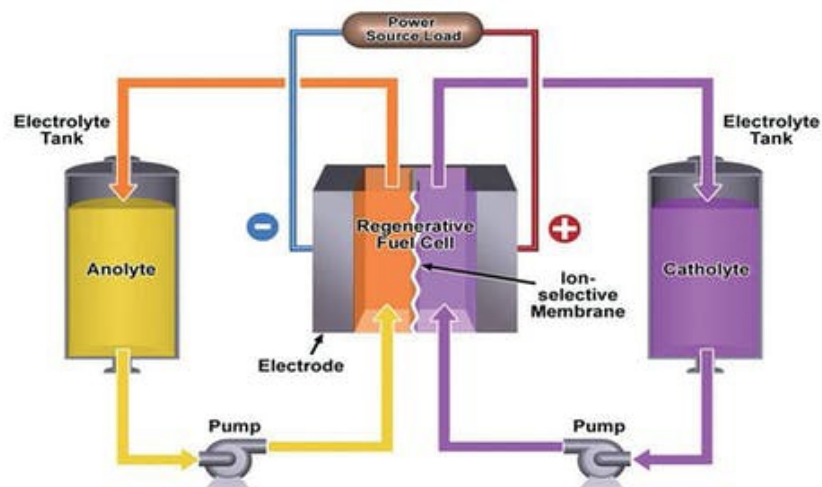


Diagram of a Flow Battery [9]

- Hydrogen Batteries – Hydrogen can be used as an electrochemical fuel cell, a lot like a battery and flow batteries. Electricity splits H₂O into H₂ and O. H₂ is stored in above-ground steel tanks or in underground caverns. The fuel cell uses redox chemistry to produce electricity. Hydrogen batteries have many applications.

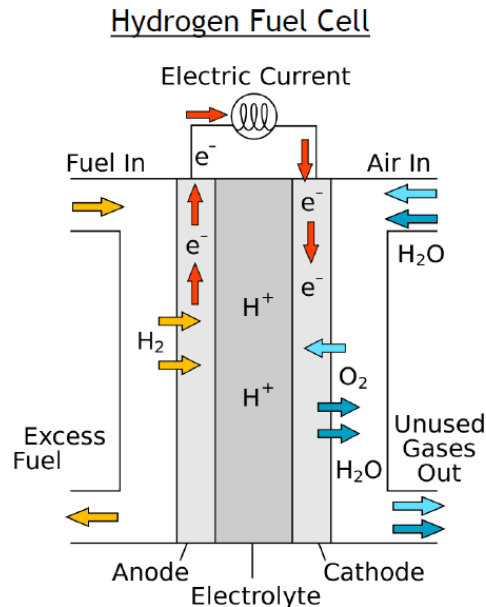


Diagram of a Hydrogen Fuel Cell [10]

4. Battery Energy Storage Systems (“BESSs”)

BESSs are large, complex complicated systems that include components that manage the battery so it does not overheat, overcharge, or undercharge.

Components include:

- Battery Storage – Batteries & Racks
- Battery Management System – Management of the battery = efficiency, depth of discharge , cycle of life
- Power Conversion System – DC to AC, AC to DC; Bi-directional inverter; transformer, switchgear
- Energy Management System – optimal monitoring and dispatch for different purposes – charge/discharge, load management, ramp rate control, ancillary services; coordinates multiple systems
- Site Management System – distributed energy resources (“DER”) control; Interconnection with grid; islanding and microgrid control
- Balance of Plant – housing, HVAC, wiring, climate control, fire protection, permits, personnel

Battery technology is improving, getting more widely deployed, becoming less expensive, while at the same time safety is improving. Much more battery capacity with longer durations is required to meet 100% carbon free goals in Illinois and across the country. Li-ion is currently the predominant technology in the market, but many other chemistries and technologies are in development. Batteries can provide important services to the grid, and many value streams. However, as discussed below, some of those values are hard to quantify, and some markets do not exist yet.

III. Background: Legislative Findings and Direction

In Section 16-135 of the Act, the General Assembly identified several findings that support the creation of an Energy Storage Program, including findings that energy storage systems:

- Reduce costs to ratepayers directly or indirectly by avoiding or deferring the need for investment in new generation and for upgrades to systems for the transmission and distribution of electricity;
- Reduce the use of fossil fuels for meeting demand during peak load periods;
- Provide ancillary services such as frequency response, load following, and voltage support;
- Assist electric utilities with integrating sources of renewable energy into the grid for the transmission and distribution of electricity, and with maintaining grid stability;
- Support diversification of energy resources;
- Enhance the resilience and reliability of the electric grid; and
- Reduce greenhouse gas emissions and other air pollutants resulting from power generation, thereby minimizing public health impacts that result from power generation.

The General Assembly further found that there are significant barriers to obtaining the benefits of energy storage systems, including inadequate valuation of the services that energy storage can provide to the grid and the public and concluded that it is in the public interest to:

- Develop a robust competitive market for existing and new providers of energy storage systems in order to leverage Illinois' position as a leader in advanced energy and to capture the potential for economic development;
- Implement targets and programs to achieve deployment of energy storage systems; and

- Modernize distributed energy resource programs and interconnection standards to lower costs and efficiently deploy energy storage systems in order to increase economic development and job creation within the state's clean energy economy.

The General Assembly therefore directed the Commission to:

- In consultation with the Illinois Power Agency, initiate a proceeding to examine specific programs, mechanisms, and policies that could support the deployment of energy storage systems;
- No later than May 31, 2022, submit to the General Assembly and the Governor any recommendations for additional legislative, regulatory, or executive actions based on the findings of the proceeding; and
- Consider and recommend to the Governor and General Assembly energy storage deployment targets, if any, for each electric utility that serves more than 200,000 customers to be achieved by December 31, 2032, including recommended interim targets.

With respect to these analyses, the General Assembly specified that the Commission should:

- Develop a framework to identify and measure the potential costs and benefits that deployment of energy storage could produce, as well as barriers to realizing such benefits;
- Analyze and estimate energy storage system impacts; and
- Evaluate and identify cost-effective policies and programs to support the deployment of energy storage systems.

The General Assembly further directed that the Commission should, when setting energy storage targets:

- Account for the costs and benefits of procuring energy storage; and
- Consider establishing specific subcategories of deployment of systems by point of interconnection or application.

IV. Framework for Identifying and Measuring Costs and Benefits

A. Benefits of Energy Storage Systems

With respect to cost-benefit framework, subsection (c)(1) of Section 16-135 of the Act provides several areas of potential benefits that should be considered.

- Avoided cost and deferred investments in generation, transmission, and distribution facilities
- Reduced ancillary services costs;

- Reduced transmission and distribution congestion;
- Lower peak power costs and reduced capacity costs;
- Reduced costs for emergency power supplies during outages;
- Reduced curtailment of renewable energy generators;
- Reduced greenhouse gas emissions and other criteria air pollutants;
- Increased grid hosting capacity of renewable energy generators that produce energy on an intermittent basis;
- Increased reliability and resilience of the electric grid;
- Reduced line losses;
- Increased resource diversification; and
- Increased economic development.

These and other benefits were explored during the energy storage system webinars. Dr. Imre Gyuk of the Department of Energy explained that energy storage systems have the ability to smooth load profiles, which can reduce wear and tear incurred when generation systems are required to start and stop intermittently. This reduction in wear and tear can eliminate or defer the need to replace existing generation. He further noted that energy storage systems can augment generation by either producing or absorbing energy. This can potentially defer the need for additional generation that might otherwise be necessary to address growing system needs or reduce the need for generation to address existing system needs and alleviate the need to replace retiring generation plants.

Dr. Hisham Otham of Quanta Technologies noted that energy storage systems can respond quickly and flexibly to control frequency flows. This can alleviate intermittency associated with many forms of renewables such as wind and solar and reduce the need for generation investment that would otherwise be necessary to address times in which intermittent resources are not available (e.g., when the sun is not shining or the wind is not blowing). He further explained that load shape is a key driver for “peaker plants,” which are typically gas-fired generation plants that are expensive to run, and therefore generally run only at peak demand when prices are also high. For example, he pointed out that the top 5% of peak loads lasts for only 25 hours in a year. Therefore, energy storage systems have significant potential to defer the need for such peaker plants.

Dr. Gyuk noted that energy storage systems defer the need for investment in transmission facilities necessary to meet load demand. For example, he cited the installation of energy storage systems on Nantucket Island, Massachusetts, which deferred the need to install additional costly submarine transmission facilities between the mainland and the island.

Dr. Hisham noted that energy storage systems can be a cost effective alternative to investing in transmission when such investment would otherwise be needed to address North American Electric Reliability Corporation (“NERC”) transmission system planning performance requirements.

Bob McKee of American Transmission Company noted that Federal Energy Regulatory Commission (“FERC”) policy allows energy storage systems to be classified as transmission facilities based upon how they operate. He further explained that Regional Transmission Organizations (“RTOs”) such as the Midcontinent Independent System Operator (“MISO”) are developing processes to treat energy storage systems as transmission assets and to evaluate the use of energy storage systems when planning transmission investments.

Jeremy Twitchell of Pacific Northwest National Laboratory explained that energy storage systems can be used to alleviate thermal overloading on transmission lines and can help maintain voltage, manage power flows, and absorb excess power. These actions can extend the life of transmission assets and defer the need for new transmission infrastructure. Mr. Twitchell notes that, when used as a transmission asset, storage system costs can be recovered through FERC-approved transmission system rates. A key consideration in such contexts, as he notes, is that even on fully-contracted, heavily utilized transmission lines, there is unused capacity most of the time. This means that such energy storage systems, even if deployed as transmission assets, have the potential to provide other grid services outside of peak periods.

Dr. Gyuk also noted that energy storage systems can defer the need for distribution substation investment. Energy storage systems interconnected to existing circuits can reduce peak loads and circuits and obviate the need for upgrades when additional load is added to such circuits, for example, through deployment of renewable generation added to the circuit.

Angie Gould, of the State of California Energy Commission, explained how California is using pilot programs to demonstrate the value of distributed solar generation plus energy storage systems as distribution assets, for example, targeting the use of such systems to reduce distribution system peak loads.

The benefits of energy storage systems go well beyond generation, transmission, and distribution investment deferrals. Patrick Balducci of Argonne National Laboratory identified numerous additional streams of benefits such systems can provide. He categorized benefits into five different categories, including bulk energy services, ancillary services, transmission services, distribution services, and customer services. With respect to bulk energy services, Mr. Balducci noted that energy storage systems can help ensure resource adequacy and provide the ability to arbitrage assets in energy markets

by creating the ability to serve load in periods of high demand with less expensive generation produced during periods of lower demand. With respect to ancillary services, he noted that energy storage systems can provide regulation, load following, spinning/non-spinning reserves, frequency response, flexible ramping, voltage support, and black start service. With respect to transmission, he noted that energy storage systems can provide congestion relief. With respect to distribution services he noted that energy storage systems can provide Volt-VAR control and conservation voltage reduction. Mr. Baldacci identified customer service benefits of energy storage systems that come from increased power reliability/power quality/outage mitigation/resiliency, time-of-use charge reductions, and demand charge reductions.

Stakeholders also provided input and energy storage program costs and benefits through the energy storage program workshop process. In his workshop comments, Andrew Barbeau of The Accelerate Group, identified seven areas potentially addressable through energy storage systems, including generation, ancillary services, transmission, distribution, renewables, community, and customers.

With respect to generation, Mr. Barbeau noted that energy storage systems have the potential to reduce capacity costs, reduce peak demand, provide for price arbitrage (e.g., allowing for purchase and storage of energy when energy generation prices are low to serve load when prices for energy generation are high), for load shifting (e.g., allowing for purchase and storage of energy when clean generation is plentiful to serve load when clean energy generation is in short supply), for energy ramping, for site-specific pollution reduction, and to reduce the need to curtail renewables when renewable generation is plentiful but not immediately in demand.

With respect to ancillary services, Mr. Barbeau noted that energy storage systems can provide regulation, frequency response, reserves, voltage support, and black start capabilities.

With respect to transmission, Mr. Barbeau observed that energy storage systems can defer transmission investment and provide relief from transmission congestion.

With respect to the distribution system, Mr. Barbeau noted that energy storage systems can defer distribution investments, provide enhanced reliability, reduce peak system demand, and provide Volt-VAR support and voltage optimization.

With respect to renewables, Mr. Barbeau noted that energy storage systems can enhance the hosting capacity available for renewables and reduce renewable energy interconnection costs.

With respect to communities, Mr. Barbeau noted that energy storage systems can provide resilience for critical facilities, allow for islanding of portions of the grid when

centralized portions of the grid are not available, and enable increased load associated with electrifying transportation, HVAC systems, and other beneficial electrification measures.

Finally, with respect to customers, Mr. Barbeau noted that energy storage systems have the potential to lower energy bill burdens, enhance system reliability and resilience, provide for enhanced power quality, and allow customers to better manage their bills.

B. Benefit Cost Analysis

To establish mid- and long-term storage deployment targets, generation expansion modeling and production cost modeling need to be performed. The generation expansion modeling identifies and optimizes the battery storage additions needed over time that would help the state meet its energy and environmental goals – the buildout of in-state clean energy generation, ensuring a reliable and resilient system, and meeting its 2045 zero-carbon goals. The production cost model calculates overall change in system operating costs and calculates the optimal operation of the system to serve projected load. The potential generation expansion needs to be co-optimized with production cost modeling.

There are numerous approaches to performing benefit cost analyses that can be used for cost-effectiveness evaluations. For example, Section 1-10 of the Illinois Power Agency Act, 20 ILCS 3855/1-10, defines a total resource cost test as a cost-benefit analysis standard used to evaluate investment in energy efficiency and demand-response measures. The total resource cost test compares the sum of avoided electric utility costs, representing the benefits that accrue to the system and the participant in the delivery of those efficiency measures and (including avoided costs associated with reduced use of natural gas or other fuels; avoided costs associated with reduced water consumption; and avoided costs associated with reduced operation and maintenance costs, as well as other quantifiable societal benefits) to the sum of all incremental costs of end-use measures that are implemented due to the program (including both utility and participant contributions), plus costs to administer, deliver, and evaluate each demand-side program, in order to quantify the net savings obtained by substituting the demand-side program for supply resources.

In its workshop comments, the Clean Energy Group identifies several other alternatives to the total resource cost test that are used by other states. While definitions of such tests can vary across states, the alternatives generally include, but are not limited to:

- The Utility Cost Test or UCT, which measures costs and benefits only to the extent they affect utility system operation and provision of utility service;

- The Societal Cost Test or SCT, which measures costs and benefits similar to the total resource cost test but tends to include more impacts on society and people outside of the utilities service area;
- The Rate Impact Measure or RIM, which measures costs and benefits similar to the utility cost test but includes estimates of utility lost revenues created by programs; and
- The Participant Cost Test or PCT, which measures the costs and benefits to program participants.

The variety of alternatives used to evaluate investment in energy efficiency and demand-response measures highlights the importance of identifying the universe of people and entities upon which any cost-benefit analysis will focus. A cost-benefit analysis should specifically state whether it is assessing net benefits considering particular utilities, program participants, ratepayers of particular utilities, Illinois residents, broader entities/classes of people (e.g., the impact on non-Illinois residents), and/or combinations of such entities and people.

Along these lines, Clean Energy Group explains that a cost-benefit analysis from the utility's perspective has very different results when examining storage as a service provided to utilities as opposed to utility-owned storage. In particular, when storage is evaluated as a service it does not include direct capital costs.

In the Commission's webinar series, Dr. Ray Byrne of Sandia National Laboratories provided several recommendations for how to assess the costs and benefits of storage deployment. Dr. Byrne provided several best practices identified by the Federal Office of Management and Budget, which are summarized here.

It is important to perform a benefit cost analysis to determine whether the benefits of a particular storage deployment decision are likely to justify the costs of such deployment and, if alternatives are available, to determine which alternative produces the greatest net benefits.

One complicating factor within such analysis is that not all benefits or costs are readily quantifiable or readily expressed in monetary units. As a result, it may be necessary to exercise professional judgement to evaluate net benefits. One approach for performing such an evaluation is to use a threshold or break-even analysis. Such an analysis seeks to determine how small non-quantifiable benefits could be and/or how large non-quantifiable costs could be in order for net benefits to be positive, once all quantifiable costs and benefits are considered. Once this is determined, evaluators can exercise professional judgement to determine if net results are likely to be positive. This evaluation might include sensitivity analyses, which identify how sensitive the estimates and results are to assumptions, inputs, and profession judgement; this will provide

reviewers an indication of the robustness of the analysis and results. Creating probability distributions for hard-to-quantify/judgement-based benefits and costs often provides a mechanism on which to make determinations (e.g., determinations might be made to proceed in cases where net results are likely negative less than 5% of the time).

Another complicating factor is how to address the intertemporal nature of benefits and costs. That is, project benefits and costs do not all occur at the same point in time. Therefore, analysis of benefits and costs should consider that investing money today in a project means foregoing returns or consumption that would otherwise be available if that money was used elsewhere (i.e., there are opportunity costs of the investment). Such an analysis considers inflation or that the purchasing power of money may decrease over time as prices increase. Similarly, individuals may consider consumption today preferable relative to consumption in the future. Various intertemporal discount rates can be employed in order to ensure that current and future costs and benefits are evaluated consistently. Because there are several different approaches to selecting such discount rates, it is generally advisable to identify any sensitivity to the discount rate selected in order to identify the robustness of the analysis and results.

In many instances, no single party may be in a position, absent information from others, to analyze and estimate all of the costs and benefits for deploying energy storage systems. Utilities, for example, are uniquely situated to assess how storage will impact the need for investment in distribution infrastructure and impact system hosting capacity. Similarly, energy storage system providers may have better information than the general public regarding energy storage system costs and capabilities. For these reasons, analyses and estimation of the impacts of energy storage systems may benefit from market processes that induce parties, particularly suppliers of energy storage systems, to reveal information on the systems. In this regard, in its workshop comments Vistra advocates that energy storage systems should be added through competitive, market-driven processes.

While competitive, market-driven processes may reveal information on system costs and capabilities, it may be more difficult to elicit benefit information through those processes. For example, there is currently no general market for carbon reduction that would directly reveal the societal benefits associated with emission reductions through competitive, market driven processes. In such cases, analyses and estimation, as opposed to observing market demand, may be needed in order to identify the full value that energy storage systems can provide.

ComEd notes that in performing this investigation, the Commission is required, among other items, to review the full value of the distributed energy resources and the manner in which each component of that value is or is not otherwise compensated. The review must take into account the scope of state and federal authority, to avoid crossing

jurisdictional boundaries or relying on unsupported assumptions about changes in federal policy. Any existing compensation must be considered to avoid setting up incompatible market and regulatory structures, excessive compensation, and unfairness in cost allocation.

Finally, each analysis should be transparent such that those reviewing the analysis will be able to identify how estimates and conclusions were derived. This includes clearly identifying methodologies, assumptions, inputs, and applicable time horizons.

C. Identifying Projects and Programs

During SNL's webinar series, Will McNamara highlighted ten key policy issues for states considering the support of energy storage systems.

1. **Procurement Mandates:** In favor of mandates, he points to the fact that mandates for storage are compatible with most Renewable Portfolio Standard ("RPS") policies, provide cost recovery certainty for utilities, and can be used to stimulate market development. At the same time, mandates require the government, instead of the market, to pick winners. In addition, it is less clear how to set appropriate procurement levels and determine benefits and storage development may occur even without mandates given the drive to 100% renewables for many states.
2. **Utility Ownership:** A benefit of utility ownership is that it allows for storage to be optimized on the distribution system, including as part of long-range, system-wide planning. In addition, utility ownership creates enhanced economies of scale and greater flexibility to use cost-effective resources. However, utility ownership creates market power concerns. With utility ownership, utilities would have an advantage over third parties. There are also uncertainties about utility cost recovery and equitable rate treatment among customers.
3. **Inclusion in Utility Integrated Resource Plans ("IRPs"):** Including storage in utility IRPs has positive aspects. Notably, thermal and electrochemical energy storage are competitive with natural gas peakers and could then be considered as an alternative. Including storage in utility IRPs provides certainty about storage's future role and can also address other policy requirements, such as for renewables. But there are downsides to including storage in utility IRPs, notably the lack of reliable cost and "best practices" information. There is also a lack of tools to allow for more granular modeling. Most importantly, including storage in utility IRPs would only apply in vertically integrated states and would not be an option for Illinois.
4. **Incentives/Tax Credits:** McNamara highlights that state incentives could encourage utilities to invest in new technologies. Without these incentives, regulatory barriers could prevent energy storage development. Customer

incentives could be linked with any economic value that is brought to the grid. But incentives also have limits. If equity is not considered, tax credits or incentives could only benefit wealthier customers. Incentive programs can be prohibitively complex, and undefined parameters could allow for “double dipping.”

5. Multiple Use Applications: In his presentation, McNamara posits that it is a benefit that there are multiple uses for storage because it allows for energy storage to achieve its full economic potential. Storage uses could include energy, capacity, environmental, and locational/temporal demand response benefits. But, as a downside, current energy storage installations are either behind-the-meter or grid-tied, but not both. In addition, some uses may have higher priority than others, and this could create conflicts in the marketplace.
6. Cost/Benefit Analysis: The advantage of cost/benefit analysis is that it will justify utility cost recovery and it could help identify and prioritize potential customers. However, there is no universal approach to defining storage costs and benefits. Assessing storage cost/benefit is difficult in part because it is an emerging technology, and different storage systems are in various stages of development. Currently, there is a wide range of performance variance, which creates large differences in costs and benefits.
7. Distribution system modeling: A benefit of effective distribution system modeling is optimizing storage sizing, placement, and operation. Distribution modeling provides local power quality improvements, mitigation of voltage deviation, frequency regulation, load shifting, and other benefits. However, distribution utilities might choose least-cost options over maximum benefit solutions. Second, misusing or mislocating storage systems on the distribution network can degrade power quality, reduce reliability, and lessen load control.
8. Changes to Net Metering: There are several pros to changing net metering for energy storage devices. Allowing storage devices that are solar powered to be paid through net metering would send strong market signals. Changing net metering for storage devices would also compensate for some states reducing the value of solar through time-of-use rates. Finally, adding storage may become a prerequisite for residential solar. Then again, some utilities may be hesitant to pay net metering rates to storage resources charged from the grid. Further, adding storage to a solar project adds another layer of complexity. Policymakers should ensure that the credit given to storage is renewable energy produced and not energy purchased and resold from the grid.
9. Changes to RPS Mandates: Including storage in RPS mandates would have benefits such as integrating intermittent renewable energy and matching renewable generation more closely with peak loads. New RPS mandates would allow storage to provide generation and load balancing services, while reducing

the need for peaking and backup generators on the grid. These mandates would also reduce customer demand charges. But changes to RPS mandates would have limits, including the risk that a reopened RPS would allow an opportunity to weaken a state's current renewable energy obligations. It is also unclear whether regulators need to encourage storage specifically, or if encouraging renewables alone is enough.

10. Interconnection: Updated interconnection standards would be useful because interconnection is a critical step for any resource that operates while connected to the grid. Updated interconnection policies could be better integrated with other policies, such as net metering, distribution planning, resource planning, and energy efficiency. However, energy storage technology remains nascent and current interconnection standards may not incorporate the full potential of services and benefits storage may provide. In addition, the integration of large amounts of DERs can negatively impact system reliability.

In his workshop comments, Andrew Barbeau of **The Accelerate Group**, recommends an approach that identifies and evaluates projects by examining answers to the following questions:

- What is needed?
- Where is it needed?
- When is it needed?
- How much is needed?
- How often is it needed?
- For how long is it needed?
- Suitability of energy storage vs alternatives
- What is needed to enable this?
- How do you ensure equitable adoption and benefit?
- How do you calculate "adequate value" for the service?
- What other costs must be considered?

Mr. Barbeau recommends creating a template based upon these questions and applying it to each of the energy services that energy storage systems provide. Once such templates are created, he recommends stakeholders identify and vote on services that can reasonably be addressed through energy storage system projects and policies, performing cost benefit analysis on those projects and policies that are currently potentially feasible, and then establishing incentives, targets, and budgets for those projects and policies that are cost beneficial.

The Accelerate Group also proposes the following specific programs and actions:

1. The Commission should direct utilities to include programs to incentivize the deployment of energy storage to provide distinct grid services as part of the utilities' Integrated Grid Plans. The utilities' Integrated Grid Plans must demonstrate how the utilities plan to achieve the goals and objectives of the statute, including specific goals for peak reduction, interconnection, non-wires alternatives, supporting renewable energy growth, and supporting beneficial electrification efforts. The Integrated Grid Plans should be directed to include the following elements:
 - a. Flexibility Program. A Bring-Your-Own-Device program that creates a simple and predictable opportunity for customer-owned devices, including energy storage, smart thermostats, electric vehicles, and other controllable load, to provide peak reduction, load shifting/ramp, renewable integration, and transmission deferral services to the energy system:
 - i. Peak Reduction/Capacity Service: A tiered load reduction program that operates during peak summer season and emergency events, allowing the utility to call on devices for greater load reduction as needed to achieve their peak reduction targets. A hypothetical 15% peak reduction goal would allow for the integration of more than 4,800 MW of load-adjusting devices statewide.
 - ii. Load Shifting/Ramp, Reduced Renewable Energy Curtailment/Transmission Deferral Service: An opt-in time-of-use rate structure that encourages the adoption of energy storage and other load-adjusting devices to reduce evening peaks and future load peaks that do not align with renewable energy production, and to shift load to times when renewable energy might otherwise be curtailed or necessitate transmission build-out. It is anticipated that by 2030, there could be a need for approximately 5,000 MW of load shifting to mid-day hours in low-load shoulder months to reduce renewable energy curtailment and to defer transmission upgrades. This program would not need to be separate from services to reduce peak load, as the services could be distinguished by season for whether they are focused on peak reduction or load shifting.
 - b. Power Quality Program. An energy storage-specific program could be implemented with Commission approval to compensate customer-owned energy storage systems on select feeders for services provided to support local power quality, through the provision of VAR support and enabling greater hosting capacity by serving as a local active power sink to prevent backfeed. A

Power Quality Program would need to identify circuits in which a power quality issue existed or was expected to emerge, as well as designate feeders at or near hosting capacity limits. Payments would be provided based on performance as compensation that is additional to any compensation received from the Flexibility Program. The Power Quality Program should enable the participation of energy storage systems in both it and the Flexibility Program simultaneously.

- c. Community Resiliency Program. A community resiliency energy storage program could be integrated into the utilities' Integrated Grid Planning process, which focuses on identifying and serving the needs of customers to help them achieve their objectives and address their energy vulnerabilities. First, community planning support and technical assistance should be provided to communities and community organizations to perform thorough Community Energy, Climate, and Jobs Plans as provided for under CEJA. Second, those community plans should be incorporated into the utilities' Integrated Grid Plans, with stakeholders developing solutions for addressing community needs. Third, as appropriate, the Commission can direct in those Integrated Grid Plans programs for the utility to provide rebates or other incentives for energy storage included as part of community resiliency projects.

The three programs should be designed to allow for an individual energy storage system to be able to participate in all programs simultaneously, to the extent practicable. Based on the assessment of grid services, The Accelerate Group believes that the Flexibility Program could be available on a system-wide basis, with consistent and predictable program participation rules. The Power Quality Payments would likely be available for identified circuits where a need has been identified. The Community Resiliency Program would be available for distinct projects in alignment with community-developed Community Energy, Climate, and Jobs Plans.

2. The Commission should open an investigation into the procurement of energy storage for distinct reliability and resiliency needs in order to support and enable the transition to a carbon-free power sector. In P.A. 102-0662, the state set out a detailed plan for the transition to a clean energy economy and, specifically, a carbon-free power sector by 2045, with interim steps along the way. As fossil fuel power plants begin to close according to their schedules, there may be reliability issues identified at a local level within the state by the grid operator. As those reliability issues emerge, it would be prudent for the Commission to consider the procurement of energy storage as a carbon-free reliability resource to mitigate any

locational reliability needs. The Commission would have to work closely with the Regional Transmission Operators to identify projected location-specific reliability issues caused by transmission constraints or grid congestion, and determine when and where the energy storage resources may be needed. Upon identified need, the Commission could direct the procurement of site-specific energy storage resources, along with operating requirements, through the Illinois Power Agency and/or through the utilities.

3. The Commission should begin efforts to quantify a DER rebate value for energy storage systems deployed to support beneficial electrification. CEJA included the specific creation of an additional DER rebate value for energy storage that was paired with beneficial electrification projects in order to reduce the need for additional infrastructure to support electrification [220 ILCS 5/16-107.6(e)(6)]. The Commission should undergo a stakeholder process to establish a value that serves as a cost-beneficial means to enable electrification that would otherwise face high grid infrastructure upgrades. The utilities would implement the rebate program alongside their other DER rebates.

Sunrun suggests a “bring-your-own-device” program for ease of implementation in Illinois. Sunrun states that a similar program in Massachusetts locks in customer compensation rates as of the date of enrollment for the duration of the Program term; currently this is \$275 / kW / season. The program allows customers to participate through aggregators or integrators, and includes batteries, inverters, thermostats, and bi-directional electric vehicles. Customers remain on the underlying interconnection tariff (e.g. net metering). Sunrun reports that Vermont’s program is similar, and provides an up-front payment of \$850/kW for 3-hour storage discharge capability with claw-backs for non-performance and a 10-year program commitment.

Enphase favors simplicity and suggests that Illinois’ future battery program should be simple enough to fit on a single sheet of paper. It argues that California has a more complex battery program that discourages participation. Enphase prefers a single statewide administrator for any program and proposes that any available benefits should be stackable. Specifically, Enphase recommends:

1. Utility tariffs should incentivize mid-day charging to reduce monthly bills and alleviate evening grid stress. Further, these incentives should be clear and easy to understand so that customers can make informed decisions about charging and discharging their storage assets.
2. Use of a third-party aggregator to collect, manage, and deploy storage resources in order to maximize the benefits from those resources. The full range of benefits

that comes from using an aggregator include voltage and frequency support, increasing hosting capacity, delivering shapeable load profiles based on peak utility load identification, and providing low-latency, high frequency data to support program performance monitoring and evaluation.

3. Coupling the new storage rebate program with a grid services program to ensure customers are incentivized to use the storage system to benefit the grid and not solely for self-consumption and backup power.

Vistra notes the potential benefits of adding battery energy storage systems to transmission and distribution grids (including both front-of-the-meter and behind-the-meter systems) and the various services that battery energy storage systems can provide. Vistra argues that, ultimately, battery storage systems should be developed through competitive market processes but also noted that current market structures and market dynamics do not support competitive, market-based development of utility-scale storage systems. As a result, Vistra states that government-provided incentives may continue to be needed during a transition period, until market forces are sufficient to drive demand for installation of storage systems to support non-dispatchable resources. Vistra also notes the significant impacts that electrification of the vehicle transportation sector will have on both the overall need for, and the benefits of, energy storage systems.

Ameren Illinois argues that, if storage is going to act as a non-wires alternative (NWA) for transmission, the storage system must be available to the distribution system on an as-needed basis. This includes the storage system committing to a verified maintenance schedule. In addition, Ameren states that:

1. If a storage device takes part in other compensation streams (value stacking), it must be approved on a case-by-case basis by the distribution system operator.
2. If utilities are required to deviate from their legislatively-mandated obligation to deploy the least cost service option in order to use NWA to provide distribution system services, the financial evaluation metric should be based on the 'Least Cost NWA Available' or the 'Least Cost Renewably-Fueled ESS Available.'
3. Two factors should be considered when calculating the environmental benefits of using storage:
 1. Environmental benefits should not be applied to NWA usage of storage, since traditional distribution facilities create no emissions
 2. Downstate Illinois imports much of its energy, and the bulk of the emissions reductions will occur out of state

4. Storage compensation for acting as a NWA should be locational, and not static, due to changes in customer load requirements and incremental DER installed.
5. Storage valuation on the distribution grid should be scaled with the amount of customer load restored and the length of time that load can be supplied by the ESS.

The Clean Grid Alliance and the American Clean Power Association (“CGA/ACPA”) recommend two programs to successfully advance storage in Illinois:

1. In the near term, CGA/ACPA recommend a Market Accelerator Program. The Market Accelerator Program would get ‘steel in the ground’ for energy storage systems that provide value through short-term, one-time market acceleration incentives.
 - a. The Market Accelerator program would jump start battery storage, identify barriers, and highlight the state’s long-term needs.
 - b. Other states have market accelerator programs. For instance, New York provides rebates to off-set costs of new systems
 - c. These accelerator programs should be simple, develop a diverse array of projects, and use an open process to attract new market entrants
 - d. CGA/ACPA recommend that Illinois should offer an incentive to the initial 600 MW of newly installed battery storage placed in service in or before the end of 2026.
2. In the longer-term, CGA/ACPA recommend that Illinois should develop a Market Sustaining Program. The Market Sustaining Program may be designed to complement specific public policy goals through specific energy storage policies – such as reduction of greenhouse gases, avoidance or retirement of peaker plants, improve resilience and reliability, peak demand reduction, accelerating utility-scale renewable growth, accelerating the growth of distribution system generation, improving system reliability by providing ancillary services, and more. The longer-term storage development plan will capitalize on the experience gained from the Market Accelerator program. The Market Sustaining Program should support storage services that are under compensated/not compensated in other markets, such as resilience planning, procuring from non-fossil capacity resources, and discharging during peak times.

CGA/ACPA states that Illinois needs at least 6 GW of storage capacity by 2032 in order to replace generation retirements and to integrate more renewable energy. They note that the MISO queue for projects in Illinois already has over 1 GW of standalone energy storage and 1.7 GW of hybrids (mostly solar-plus-storage) and the PJM queue

contains over 3 GW of energy storage for Illinois. CGA/ACPA point to New York, Connecticut, and Maine with storage targets that are 15-20% of their state or utilities' peak demand by 2030. CGA/ACPA state that Illinois has nearly 4 GW of announced or planned retirements from 2022 to 2030 and that CEJA's clean energy targets will ramp up renewable energy production in Illinois. Together, these capacity retirements and additions of renewable resources will significantly increase the value of deploying energy storage capacity for resource adequacy.

CGA/ACPA states that it takes time, effort, and capital to develop larger-scale battery storage projects in MISO and PJM. By waiting to even begin setting longer-term targets, the State could be delaying by several years the benefits identified. Longer-term storage targets encourage the investment and competition that will provide lower prices for consumers. The timeline and resources provided to prepare this draft report was insufficient to perform the benefit-cost analysis and system modeling necessary to set storage targets. Therefore, CGA/ACPA recommends a follow-up analysis by the ICC Staff and/or IPA that identifies the amount of storage needed in Illinois by 2032, consistent with the buildout of in-state clean energy generation expected to deliver a reliable, resilient, and zero-carbon electric grid by 2045. The analysis would identify potential 2032 and interim targets for different project types as directed by Public Act 102-0662, and appropriate program budgets that could deploy storage to achieve those targets. The analysis should be adequately funded to produce a useful system model, such as a production cost or capacity expansion model, and solicit the input of stakeholders to inform scenarios' design and modelling.

Enel supports the comments submitted by the Clean Grid Alliance that outline a two-pronged approach for the Market Acceleration and Market Sustaining Programs for storage. Enel would recommend that the Connected Solutions program in Massachusetts be included as an example of a Market Sustaining Program that Illinois should consider implementing to drive the deployment of storage. These types of programs could be developed and implemented within 2 years based on the information and best practices developed in other jurisdictions. Enel recommends following best practices that have been learned through the creation, implementation, and deployment of distributed storage programs in other states:

1. Allow for utility visibility and operational control;
2. Maximize ROI by aligning dispatch requirements with times of greatest ratepayer and reliability benefit (or policy goals); and
3. Only compensate for actual performance, while providing revenue certainty for performers.

V. Barriers to Realizing the Benefits of Energy Storage Systems

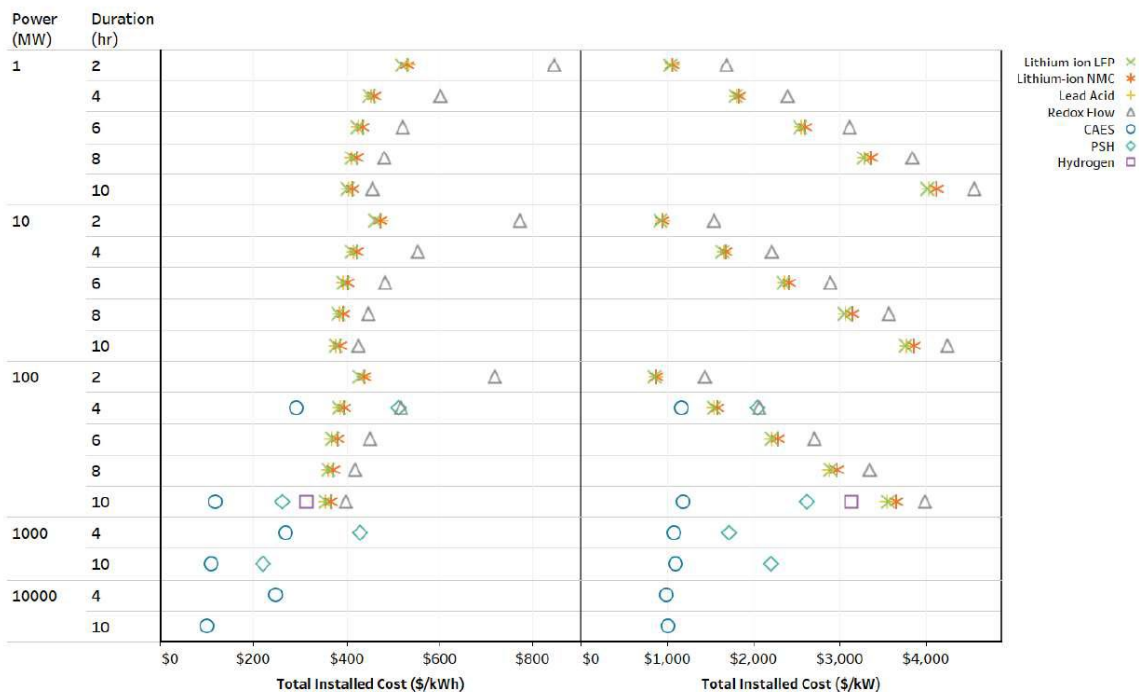
A. Cost

The initial costs of Energy Storage Systems (ESS) can appear high relative to comparable resource investments, as upfront capital costs account for most of an ESS's costs over its service life. Factors such as topography, climate, and overall size of the systems can contribute to the construction cost.

Maintenance and ongoing expenses for operational upkeep will also need to be considered in the ongoing costs. Initially, a manufacturer warranty can help reduce this expense. However, further support must be considered after the warranty period ends to avoid reducing service life of the system. Expenses such as cost per kilowatt hour are dependent on the type of ESS chosen and can vary.

Additionally, it is critical to note that energy storage systems are not generation – which is to say, their valuation is not based on maximizing output, as might be the case with renewable power generation. Rather, energy storage systems provide a limited amount of energy at specific times when it is most valuable. For this reason, their capacity is of significant value relative to their energy output, just as it can be for combustion turbines. Direct comparisons to other resources can be accomplished in a cost of capacity approach – such as in \$/kWh installed (or \$/KWh installed-year, to capture service life).

2020 ESS Cost Estimates by Power (MW), Duration (hr), and Technology Type



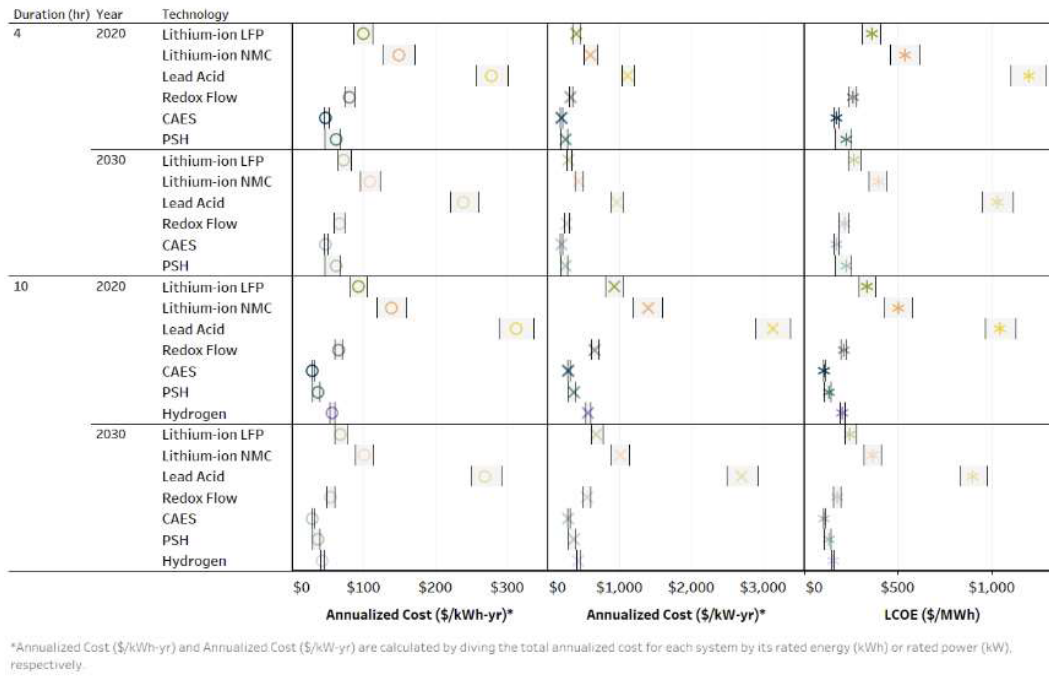
Since capacity does not capture every aspect of energy storage, there are also other means to compare costs. One alternative comparison is Levelized Cost of Energy (LCOE), in \$/MWh. LCOE calculates present value of the total costs and operating costs of an ESS over its assumed lifetime. The prices shown in the table above¹ reflect the lifetime costs (capital costs, operating costs, fuel cost, etc.) divided by the lifetime energy production (in MWh). Megawatt hours (MWh) is a widely used unit to describe capacity, energy consumption, and production. The monthly Illinois average household consumption is 0.721 MWh, which describes the monthly amount of energy that is supplied to each household either from power plant generation or discharged from storage systems. LCOE is not the cost consumers pay and is used as a cost estimate for investors.

The table below² shows comparative LCOE for technologies, which represent the breakeven price needed to produce 1 megawatt-hour every hour, per ESS, to pay off the ESS over its lifetime. LCOE takes present values of total building and operating costs. Note that comparative annualized capital costs are also presented for different technologies. As the technology advances, the costs are expected to be reduced.

¹ U.S. Department of Energy, “2020 Grid Energy Storage Technology Cost and Performance Assessment,” Executive Summary at viii, Figure ES-1 (Dec. 2020); available at: <https://www.pnnl.gov/sites/default/files/media/file/Final%20-%20ESGC%20Cost%20Performance%20Report%2012-11-2020.pdf>.

² U.S. Department of Energy, “2020 Grid Energy Storage Technology Cost and Performance Assessment,” Executive Summary at x, Figure ES-3 (Dec. 2020); available at: <https://www.pnnl.gov/sites/default/files/media/file/Final%20-%20ESGC%20Cost%20Performance%20Report%2012-11-2020.pdf>.

Annualized Cost and LCOE by Energy Storage Technology and Year, 100 MW (4-hr and 10-hr) Systems



KEY:

- Lithium-ion LFP: Lithium-ion lithium iron phosphate battery
- Lithium-ion NMC: Lithium-ion nickel manganese cobalt battery
- CAES: Compressed Air Energy Storage
- PSH: Pumped Storage Hydro

B. Safety

Lithium-ion batteries pose safety risks stemming from thermal runaway, in which a cell in a lithium-ion battery pack overheats and causes a chain reaction of other overheated cells, resulting in a fire or explosion. Lithium-ion batteries are high density which means there is a lot of energy packed into a small space. If a failure occurs, that energy could be released in the form of smoke, explosions, or fire. An example of a lithium-ion battery is a Tesla battery. The Tesla battery uses thousands of cells and, if one cell fails and propagates its failure, it can result in a much larger problem. With so many cells in the battery, it increases the chances of issues or failure.

Lithium-ion batteries can fail for many reasons: thermal abuse, electrical abuse, mechanical abuse, internal defects, and environmental abuse. Thermal abuse occurs when the battery is exposed to high heat from an external source. Electrical abuse is overcharging, rapid discharging, or unbalancing and is one of the main reasons for a battery failing. Mechanical abuse is dropping or hitting the battery. This can occur in the manufacturing space or during assembly. Internal defects are dendrites (short circuit and fire hazard), separator quality control (poor quality control can lead to terminals

contacting, another fire hazard), and other containments. Environmental abuse results from flooding, seismic activity, or absent or poorly designed HVAC (filtering problems and thermal regulation problems). Filtering problems can result in inefficiency in the system and poor air quality. Air flow may also be restricted and can cause thermal problems.

Any and all of these failures could lead to thermal runaway. Thermal runaway is the process in which self-heating occurs faster than heat can be dissipated, resulting in vaporized electrolyte, fire, or explosion. Even after there has been damage, the batteries may still contain energy inside of them, known as stranded energy. The size and location of the systems play a factor into safety. Flammable or toxic gases can be created as a result of thermal runaway. The gases created can be: Hydrogen Fluoride*, Hydrogen Sulfide*, Sulfur Dioxide*, Hydrogen Cyanide*, Hydrogen Chloride*, Carbon Monoxide*, Propylene, Methane, Hydrogen, Ethane, and Ethylene*.

*Marked gas compounds are severely dangerous in either high levels, or moderate levels with long term exposure. Non-marked compounds are relatively safe but should be kept within specified levels.

Sodium-sulfur batteries are another battery type that pose safety risks. Sodium-sulfur batteries must be kept at a temperature between approximately 300 to 350 degrees Celsius, which poses a safety risk and requires systems that can tolerate a very high temperature.

C. Regulation

Regulated or managed markets such as wholesale energy markets do not always provide a complete set of price signals that compensate energy storage systems for the benefits they produce, which may create uncertainty regarding cost recovery. For example, energy storage systems may be a viable substitute for electric transmission facilities, but may, under the current transmission compensation structure, not be compensated in the same manner or to the same extent when they provide functionality comparable to transmission facilities.

When energy storage systems are permitted to be compensated for the electric transmission benefits they provide, they may be limited to receiving only compensation related to the transmission benefits even in cases where the energy storage systems have the potential to additionally provide non-transmission benefits. This prevents such systems from capturing revenues they can, for example, earn by transacting in energy markets during periods when their transmission functionality is not needed and they have excess capacity.

When energy storage systems are permitted to both serve as transmission assets and participate in energy markets, it may not always be clear as to when and how the

assets will participate and recover their costs. For example, participation in energy markets by a storage asset may subject energy storage assets to unplanned recalls when a transmission need arises and subject the asset to penalties for failing to deliver on energy market commitments.

D. Measurement and Verification

If energy storage system providers are compensated for the manner in which they operate and the consequent value such operations provide, it may be necessary to measure and verify performance. Additional metering and telemetry required to perform measurement and verification has the potential to increase the cost of deploying and operating an energy storage system and be a disincentive to investment in such systems.

E. Duration

Storage devices are limited in how much energy they can store at a given time. Most energy storage systems struggle to provide consistent power over the course of a day. If storage devices are paired with renewable generation sources, long periods without sun or wind could limit those resources' capacity to recharge. Furthermore, given that some storage options such as batteries degrade over time, the ability of storage assets to provide power over longer stretches of time remains a concern. For some ESS, like rail storage, the duration can be increased through regenerative braking, or increasing the length of the slope used in rail storage, but that entails increased costs.

There are persistent questions about how large storage facilities need to be in order to reliably serve customer needs, particularly during a multi-day event such as a polar vortex. Issues arise when consumers tend to be at home such as weekends on holidays, and in situations when more consumers work from home. With these circumstances the demand may fluctuate, thus causing the peak demand periods to be extended.

F. Market Failures

Environmental externalities can create market failures when, for example, entities emitting pollutants do not consider the costs that their emissions impose on other people or entities. Energy storage systems have the potential to charge during periods of low electrical system demand and discharge during periods of high system demand. This can reduce the need for and use of fossil fuel electric generation facilities that are generally used infrequently during times of high system demand and that emit pollutants.

It can allow such “peaker” generation to be replaced by redirecting non-emitting clean energy produced by renewable facilities that generate only intermittently. If market prices do not reflect environmental externalities, then storage resources will not receive compensation for their environmental benefits.

G. Interconnection

Interconnection delays and/or costs can increase the cost of deploying and operating an energy storage system and be a disincentive to investment in such systems. In some cases these increases can be indirect to the extent that interconnection costs remain uncertain during and even up to the time that interconnection is complete.

H. Uncertainty of Benefits

Determining benefits associated with avoided or deferred transmission investments can be difficult. Transmission planning often involves long lead times, which can make it difficult to identify when storage deployment is reducing the need for transmission investments. Additionally, because transmission serves multiple load centers, it can be difficult to identify the exact impact that deploying storage in a load area has on particular transmission investments.

Determining benefits associated with avoided or deferred distribution investments poses different difficulties. The impact of storage on distribution may be localized requiring extremely granular and, therefore, onerous analysis (e.g., at the individual feeder level).

Regional Transmission Operator planning relies on power flow models to evaluate the transmission system’s ability to match generation to load in real time. The introduction of energy storage into the transmission system allows power flows to be redirected in one period to provide benefits to the system in a later period. Power flow modeling is complicated by, and may not be able to readily incorporate, the intertemporal component that energy storage system presents. This can make the value of energy storage systems to the transmission network uncertain.

Storage remains a fairly new technology. It is not yet clear how storage systems will be incorporated in RTO planning processes, especially considering FERC Order 2222 or developments around storage as a transmission only asset.

The Commission, with respect to other actual or potential benefits of deployment of energy storage systems besides avoided system investments, also recognizes that there is a considerable degree of uncertainty, for various reasons, including that there is no evidentiary record in this docket, ESS still is a fairly new technology, that there are uncertainties about demand, and that various benefits are untested or difficult to determine. The Commission notes that Commonwealth Edison and Ameren Illinois are engaged in certain current demonstration projects or development programs that are intended to generate more data on some (not all) of these subjects. These projects demonstrate energy storage system capabilities including grid-forming storage, peak shifting capacity deferral, and resiliency/reliability. However, until the Commission has much more robust information that has undergone scrutiny in the development of an evidentiary record, including information on the total costs of storage operation, it is very difficult for the Commission to make final decisions on what ESS deployments should be encouraged or incentivized, and what legal changes might be desirable, as well on what ESS deployment targets, if any, should be set.

VI. Programs That are Required or Possible Under Existing Authority

A. Overview

The webinar and workshop series conducted by the Commission, with the support provided by Sandia National Labs and Department of Energy, elicited a large amount of valuable information, and stakeholders provided feedback that serves as a critical foundation to the establishment of an Energy Storage Program in Illinois. As described above, participants have provided information on (1) myriad energy storage technologies; (2) the potential benefits of energy storage systems; (3) costs to build, deploy, and operate energy storage systems; (4) frameworks for performing cost-benefit analyses; and (5) barriers to the deployment and operation of energy storage systems, generally and in Illinois. The Commission greatly appreciates the time and effort of participants in this process and their valuable contributions.

The Commission also recognizes that, in addressing the subject of energy storage deployment options, including potential value streams and compensation, it must take into account not only Section 16-135 of the Act, but also other applicable provisions of the Act and of federal law. For example, the Federal Energy Regulatory Commission (“FERC”) regulates participation of energy storage in wholesale electric markets and is the regulator of electric transmission rates. See, e.g., “Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators”, 162 FERC ¶ 61,127 (final rule Feb. 15, 2018) (FERC Order No. 841) and 167 FERC ¶ 61,154 (order on rehearing and clarification May 16, 2019) (denying rehearing on Order No. 841’s lack of State opt-out for local electric storage resources but making certain modifications) (FERC Order No. 841-A), *aff’d*, National Assoc. of Regulatory Utility

Commissioners v. Federal Energy Regulatory Comm'n, 964 F.3d 1177 (D.C. Cir. 2020); 220 ILCS 5/16-108(a).

B. Energy Storage Programs Mandated by Public Act 102-0662

While potential new pilot programs are identified for consideration below, there are three storage programs already included within the provisions of P.A. 102-0662.

1. Utility-Scale Pilot Projects.

Pursuant to Section 8-218 of the Public Utilities Act, Ameren Illinois may propose, plan for, construct, install, control, own, manage, or operate, up to 2 pilot projects consisting of utility-scale photovoltaic energy generation facilities. The law permits Ameren Illinois to plan for, construct, install, control, own, manage, and operate, energy storage facilities in connection with the photovoltaic electricity generation pilot projects. The cost for this program can be up to \$40 million.

2. Coal to Solar and Energy Storage Initiative Grants.

Pursuant to Section 1-75(c-5) of the Illinois Power Agency Act ("IPA Act"), the Illinois Power Agency ("IPA") is required to procure renewable energy credits from new renewable energy facilities to be installed at or adjacent to the sites of electric generating facilities that, as of January 1, 2016, burned coal as their primary fuel source. During an initial procurement, the IPA will select projects from new renewable energy facilities of at least 20 megawatts but no more than 100 megawatts of electric generating capacity and energy storage facilities having a storage capacity equal to at least two megawatts and at most ten megawatts. The projects from this first procurement are to supply renewable energy credits aggregating to no fewer than 400,000 and no more than 580,000 renewable energy credits per year. During a second procurement, the IPA will select projects from new renewable energy facilities of at least five megawatts but no more than 20 megawatts of electric generating capacity and energy storage facilities having a storage capacity equal to at least 0.5 megawatts and at most one megawatt. The projects from this second procurement are to supply renewable energy credits aggregating to no more than the difference between 625,000 renewable energy credits per year and the number of renewable energy credits per year procured through the first procurement. The cost for this program can be up to \$375 million.

3. Coal to Solar and Energy Storage Initiative Renewable Energy Credits.

Pursuant to Section 1-75(c-5) of the IPA Act, the Department of Commerce and Economic Opportunity ("DCEO") will provide grants to support the installation of

energy storage facilities at the sites of up to three qualifying current or former coal-fired electric generating facilities located in the Midcontinent Independent System Operator, Inc. (“MISO”), region in Illinois and the sites of up to two qualifying electric generating facilities located in the PJM Interconnection, LLC (“PJM”) area. In each case, the proposed energy storage facility at the site will have energy storage capacity of at least 37 megawatts. The Department is authorized to utilize up to \$280.5 million for such grants.

It will be valuable to gain information from the deployment of these three energy storage programs in order to assess how the energy storage systems are being used, what services they are providing, what cost-savings or revenue they are securing, and identifying any obstacles or challenges to their deployment.

C. Staff Recommendation 1: Energy Storage Targets

Despite the substantial and useful information and feedback provided to the Commission, it does not appear that setting specific energy storage deployment targets for Illinois’ larger electric utilities is realistic at this time. Factors supporting this conclusion include the relative nascence of many storage technologies; the lack of direct operational experience with most of the burgeoning energy storage technologies by Illinois public utilities; and the lack of detailed cost and benefit information resulting from actual Illinois energy storage system deployment and operation experience. Establishing overall energy storage targets under such uncertain conditions risks over-deployment of energy storage resources in general; deployment of energy storage resources where they are not cost beneficial; increased costs to rate payers; introducing bias into technology selection; and generally providing adverse impacts to Illinois utility consumers and citizens. Establishing targets does not appear to be a reasonable policy to pursue at this stage in the process.

Despite these risks, the webinar and workshop process produced sufficient information to conclude that there are measurable net benefits to be realized from prudent deployment and operation of energy storage systems in several circumstances. Additionally, it is likely that energy storage systems will be necessary for the integration of renewable resources needed to meet the 100% clean energy requirements and decarbonization goals established by P.A. 102-0662.

After gaining more actual experience with energy storage system deployment, Illinois may be better positioned to quantify the benefits and costs of energy storage systems and to set deployment targets. There are existing and upcoming opportunities within the Commission’s authority to design policies, programs, and investments, as appropriate, to reduce barriers to obtaining the benefits of energy storage systems, which

may incent some energy storage system deployment. Leveraging existing authority may better position Illinois to quantify both the benefits and the costs of energy storage systems, and to better identify circumstances in which energy storage systems would be cost-beneficial. Additional pilot programs, as recommended below, will also allow Illinois to gain experience with deployment and operation of energy storage systems and to experiment and to learn from different energy storage policies and programs.

Several parties recommended that the Commission engage a technical consultant to, among other things, evaluate the future role of storage in Illinois relative to PJM and MISO; run a generation expansion optimization model and a production cost model that will calculate a range of front of the meter utility-scale resource additions that would optimally serve projected load; ensure reliable and resilient service; and meet state decarbonization targets and manage the analysis and collection of stakeholder input in this respect. The expertise of such a consultant will enable the Commission to properly model and evaluate Illinois' storage needs and benefits which will provide a proper foundation for setting specific energy storage deployment targets. The Commission agrees with this recommendation. If the General Assembly adopts this recommendation, the Commission requests that the General Assembly provide respective appropriation authority that will allow the Commission to pay for the study and consultant.

D. Staff Recommendation 2: Additional Opportunities to Explore Energy Storage Using Existing Authority

1. Energy Storage Paired with Electric Vehicle Chargers.

The Commission is directed by Section 16-107.6(e) of the PUA to open an independent, statewide investigation into the value of, and compensation for, distributed energy resources by no later than June 20, 2023. Pursuant to Section 16-107.6(a), distributed energy resources include energy storage systems. The Commission is required to establish an annual process and formula for the compensation of distributed generation and energy storage systems. The Commission is to ensure that compensation for distributed energy resources, including base rebates and any payments for additive services, reflects all reasonably known and measurable values of the distributed generation and energy storage systems over the full expected useful life of such systems. In performing this investigation, the Commission is required, among other items, to review the full value of the distributed energy resources and the manner in which each component of that value is or is not otherwise compensated. Another requirement is an assessment of how the value of distributed energy resources may evolve based on the present and future technological capabilities of distributed energy resources and present and future grid needs. The result of this investigation will be the development of a rebate

and other compensation mechanisms for distributed energy resources, including energy storage, that is paid by utilities to qualifying projects.

During the course of these Energy Storage Program workshops, the Commission also hosted a series of Beneficial Electrification workshops. The Beneficial Electrification workshops, which focused on electrification of the transportation sector, suggest that electrification of medium and heavy duty transportation fleets could have environmental benefits particularly for environmental justice communities where intermodal transportation hubs are located. Medium and heavy duty electric vehicle fleets may not be well suited in every instance, however, to charge only during off peak hours or during periods when renewable energy is abundant. Similarly, people traveling long distances for business or leisure and relying on public fast charging systems may not be in a position to delay charging until off peak hours. In such cases, energy storage systems paired with electric vehicle charging equipment may allow electric vehicles to charge during peak periods using energy inserted into storage during off-peak periods or periods when renewable energy production is abundant. Further, energy storage, when paired with EV charging, could be used to limit the amount of power capacity needed from the utility at any point in time, reducing the burden on the grid infrastructure. To support these types of projects to further beneficial electrification efforts, P.A. 102-0662 includes the development of an additional DER rebate value for distributed energy resources that are paired with or located in close proximity to beneficial electrification projects [220 ILCS 5/16-107.6(e)(6)]. As part of the investigation directed by Section 16-107.6(e), the Commission will evaluate the value of energy storage and other distributed energy resources that are supporting beneficial electrification projects, to be paid as part of the supplemental rebate value provided for under the statute. DER rebates and compensation developed using data provided as part of the utilities' Integrated Grid Plans could further be designed to support efforts to bring at least 40% of the benefits of grid modernization and clean energy to Equity Investment Eligible Communities, as required under Section 16-105.17(d)(3) of the PUA.

2. Multi-Year Integrated Grid Plans: Flexibility Programs.

Until such time as the Commission determines compensation for distributed generation and energy storage systems through its investigation, owners or operators of energy storage systems associated with distributed generation in Illinois are eligible to receive base distributed generation rebates at values prescribed by Section 16-107.6(c) of the PUA. The generation devices that are compensated for storage in exchange for this base rebate will be required to participate in one or more programs, determined through the Commission's Multi-Year Integrated Grid Planning process, that are designed to meet peak reduction and flexibility. Illinois' electric utilities, ComEd and Ameren Illinois, are required by Section 16-105.17 of the PUA to file Multi-Year Integrated Grid Plans as

part of a robust stakeholder process. Included in those plans are requirements around ensuring coordination of Illinois' renewable energy, climate, and environmental goals with the utility's distribution system investments facilitating the availability and development of distributed energy resources, enabling distributed energy resources to provide grid benefits and support grid services, conducting an evaluation of the short-term and long-run benefits and costs of distributed energy resources, and leveraging customer distributed energy resources to facilitate load flexibility, non-wires alternatives, and other solutions.

The development of the peak reduction and distribution system flexibility programs in the utilities' Multi-Year Integrated Grid Plan processes are intended to meet complementary objectives as those identified in the Energy Storage Program and can be an effective mechanism to reduce barriers to obtaining the benefits of energy storage systems. The Commission could evaluate the creation of such programs for each utility in the model consistent with the Bring-Your-Own-Device proposal presented in the workshops. A Bring-Your-Own-Device program creates a simple and predictable opportunity for customer-owned devices, including energy storage, smart thermostats, electric vehicles, and other controllable load, to provide peak reduction, load shifting, ramp (the ability to quickly increase or decrease generation), renewable integration, and transmission deferral services to the energy system. Peak reduction or capacity services can include a tiered load reduction program that operates during peak summer season and emergency events, allowing the utility to call on devices for greater load reduction as needed to achieve their peak reduction targets. Programs to incentivize load shifting, ramp, reduced renewable curtailment, and transmission deferral can include energy storage and other load-adjusting devices to reduce evening peaks and future load peaks that do not align with renewable energy production, and to shift load to times when renewable energy might otherwise be curtailed or away from times of high demand that might otherwise necessitate transmission build-out.

A Bring-Your-Own-Device Program could provide for direct participation by storage owners or operators or participation through aggregators for residential, institutional, commercial, and industrial customers. Direct control of distributed energy resources could, where otherwise not required by the programs associated with the base distributed energy resource rebates, remain with the system owner or aggregator provided that the operation consistent with program requirements can be reasonably verified. Program payments could be distributed to owners or operators or directly to an aggregator entity, either at the election of an individual participating customer, or via a direct services agreement between the utility and the aggregator (e.g., for a specific amount of capacity). Rates could be established under a standardized minimum fixed rate system for the duration of participation, subject to performance rules consistent with use

cases, punitive measures for non-performance, and payments for performance. Additionally, such a program could be designed so that customers are rewarded for deploying storage in combination with renewable distributed generation through reduced interconnection costs to the extent that storage deployment reduces utility interconnection costs. Flexibility Programs could further be designed to support efforts to bring at least 40% of the benefits of grid modernization and clean energy to Equity Investment Eligible Communities, as required under Section 16-105.17(d)(3) of the PUA.

3. Multi-Year Integrated Grid Plans: Non-wires Alternatives and other Third-Party Services.

Section 16-105.17(f)(2)(K) of the PUA includes the requirement that utilities' Multi-Year Integrated Grid Plans include the identification of potential cost-effective solutions from nontraditional and third-party owned investments that could meet anticipated grid needs, including, but not limited to, distributed energy resources procurement, tariffs or contracts, programmatic solutions, rate design options, technologies or programs that facilitate load flexibility, non-wires alternatives, and other solutions. Section 16-105.17(f)(2)(K) also requires the Commission to establish rules determining data or methods for Solution Sourcing Opportunities.

The Commission will evaluate the creation of non-wires alternatives for each utility as part of the utilities' plans. Such non-wires alternative opportunities would create a process wherein Ameren Illinois and ComEd each identify locations on their networks where the deployment of storage combined with an agreement on how to operate the storage system would prevent otherwise necessary short-term distribution grid investments. Requests for proposals could then be issued for projects meeting the sizing and operational needs of the utilities and the projects could be selected based upon bid prices in combination with the projects' abilities to meet identified needs and other selection criteria.

Examples of such Solution Sourcing Opportunities could include opportunities to avoid the need for distribution expansion, as well as to provide power quality services. For power quality, utilities could compensate customer-owned energy storage systems on select feeders for services provided to support local power quality, through the provision of reactive power support and enabling greater hosting capacity by serving as a local active power sink to prevent backfeed. Utilities would need to identify circuits on which a power quality issue existed or was expected to emerge, as well as designate feeders at or near hosting capacity limits. Payments would be provided based on performance as compensation that is additional to any compensation received from flexibility programs. Solution Sourcing Opportunities could further be designed to support

efforts to bring at least 40% of the benefits of grid modernization and clean energy to Equity Investment Eligible Communities, as required under Section 16-105.17(d)(3) of the PUA.

The Commission notes that Multi-Year Integrated Grid Plan and Beneficial Electrification proceedings have not yet been initiated and the Commission does not yet have the benefit of evidentiary records from those proceedings upon which it can make related determinations regarding potential energy storage systems. Therefore, while the Commission believes it is important to evaluate the programs above in such proceedings, the Commission is not adopting such programs or making determinations regarding their merit.

VII. Potential New Pilot Programs Requiring Legislative Action

The programs described above are each authorized or mandated by P.A. 102-0662. The programs proposed as part of pilots below are not. In many instances, or perhaps all of them, statutory authorization will be necessary to fully implement the programs. Even where arguably not strictly necessary, receiving statutory authority for such programs will avert legal challenges that may delay implementation of the programs and limit their ultimate use as informational pilots.

A. Benefits of Pilot Programs

The information gathered from pilot programs, both those identified above and those recommended below, will provide the Commission with information it needs to investigate the value of energy storage systems. The Commission is directed by Section 16-107.6(e) of the PUA to open an independent, statewide investigation into the value of, and compensation for, distributed energy resources by no later than June 20, 2023. Pursuant to Section 16-107.6(a), distributed energy resources include energy storage systems. In performing this investigation, the Commission is required, among other items, to review the full value of the distributed energy resources and the manner in which each component of that value is or is not otherwise compensated. The investigation must also include an assessment of how the value of distributed energy resources may evolve over time, based on the present and future technological capabilities of distributed energy resources and present and future grid needs. The Commission's investigation will benefit from the information that energy storage system pilots can provide.

The discussion here of pilot programs is not intended to exclude that demonstration projects also may be the best tool for developing some forms of information.

B. Ensuring Value from New Pilot Projects

To create programs of value, the pilot programs must be fully evaluated to identify resulting benefits and costs. While, as noted, there are many types of cost benefit analysis that could be employed for these tasks, there are three in particular that may provide important information to the Commission and Illinois policymakers. First, a total resource test comparable to that used for evaluation of energy efficiency programs in Illinois will assess the economic efficiency of such programs. Second, a cost-effectiveness test will evaluate whether the approach was the most cost-effective option for achieving the goal. Third, a ratepayer impact test will assess how such programs impact utility rates. When performing such tests, evaluators should strive to identify all benefits associated with the program and identify when particular program benefits are not quantifiable. If benefits are not quantifiable, the evaluators should either provide a judgment-based estimate of such benefits or explain how large such benefits would need to be in order to make a program that is otherwise not cost beneficial, under one or more cost benefit analyses, cost beneficial.

An important design element in any of the pilot programs described above will be the collection of verifiable program information tied to the premise of the pilot's design. Therefore, financial support under all of the pilot programs should be contingent on program participants providing verifiable operations information to program administrators. In some cases, utilities may be able to provide operations information based upon the information collected by their own systems (e.g., advanced metering infrastructure) and in other cases, such information might come from the participants' own equipment (e.g., smart inverters). Program participants should also provide verifiable information on compensation received by the projects, including wholesale revenue, which will inform future examinations of whether projects are compensated or not for each component of value they provide.

Pilot procurements should be designed so that systems are compensated based upon how they agree to operate, being mindful of not paying systems multiple times for particular beneficial operation. For example, adders for systems that currently receive RPS REC payments could be based upon an agreement by the system operators to supply energy during specified peak periods or other times of high demand or heightened system need. Thus, REC payments would be paid as they are now, but the system would receive additional compensation for delivering the energy from the system during specified time periods. The information presented in the workshop process indicates that the benefits energy storage systems produce rely critically on how the systems are operated. To ensure accurate estimates of the benefits of energy storage systems, it is critical that those systems are operated transparently according to program guidelines. This does not mean, however, that programs need to or should be overly complex in

design. To keep programs simple, it may be important to design the programs so that compensation is not explicitly tied to every facet of system operation. In such cases, the way the system is operated should nonetheless be reported and/or tracked. Such tracking will provide information on the extent to which simplified programs based upon limited operational requirements result in additional beneficial system operations.

Pilot programs should also be designed to incorporate as many of Illinois' public policy goals as is feasible, given budgetary and other operational considerations. For example, the programs should be designed so that programs provide benefits to all communities, ensuring that equity-eligible communities and equity-eligible persons explicitly benefit through local emissions reductions, improved resiliency, support for the achievement of decarbonization and renewable energy goals, generation of wealth and equity, increased economic development and job creation, and increased energy affordability. Pilots should also be technologically neutral and, by design, should also seek to evaluate different technologies with different operating capabilities, provided the systems meet the definition of an energy storage system contained in P.A. 102-0662.

Based upon the program proposals above, the pilot programs could be bifurcated for administrative purposes. Pilot programs involving program payments in addition to existing RPS program payments could be planned and administered by the IPA and program administrators hired by the IPA, subject to agreement by the IPA and existence of necessary resources. Non-RPS related programs could be administered by independent third-party contractors hired by Illinois' large electric utilities. Alternatively, some or all programs could be planned and administered by an independent administrator or administrative agency established through statute.

To avoid undermining existing programs such as the RPS program, the pilot programs could be funded through a new Energy Storage Program Charge to be recovered per kilowatt-hour from customers of Illinois' large electric utilities. Given the inherent uncertainty regarding whether pilot programs are cost beneficial, and concerns regarding utility service affordability, pilot programs could be funded through a capped charge on all utility customers. Caps could be set, for example as they are for other Illinois public policy programs, based upon the amount paid per kilowatt-hour by eligible retail customers during a specific period (e.g., the delivery year ending May 31, 2009). A rate cap will ensure program costs are limited. Additionally, the program could be designed such that low-income customers, as defined in Section 8-201.2 of the PUA, are not assessed such charges. This will eliminate affordability impacts on the most vulnerable utility-service customers.

To ensure transparent, independent evaluation, the programs could be evaluated by an independent evaluator comparable to how utility energy efficiency program evaluations are currently performed in Illinois. Evaluation costs could, also similar to how

utility energy efficiency programs are structured, be limited and paid for from the pilot program charge recoveries.

C. Staff Recommendation 3: Potential Additional Pilot Programs

Included below is a list of potential pilot programs and related policies and procedures to support them.

1. *A program that provides compensation for energy storage systems that are built and operated in conjunction with existing or new utility-scale renewable energy facilities funded through the Illinois Renewable Portfolio Standard (“RPS”).*

This program could compensate participants for supplying the energy associated with renewable energy credits to the grid during specified time intervals, rather than only when the renewable energy facilities are generating. This could be accomplished through providing participants a payment, in addition to existing renewable energy credit payments, based upon how the combined system operates. There are several potential benefits that adding energy storage systems to utility-scale renewable deployments could produce. Energy storage systems might allow utility-scale storage systems to better supply energy to the grid during times of peak need, while also reducing the need for fossil-fueled, peaker-plant generation. Not only can energy storage systems used in this capacity reduce greenhouse gas and other pollutant emissions, energy storage systems used in this way may also provide grid reliability benefits similar to those currently provided by peaker plants. If long-term energy storage systems are deployed in the pilot, they may also demonstrate grid resiliency benefits. Projects could be selected from RPS-supported facilities, through a competitive procurement process with the potential for multiple procurements for projects meeting various other Illinois policy goals including, but not limited to, projects that provide benefits to equity investment eligible communities and to equity eligible persons.

2. *A program that provides compensation for energy storage systems that are built and operated in conjunction with existing or new distributed generation and/or community solar renewable energy facilities currently supported through the RPS.*

Again, this program could compensate participants for supplying the energy associated with renewable energy credits during specified time intervals rather than only when the renewable energy facilities are generating. This could be accomplished through providing a payment in addition to existing renewable energy credit payments. As with deployment in conjunction with utility-scale

renewables, energy storage systems deployed in conjunction with distributed generation or community solar renewable generation will allow such renewable generation to deliver energy to the distribution system during system peaks or other identified times to meet Illinois grid needs and other policy goals. Benefits of employing energy storage systems in this manner could include environmental, reliability, and resiliency benefits. Deployment of such projects could also result in the avoidance or deferral of distribution system investments. Similar to the Adjustable Block Program,³ this model could include a transparent and pre-determined schedule of offered prices and requested quantities. The program could be comprised of multiple quantity blocks based upon Illinois policy goals, such as blocks for community solar projects, blocks for distributed generation projects, blocks for projects that serve low-income participants, and blocks that may meet other Illinois policy goals such as serving equity investment eligible communities and equity eligible persons.

3. *A program wherein Ameren Illinois and ComEd, working in conjunction with their respective Regional Transmission Organizations (PJM and MISO), each identify locations where the deployment of storage combined with an agreement on how to operate the storage system would prevent otherwise necessary short-term transmission system investments.*

Requests for proposals could then be issued for projects meeting the sizing and operational needs of the utilities and the RTOs. The projects could be selected based upon bid prices in combination with the projects' abilities to meet identified needs and other selection criteria.

4. *A program wherein Ameren Illinois and ComEd, working in conjunction with their respective Regional Transmission Organizations (PJM and MISO), each identify locations where the deployment of storage could meet ancillary service needs and provide for cleaner and/or more cost-effective operation of the electric grid.*

Requests for proposals could then be issued for projects meeting the sizing and operational needs of the utilities and RTOs. The projects could be selected

³ The Adjustable Block Program, established in FEJA and modified in CEJA, is a program for solar distributed generation and community solar projects that sets the REC prices in advance. It features standard block REC prices where each block constitutes a quantity of nameplate capacity with a REC price attached to that block. When a block is fully subscribed by qualifying projects, projects may then qualify for the next block (which features a different price).

based upon bid prices in combination with the projects' abilities to meet identified needs and other selection criteria.

5. *A program that works to support community resiliency efforts, and is focused on identifying and serving the needs of customers to help them achieve their objectives and address their energy vulnerabilities.*

First, community planning support and technical assistance should be provided to communities and communities organizations to perform thorough Community Energy, Climate, and Jobs Plans as provided for under CEJA. Second, those community plans would make them eligible for energy storage funding in order to address community needs, as determined through the Community Plans.

6. *A program in which the electric utilities, working with PJM and MISO, identify points on their transmission grids in Illinois at which installation of utility-scale energy storage systems would be necessary or beneficial to support grid reliability, stability, and operability.*

This program would seek to identify locations on the utilities' transmission grids for installation of utility-scale energy storage systems and may include locations of legacy dispatchable generating units which have recently retired or are scheduled to retire, and therefore may require replacement by dispatchable resources to maintain reliability, stability, and operability of the transmission network. Competitive, price-based bidding events could be conducted to select qualified third parties to install and operate utility-scale storage systems at those locations. This program may benefit from incentives being provided to qualified projects.

7. *A Market Accelerator Incentive Program to jumpstart ESS deployment in Illinois with a onetime incentive payment.*

Structured as a simple, open process to attract a diverse array of new market entrants, this program can capitalize on the current market signals by offering a one-time incentive based on total installed capacity. (If \$/kW is used, duration should be specified, such as \$/kW-month or \$/kW-year.) It can be made available on "first-come first-serve" basis to the first 600 MW of applicants who meet minimum criteria of project viability. The program could be targeted for newly installed battery storage placed in service before the end of 2026 and not

participating in energy storage programs mandated by P.A. 102-0662. The incentive could be amortized and paid over multiple years.

8. Community Solar Paired with Storage Interconnection Study

Community solar paired with storage potentially faces unique barriers when interconnecting to the grid. An independent study that focuses on the entirety of the interconnection process for a community solar project paired with storage could further inform the Commission and stakeholders about the unique challenges and opportunities of this combination. Such an analysis to identify barriers to the deployment of storage paired with existing and new community solar may help incent a diverse set of ESS throughout the state. It would be beneficial for the Commission to engage an independent and experienced consultant to collect, analyze, and report to the Commission, the relevant data related to such a study. Because the Commission's existing budget does not include costs for engaging such a consultant, the Commission asks that the General Assembly provide the respective appropriation authority for the Commission's costs of hiring such an expert consultant.

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