January 2020 PNNL-29591 / SAND2020-0161 R

Southeastern Energy Storage Symposium and Workshop

Report on Proceedings and Lessons Learned

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for the Office of Electricity

Funded by the Energy Storage Systems Program of the U.S. Department of Energy
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operated by
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for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

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Southeastern Energy Storage Symposium and Workshop

Report on Proceedings and Lessons Learned

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December 2019

Prepared for
U.S. Department of Energy, Contract DE-AC05-76RL01830

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Acknowledgements

This report and the event described herein were both funded by the U.S. Department of Energy – Office of Electricity's Energy Storage Program, under the direction of Dr. Imre Gyuk.

The authors also wish to acknowledge the invaluable role of Southern Research in making this event possible, including assisting in its planning and providing the venue and logistical support.

Executive Summary

On July 17-18, 2019, the U.S. Department of Energy (DOE), Sandia National Laboratories (SNL), Pacific Northwest National Laboratory (PNNL), and Southern Research (SR) conducted the Southeastern Energy Storage Symposium and Workshop, a two-day event on energy storage technologies in Birmingham, AL. The first day of the event (Symposium) was open to all interested parties; the second day (Workshop) was open only to employees of state energy regulatory agencies. The event was conducted as part of the Energy Storage Program within the DOE's Office of Electricity.

One of the missions of the Energy Storage Program is to reduce institutional and regulatory hurdles faced by energy storage. State regulatory agencies, which are charged with applying regulations and reviewing utility resource investments, are a key audience for this work. Because regulatory agencies are designed to be reactionary in nature – responding to utility filings and implementing state policies – they generally have limited resources and mechanisms for investigating new technologies and developing policies to accommodate them. One of the goals of the Energy Storage Program is to objectively inform regulatory proceedings and assist regulators in identifying the role of energy storage in accordance with state energy policies.

Face-to-face interaction with state regulators serves two important functions for the Energy Storage Program: sharing program research to inform regulatory proceedings, and learning about the energy storage-related challenges that regulators face. In 2017, the Energy Storage Program hosted a workshop for state regulatory staff from the Western U.S. in Salt Lake City, UT. Lessons learned from that event informed the design of the Birmingham event.

The Symposium featured three keynote presentations and six panel discussions addressing various aspects of energy storage. The Workshop featured an interactive discussion with participants about the specific challenges they face as they incorporate energy storage into their proceedings and seven presentations from laboratory personnel focused on energy storage technologies through a regulatory lens.

The Workshop's discussion section revealed several thematic trends associated with the growth of energy storage technologies:

- Early energy storage acquisitions are blurring the lines between traditional resource planning and resource procurement, which complicates regulatory oversight;
- Regulators need more guidance from state policymakers about how storage fits into state energy policies;
- Corporate and municipal demand is becoming a significant driver for energy storage; and
- Emerging applications for energy storage, such as transmission and resilience, may create new opportunities, but regulatory innovation will be needed to enable storage contributions.

State regulators also identified several specific technical challenges that limit the deployment of energy storage in the near term, which they are actively working to resolve. Some examples of the complex regulatory matters discussed were successful pilot program design, applicability of state energy resource

certification requirements to energy storage, coordinating state and regional planning processes, and the role of storage in decarbonization plans.

In a discussion at the end of the Workshop and in an online survey circulated afterward, participants were asked for their feedback on the event. Feedback in both settings was generally positive. In the in-person discussion, attendees said the event made them feel better prepared to address energy storage in their work. They also provided constructive criticism, saying that the agenda across the two days was too dense and that more practical examples of energy storage deployments would be helpful.

At the end of the Workshop, organizers asked for suggestions about useful regulatory research that the Energy Storage Program could perform in the future. Responses focused on the role of energy storage when paired with solar PV, because participants said that based on resource needs and developing trends, most of the energy storage projects developed in the Southeastern U.S. will likely be co-located with solar. But how the operational characteristics and applications for energy storage change when tied to solar are not yet clear, they added, and additional research to illuminate those issues would be helpful.

Asked the same question in the survey, respondents echoed the interest in solar plus storage research and also suggested more investigation of storage policy options for vertically integrated states, detailed explanation and demonstration of options to value energy storage in resource planning processes, and development of a methodology for creating state incentives for energy storage.

The overarching takeaway from the event is that the energy storage industry has reached a major point of inflection. Even in states that have no incentives or policies in place for energy storage, and varying interest in decarbonization, utilities are beginning to competitively select storage in their resource portfolios and propose projects to regulators for rate base. Regulators, in turn, are working to understand how utilities reached their conclusions and how storage can be incorporated into state policies. As more energy storage projects are proposed and built, a new generation of specific regulatory challenges that energy storage faces are coming into focus.

Based on the lessons learned from the Southeastern Energy Storage Symposium and Workshop, the Energy Storage Program should consider the following program delivery recommendations:

1. Equitable Regulatory Environment program activities should expand to accommodate emerging business models and regulatory demands;

2. Face-to-face, interactive events organized regionally for the benefit of states should remain a key component of the Energy Storage Program; and

3. Energy Storage Program staff should identify research gaps related to the operational characteristics and applications of solar plus storage resources.

Acronyms and Abbreviations

CAES	Compressed Air Energy Storage
CAISO	California Independent System Operator
DER	Distributed Energy Resource
DOE	Department of Energy
FERC	Federal Energy Regulatory Commission
GW	Gigawatt
IRP	Integrated Resource Plan
MISO	Midcontinent Independent System Operator
ORNL	Oak Ridge National Laboratory
PNNL	Pacific Northwest National Laboratory
PSH	Pumped Storage Hydropower
SNL	Sandia National Laboratories
SR	Southern Research
WPTO	Water Power Technologies Office

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1.0 Background and Introduction

In 2013, DOE issued a report, "Grid Energy Storage," which identified several barriers to deployment of energy storage systems and presented a four-pronged strategy for addressing them. To implement that strategy, DOE's Office of Electricity operates the Energy Storage Program, which funds research at the national laboratories and universities, and partners with states and utilities to deploy and analyze energy storage projects. The Energy Storage Program is divided into four thrust areas based on the strategy described in the 2013 report (DOE 2013):

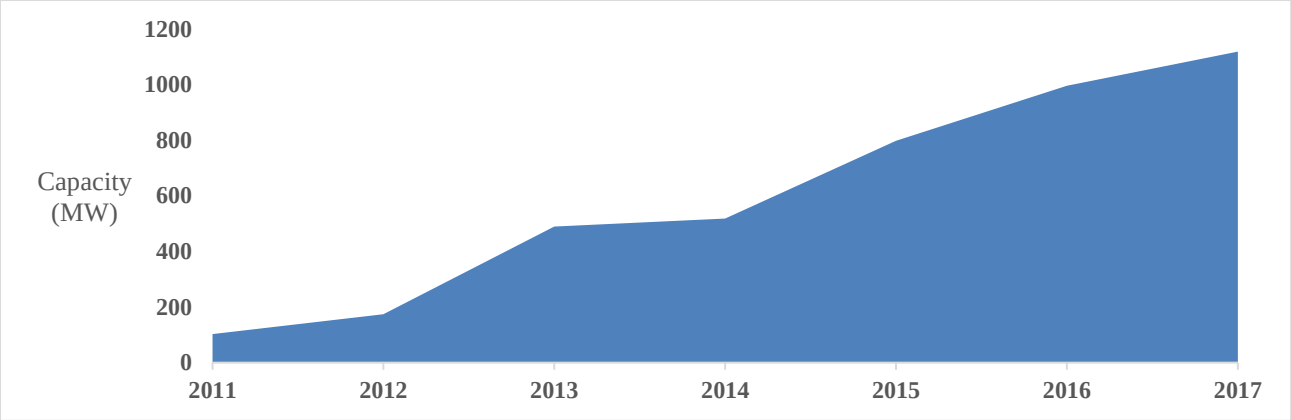
1. Cost-Competitive Energy Storage Technology;
2. Validated Safety and Reliability;
3. Equitable Regulatory Environment; and
4. Industry Acceptance.

The mission of the Equitable Regulatory Environment thrust area is to "reduc(e) institutional and regulatory hurdles" for energy storage technologies "to levels comparable with those of other grid resources" (*id.*). Because state utility commissions review utility plans and approve investments for cost recovery, they act as a gatekeeper for developing and applying regulations governing the construction and usage of storage assets, and are therefore a key audience.[1]

Due to their unique operational flexibility and relative novelty, energy storage assets do not fit neatly into existing regulatory and resource planning practices. As a result, several states have endeavored in recent years to update regulations and policies to better accommodate energy storage technologies (PNNL 2019). Through the Equitable Regulatory Environment thrust area, one of the missions of the Energy Storage Program is to share its research to educate decisionmakers and inform those proceedings.

Rapid growth of energy storage technologies in recent years has increased the need for this work. Pumped storage hydro (PSH) is the predominant source of energy storage in the U.S., accounting for approximately 24.5 gigawatts (GW) of the country's total installed 26 GW (or 94 percent) of energy storage (DOE and SNL 2019). But as Figure 1 demonstrates, other forms of energy storage, primarily batteries, have experienced rapid growth in recent years:

[1] The amount of oversight state utility regulators exercise over utility planning and investment depends on the state's regulatory structure. In vertically integrated states, in which a utility owns generation, transmission and distribution assets, state regulators have broad authority over resource planning and investment decisions. In deregulated states, where generation, transmission and distribution assets are owned by separate entities, state regulators may only regulate planning and investment on the distribution system.



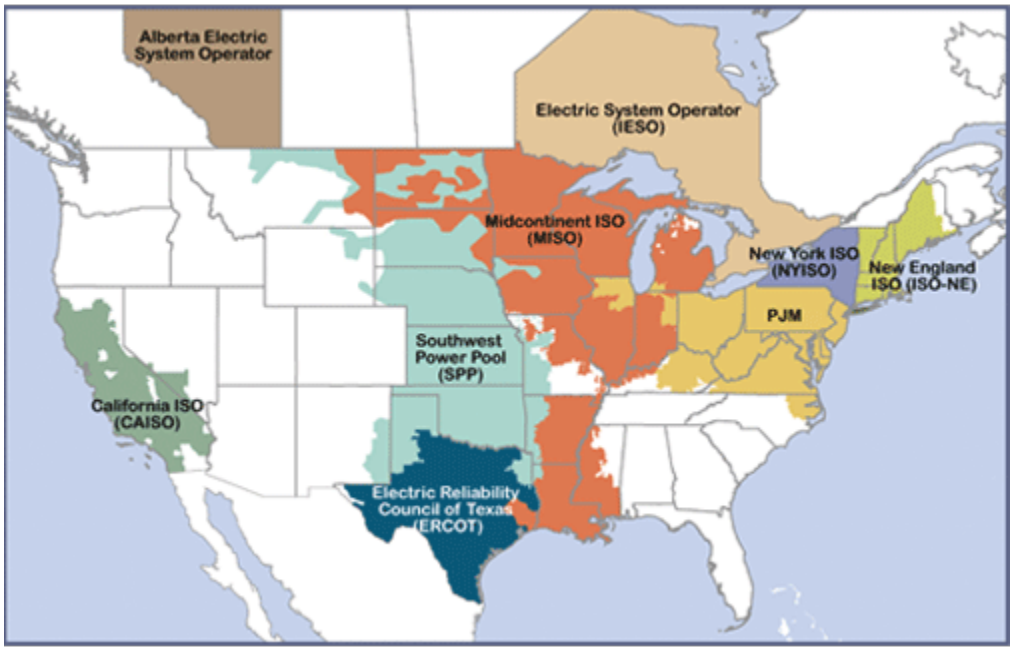
DOE and SNL 2019

Figure 1: Cumulative Non-PHS Energy Storage Deployments in the U.S., 2011-2018

To assist states in navigating the opportunities and challenges raised by the rapid growth of the energy storage industry, the Energy Storage Program hosted a workshop for state regulatory staff from the western U.S. in Salt Lake City, UT in 2017. Representatives from 10 states attended the one-day workshop, which had two purposes: to share program research and experience with regulatory staff, and to get feedback from staff about the specific storage-related challenges they were facing in their proceedings and how the Energy Storage Program might direct its efforts to inform those challenges. Event organizers captured four key lessons from that event:

1. Regulators are keenly interested in learning about the practical implications of energy storage on the work they do;
2. Participants want more content from the Energy Storage Program;
3. Regulators highly value the ability to network with counterparts in other states; and
4. Involving participants earlier in the planning process may improve participation and outcomes (Twitchell 2019).

With that feedback, the national laboratories targeted the southeastern U.S. for a second workshop. The emphasis on the southeastern U.S. was strategic, as like the western U.S., it largely consists of vertically integrated states that do not participate in an organized regional energy market, as shown in Figure 2:



FERC 2019

Figure 2: Map of U.S. Regional Energy Markets

In a vertically integrated state, an individual utility is responsible for all grid functions – generation, transmission, and distribution. In a regional market, the market operator is responsible for the generation and transmission functions, while utilities (often called load-serving entities in regional markets) are only responsible for electric distribution.

Recent policy developments have made this an important distinction where energy storage is concerned. The Federal Energy Regulatory Commission (FERC), which regulates the structure of regional markets, directed market operators in 2018 with Order 841 to develop tariffs that recognize the unique capabilities and characteristics of energy storage technologies (FERC 2018). While FERC's order has prompted collective action within each regional market to identify the barriers that energy storage faces in generation markets and take steps to address them, vertically integrated states are essentially on their own in navigating this complex, technical issue. And even in reorganized states, state regulators have the responsibility for regulating storage projects connected to the distribution system, which is not subject to regional markets and FERC regulation. Because state regulatory commissions are generally bound by statutes and longstanding precedence that require approval of the least-cost resource option, new technologies generally face complicated regulatory proceedings before they can be approved (Monast and Adair 2013).

State utility commissions, however, are designed to be reactionary in nature, with core functions of responding to utility filings and implementing state policies. As a result, most commissions have limited resources and mechanisms to proactively investigate and develop policies for new technologies. By understanding and conducting research into the unique informational needs of state regulatory commissions, the Energy Storage Program can objectively inform regulators and facilitate the resolution of state proceedings related to energy storage. These efforts are critical to achieving the Equitable Regulatory Environment task goal of reducing regulatory barriers to energy storage.

Partnerships are a key component of the Energy Storage Program, and were invaluable in the planning and delivery of the Southeastern Energy Storage Symposium and Workshop. Though the Energy Storage Program has existing partnerships with researchers and utilities in the region, it had not directly engaged with southeastern U.S. state regulators before this event. By partnering with Southern Research, an independent research agency that receives funding through the Energy Storage Program, laboratory personnel were able to access existing professional networks and approach state regulators with the partnership and support of a trusted regional entity. The National Association of Regulatory Utility Commissioners (NARUC), the national organization of state utility commissions, was also a valuable partner in the process.

The remainder of this report will discuss the Southeastern Energy Storage Symposium and Workshop and the lessons learned from the event. Section 2 summarizes the event itself and the presentations given, while Section 3 focuses on an interactive discussion with state regulators on the second day that provided important insights into the specific challenges faced by states as they work to integrate energy storage into the regulatory process. Section 4 summarizes the feedback received from event attendees, and Section 5 presents conclusions and recommendations for future Energy Storage Program research and outreach.

2.0 Event Summary

The Southeastern Energy Storage Symposium and Workshop was a two-day event conducted on July 17-18, 2019, in Birmingham, AL. Day one of the event (Symposium) was open to all interested parties and drew more than 100 participants representing regulatory agencies, utilities, universities, consulting firms, and project developers. Day two of the event (Workshop) was open only to employees of state regulatory agencies and drew 25 regulators representing nine states. Appendix A contains agendas for both days, while Appendix B contains a roster of state attendees.

From the Energy Storage Program's perspective, the event had two goals. The first was to share program research with regulators, utilities and other parties to inform regulatory proceedings related to energy storage. The second was to hear from regulators about the specific challenges they have encountered in those proceedings to inform and shape the work of the Equitable Regulatory Environment thrust area.

Speakers for the event came from national laboratories, utilities, regulatory bodies, universities, and consulting firms. This section will briefly summarize the information presented each day.

2.1 Day One: Symposium

The Symposium featured a full agenda of presentations and panel discussions on multiple energy storage topics. Because the Symposium featured three keynote addresses and six panel discussions involving 20 industry professionals, this report will not discuss each participant's contribution. Rather, it will present key topics and themes that emerged across the day's presentations.

Storage is more than batteries

In an opening keynote and welcome on behalf of DOE, Alejandro Moreno, Director of the Water Power Technologies Office (WPTO) at DOE, reminded the audience that while batteries have seen rapid growth in recent years, PSH still represents more than 94 percent of energy storage capacity in the U.S. Rather than viewing the two as competing technologies, however, Moreno said they should be viewed as complementary. Batteries offer downward scalability that enables them to address local flexibility needs, while PSH offers an upward scalability that allows it to address bulk power flexibility needs.

Several utility speakers echoed the theme. Jeff Burleson, Senior Vice President of Environmental & System Planning at Southern Company, said in a morning keynote that the utility's current need is for relatively short-duration (2 hours or fewer) storage devices, which suggests that batteries are likely the best fit for near-term storage needs. But as the resource mix continues to move toward variable renewable resources, Southern will continue to analyze PSH and compressed air energy storage (CAES) for meeting longer-duration flexibility needs, he said. Similarly, a panel of utility experts said that while lithium-ion batteries offer a lot of potential, lingering concerns related to recyclability, flammability, and mining practices are driving strong utility interest in technology diversification, with flow batteries a topic of particular interest.

From the regulatory sector, Commissioner Tim Echols of the Georgia Public Service Commission cautioned against "regulatory infatuation" with energy storage. Noting that lithium-ion batteries have created high expectations in the electric industry, Echols repeated the challenges mentioned on the utility

panel – recyclability, flammability, and mining practices – and cautioned that over-reliance on lithium-ion before those challenges are fully understood could result in drawbacks later on.

Drivers for storage are evolving

Renewables integration is one of the most commonly cited uses for energy storage, and the southeastern U.S. is no exception. Several utility speakers noted that pairing storage with planned and existing solar facilities is one of the primary drivers for storage in the region. Representatives from Florida Power & Light, which earlier in the year announced one of the largest solar plus storage facilities to date in the U.S. as part of a plan to replace aging natural gas generators,[1] indicated that they were considering additional solar plus storage investments to meet future capacity needs. In Georgia, regulators had just approved Georgia Power's integrated resource plan (IRP), which included planned investments in energy storage to integrate new renewables and replace retiring coal plants.

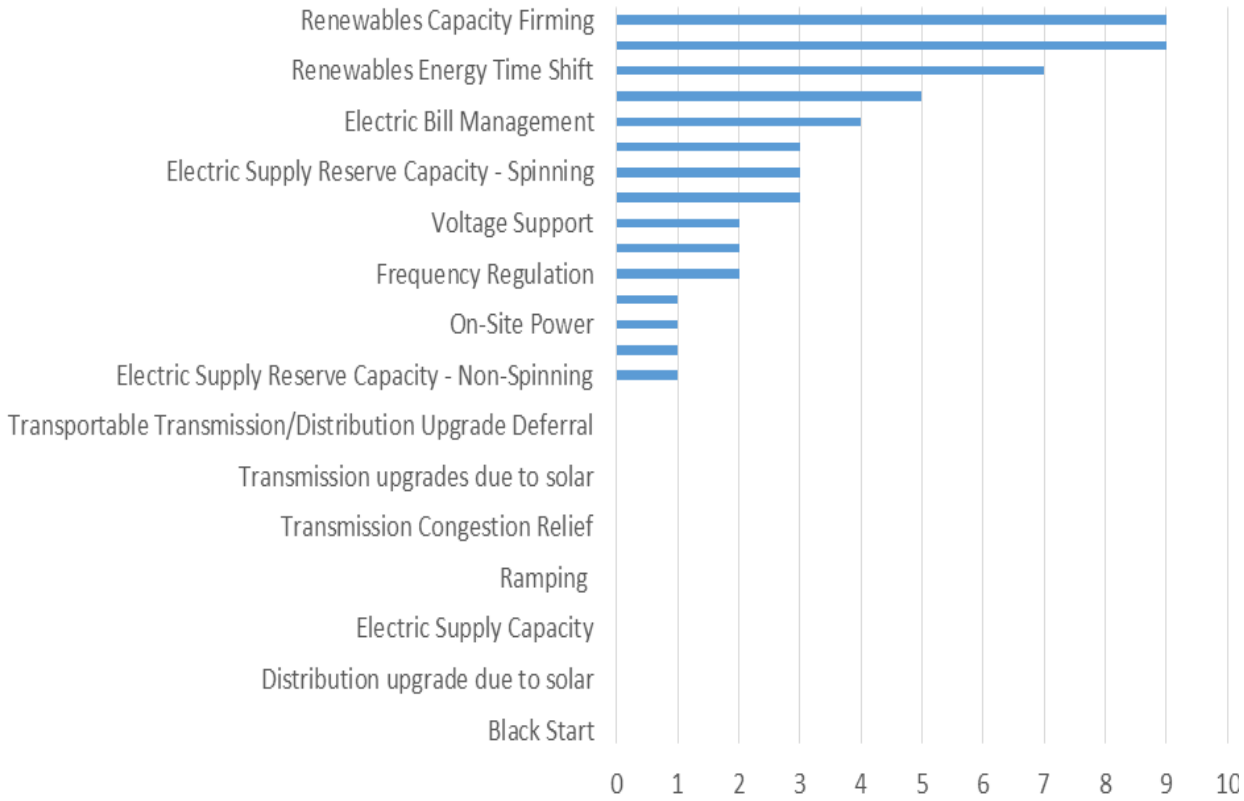
But as storage technologies continue to develop and costs continue to come down, several speakers noted that additional applications are becoming cost-effective. On a panel contrasting front-of-meter and behind-the-meter applications and challenges, Jessica Harrison, Director of Research and Development at the Midcontinent Independent System Operator (MISO), discussed an ongoing initiative at MISO to incorporate energy storage into the transmission planning process and to develop regulations that would allow energy storage to serve as a dual use (transmission and generation) asset.

Additional discussions focused on applications associated with distribution-connected storage. Participants in the utility panel discussed a renewed focus on distribution system planning and identifying opportunities to defer or displace distribution infrastructure investments with storage. Members of other panels also discussed the secondary use of vehicle batteries for distribution applications, and improving grid resilience by strategically placing storage to back up critical loads.

Properly valuing storage requires sophisticated modeling

One of the most commonly recurring themes throughout the two-day event was how the unique capabilities of energy storage cannot be captured by traditional resource planning tools, and that more granular modeling tools are needed to accurately value storage and compare it to other resource options. In his morning keynote, Alejandro Moreno of DOE shared a graphic demonstrating all the applications that energy storage projects in the Southeast have been built to serve, with the caveat that since many services are mutually exclusive, optimization of energy storage assets requires models capable of considering all of those values and their tradeoffs (Fig. 3).

[1] See reference to Manatee decommissioning proposal in Appendix C.



DOE and SNL 2019

Figure 3: Use Cases for Energy Storage Projects in the Southeastern U.S.

Accurate valuation of energy storage, Moreno continued to explain, requires a model that not only accounts for all the services that storage can provide, but one that also considers the technological characteristics of storage. Each type of storage, whether PSH, a lithium-ion battery, a flow battery, or something else – performs differently, and an important component of a model's accuracy is its ability to capture those characteristics.

On a subsequent panel exploring valuation, Ben Kaun, Energy Storage Program Manager at the Electric Power Research Institute, explained that traditional resource planning tools are not designed to consider such complex resource types. To assist utilities, regulators, and developers to better understand the benefits of energy storage, EPRI created a publicly available analytical tool capable of such analysis called StorageVET.

Energy storage policy development involves multiple angles

While valuation challenges were a focal point of the conversations at the event, other panelists and presenters discussed other aspects of energy storage policy development. Utility presenters raised complex questions of ownership, federal regulators discussed interconnection standards, and engineers from various entities discussed codes and safety.

Regarding ownership, utility panelists noted that the legal structures of most utilities that serve the Southeast – multi-state utilities grouped under a common holding company – raises complex questions. Should storage assets be owned by the holding company, or by load-serving utilities? In deregulated

regions, should storage be a regulated transmission asset, a competitive generation asset, or a regulated distribution asset? What regulatory changes would be necessary to allow a single storage device to serve multiple functions? Panelists said their utilities were developing multi-pronged approaches for deploying storage at multiple levels and for multiple purposes, and working with regulators to develop cost recovery processes.

On interconnection practices, representatives from FERC and the North American Electric Reliability Corporation (NERC) discussed the practical considerations for interconnecting energy storage devices and lessons learned from deploying projects in the field. They also discussed the interconnection standard adopted in IEEE 1547 and the flexibility it offers utilities and regulators to deploy storage in ways that will address grid needs in accordance with state policies.

On codes and safety, engineers from SR, national laboratories, and CSA Group discussed recent, high-profile battery fires and stressed that as policymakers consider approaches for facilitating energy storage deployments, it is important that they also ensure that electrical, fire, and other safety codes are up to date.

2.2 Day Two: Workshop

As stated in Section 1, the role that state regulatory commissions serve in developing and applying energy regulations makes them a key audience for the Energy Storage Program, and objectively informing regulatory proceedings related to storage is a key task of the Equitable Regulatory Environment thrust area. To ensure that the event met the unique informational needs of regulators, the workshop on day two was limited to state regulatory commissioners and staff, and presentations were provided by national lab personnel familiar with regulatory processes.

A large share of the workshop (90 minutes) was devoted to a facilitated discussion among attendees about the specific storage-related issues that have been raised in each state. Because the lessons learned in that session are of significant strategic interest for the Energy Storage Program, outcomes of the State Discussion are the focus of Section 3.

Lab personnel from SNL, PNNL, and Oak Ridge National Laboratory (ORNL) gave seven presentations on energy storage topics from a regulatory perspective. This subsection will briefly summarize each presentation.

DOE Energy Storage Program Introduction – Michael Starke, ORNL

Speaking on behalf of DOE, Michael Starke welcomed workshop participants and provided a brief overview of the Energy Storage Program. He summarized the program's mission as "Reducing cost while quantifying the entire value stream." By approaching the question of energy storage from both sides – developing safe, low-cost storage technologies while providing technical and analytical support to ensure that the benefits of those technologies are understood – the program seeks to ensure that energy storage becomes a viable option in building a flexible and efficient grid.

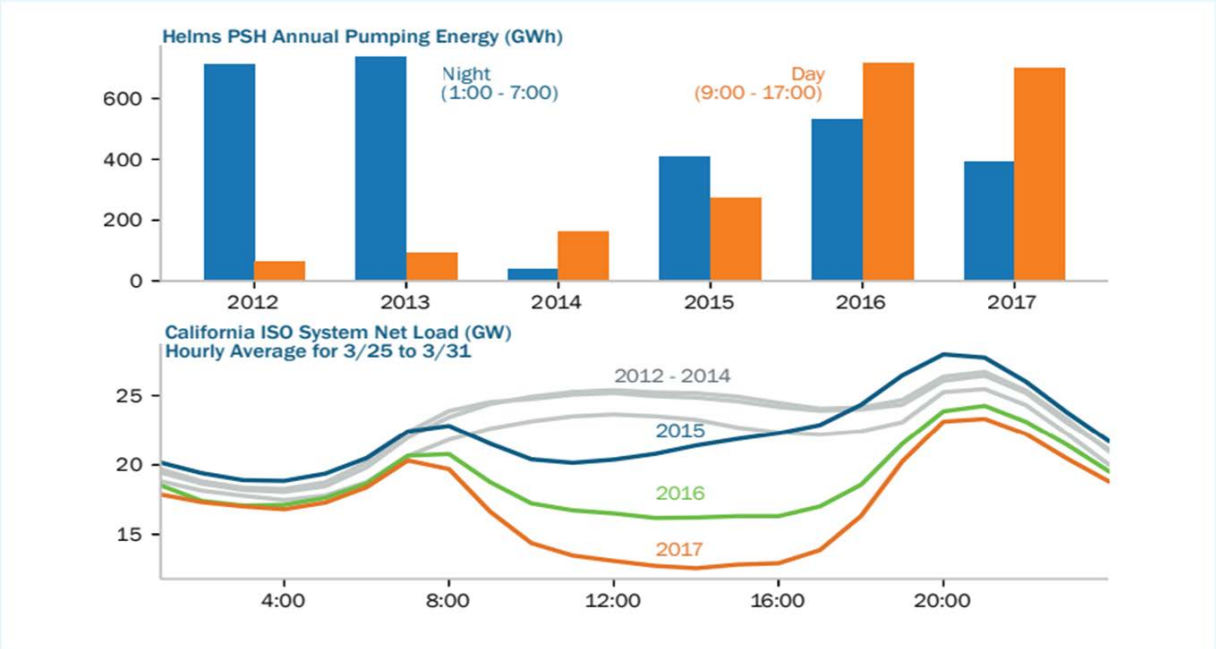
Overview of Energy Storage Technologies – Ben Schenkman, SNL

To establish a technical foundation for the day, Ben Schenkman provided an overview of various energy storage technologies. He discussed PSH, CAES, flywheels and various battery chemistries, sharing the

characteristics and principal grid applications of each technology. He also briefly discussed current Energy Storage Program research efforts to develop flow batteries and metal-air batteries, and concluded with a review of battery cost trends.

Pumped Storage Hydropower – Rebecca O'Neil, PNNL, and Alejandro Moreno, DOE

Given the presence of several large PSH facilities in the Southeast and legislation in Virginia promoting the development of PSH facilities,[1] workshop organizers dedicated a session specifically to PSH. In a joint presentation, Rebecca O'Neil of PNNL and Alejandro Moreno of DOE explained that as the amount of variable generation on the grid has increased, the operations of existing PSH facilities has evolved from the traditional, daily cycling model to a more dynamic model to help integrate renewables and balance the grid throughout the day, as demonstrated in Figure 4:



DOE 2018

Figure 4: Annual pumping energy consumption at Helms PSH facility (top) versus CAISO net load (bottom).

As grid flexibility needs continue to grow, O'Neil and Moreno explained that WPTO's focus is on ensuring that the flexibility of PSH is understood and properly valued, that technology innovation for PSH follows where its future value will be, and on addressing the practical challenges associated with developing and expanding PSH projects.

Energy Storage Valuation: Principles and Lessons Learned from the Field – Patrick Balducci, PNNL

Sharing lessons learned from economic analyses conducted on 14 projects, Patrick Balducci of PNNL explained the various grid services that energy storage is capable of providing. He also explained that while storage can do many things, the selection of a particular service comes with opportunity costs in the

[1] Virginia General Assembly, HB 2747 (2017).

form of all the other services that weren't selected, as well as those that won't be available while the device recharges. To study those tradeoffs, PNNL developed the Battery Storage Evaluation Tool.

Across all of the projects studied, Balducci concluded, the primary lesson that emerged was the relationship between usage and performance. How a battery is used has significant impacts on its performance in both the short and long terms. A battery discharged at its maximum rated output, for example, would provide less energy per cycle than an identical battery discharged at a lower level. Over time, the battery discharged at maximum output would also experience more rapid degradation and have a shorter useful life. Understanding those relationships and developing models that capture them is an active area of research and the next step in refining the valuation of energy storage technologies.

Maximizing Storage Value in Regional Markets and the QuESt Tool – Alex Headley, SNL

Because of the varying structures of the nation's regional energy markets, the value of energy storage can change significantly from one market to another. To identify the value of energy storage under those different market structures, SNL developed the QuESt tool. Alex Headley of SNL presented the tool and a case study of how it was used to help inform a proceeding in New York to establish a value-based compensation structure for distributed energy resources (DERs). By using the QuESt model to quantify the market revenues that DERs could earn under different tariff options, SNL was able to inform the discussion and identify the optimal size and type of DERs under different circumstances.

Energy Storage and Grid Resilience – Vanessa Vargas, SNL

One of the most promising emerging use cases for energy storage is resilience, but as Vanessa Vargas of SNL explained in her presentation, resilience remains a complicated subject. Where reliability is a well-defined concept supported by tangible standards, resilience has neither an agreed-upon definition nor supporting standards. Absent those standards, metrics and planning objectives are difficult to develop. Vargas said that SNL is working to develop performance-based resilience metrics, and added that any conversation about resilience metrics must recognize that while major grid interruptions are low-probability events, they have severe consequences (Fig. 5).

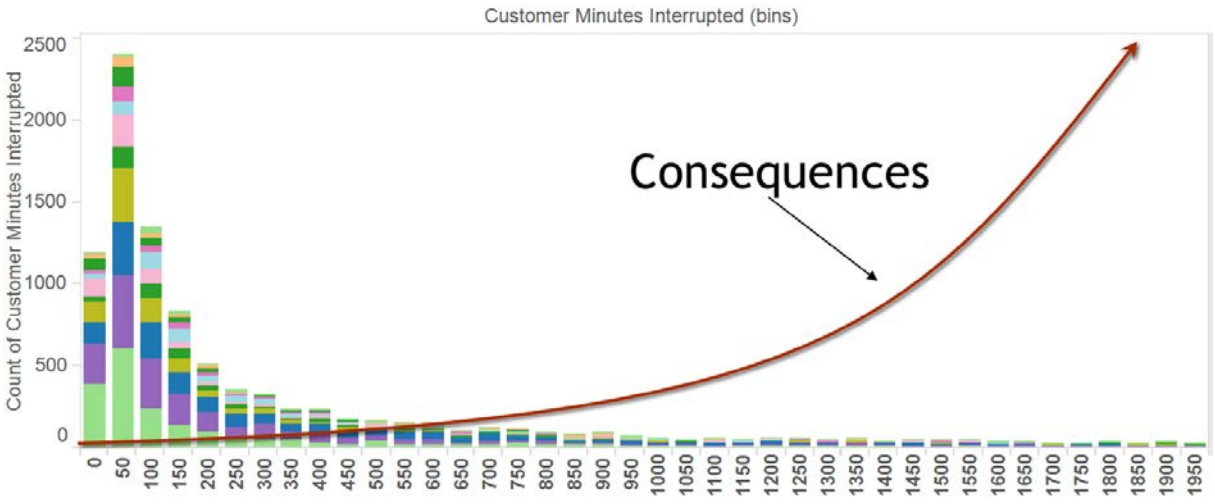


Figure 5: Histogram of Customer Interruption Events, by Duration

Emerging Policies and Planning Practices for Energy Storage – Jeremy Twitchell, PNNL

As was stated several times throughout both days of the event, traditional resource planning tools and regulatory models are not designed to value the unique characteristics of energy storage resources. Jeremy Twitchell of PNNL shared examples of the various policies that states have implemented to adapt their processes to include energy storage and emerging practices in resource planning to better value energy storage. He shared recent research at PNNL finding that as utilities include more energy storage services in their models, they are more likely to select energy storage as part of a cost-effective resource portfolio.

3.0 State Discussion

Following the Workshop introductions and welcomes, organizers set aside 90 minutes for a facilitated discussion among participants about the energy storage-related issues they are facing in their respective states. This discussion was a focal point of the event, as it was the primary avenue for learning about the specific types of barriers that the Equitable Regulatory Environment area should address in its research efforts.

The discussion also helped attendees to identify their counterparts in neighboring states and facilitated the development of professional regional networks that can maintain ongoing discussion. The previous workshop in Salt Lake City included a similar interactive discussion, and it was the most highly rated portion of the event by participants. One of the key findings in the report on the Salt Lake City event was that "Regulators highly value the ability to network with counterparts in other states," and that facilitated networking should be a prominent component of future workshops (Twitchell 2019). In Birmingham, the state discussion was the Workshop's longest session.

In the state discussion, a representative from each state provided a brief overview of the role that energy storage is playing in current proceedings and the specific challenges that it has raised. Attendees were encouraged to ask questions of one another, with Rebecca O'Neil of PNNL facilitating the discussion. To help frame the discussion, organizers prepared a memo detailing storage-related regulatory developments and dockets in all of the participating states. The memo, which has been updated based on feedback obtained in the discussion, is included in Appendix C.

Across the presentations, the unifying theme was that energy storage has reached a significant point of inflection. Where the discussion at the Salt Lake City workshop in 2017 largely focused on legislative mandates or regulatory proceedings to establish guidelines for how utilities should be treating energy storage, most of the states represented at the Birmingham workshop are in a position in which utilities are approaching regulators with proposals to acquire energy storage. This is noteworthy, because as demonstrated on PNNL's Energy Storage Policy Database, most of the states in the workshop don't have top-down energy storage policies in place. Rather, the technology has advanced to a point at which utilities are selecting energy storage through competitive analytical processes and proposing projects to their regulators, which has raised a diverse array of questions and challenges.

The following section breaks down the lessons learned during the discussion into two broad groups: themes, and technical challenges. Themes refer to trends and the broader regulatory questions raised by energy storage that can generally inform Energy Storage Program research areas. Technical challenges refer to specific matters of practice that present immediate obstacles to energy storage deployment, and may be considered for more direct investigation by the Energy Storage Program.

3.1 Themes

The rapid rise of energy storage's profile in the southeastern U.S. can be attributed to multiple driving forces, and it raises big questions about longstanding regulatory practices. This subsection will identify and briefly explore four of those themes.

Energy storage is not well represented the respective roles of traditional resource planning and acquisition process. Traditionally, utilities have identified resource needs and determined how to fill them through an IRP or similar process. These planning processes provide documentation showing that the utility considered various options and selected the most cost-effective portfolio for meeting future needs. The plans serve an important regulatory function in allowing regulators to follow the process and determine whether the utility's resulting decisions were prudent – a necessary determination before utility investments can be recovered from ratepayers.

In the case of energy storage, however, that process is becoming strained. Representatives from three states mentioned receiving proposals from utilities for storage projects that had not been identified through a traditional planning process, and how this lack of a planning predicate created difficulties for commission staff to review the proposal and make a recommendation to their commissioners.

This challenge is not unique to these states. As with any new energy technology for which benefits and capabilities are not yet understood, utilities tend to explore them through pilot projects to inform subsequent planning processes. In a recent paper funded by the Energy Storage Program, for example, researchers reviewed IRPs from around the country to see whether utilities are adjusting planning processes to better value energy storage. One of the team's findings was that of the 21 utility plans reviewed, 12 indicated plans for an energy storage pilot project – including several utilities that either had not studied energy storage in the IRP or had studied it, but found it to not be cost effective (Cooke 2019).

Regulators need more policy guidance. Most state utility commissions are established under legislative or executive authority, and are structured to be reactionary in nature, responding to utility requests and implementing legislative direction. As such, they generally lack the resources and authority to proactively investigate new resources such as energy storage and set policy on their own motion.

Representatives from multiple states noted that their commissions felt a need for more specific policy guidance on the role of energy storage in their state. Even in some states where the legislature had passed energy storage legislation, regulators said more practical guidance is still needed.

One attendee who had previous experience working in a state legislature explained that most legislators are not really aware of the detailed nature of the work that public utility commissions do. The individual encouraged participants to work with their commissioners to reach out to legislators to educate them about the utility commission and communicate their needs.

Corporate demand is becoming a significant driver for storage. While most states in the southeastern U.S. region do not have renewable energy requirements for their load serving utilities, some participants said that large corporate customers have emerged as major source of demand for clean energy. Research by the National Renewable Energy Laboratory found that to meet all of the adopted clean energy goals by municipalities, corporations, and educational institutions in the southeastern U.S., the region would need to build at least 2,000 MW of additional solar PV, and depending on how some municipal goals are interpreted (i.e., whether a municipal clean energy goal applies only to municipal facilities or to all load within the municipality), possibly as much as 13,900 MW of additional solar (Heeter 2019).

Attendees suggested that as those goals are pursued, they will also create a demand for energy storage to integrate the new resources. For example, one participant noted that Duke Kentucky's most recent IRP

specifically identified customer renewable energy goals as a driving force in its selection of solar plus storage resources.

Emerging applications may create new markets for energy storage, but challenges remain. As discussed in the valuation section above, energy storage valuation at present usually consists of analyzing several "smaller" services that storage can provide and identifying the optimal mix of them. The conversation touched on high-value applications that energy storage could potentially provide in the future, but attendees noted that regulations are not yet in place for storage to readily provide this service and be compensated. Three such applications were discussed: capacity, transmission, and resilience.

On the question of capacity, several state representatives noted pending retirements of large fossil fuel generators and the potential role of solar plus storage in replacing the lost capacity. In Arkansas, commission staff said four major coal plants are scheduled for retirement beginning in 2028, so significant capacity resources will need to be added before then. In Florida, commission staff discussed a recent proceeding that resulted in the selection of a large solar plus storage acquisition to replace a retiring gas plant.

But in some states, there is still uncertainty about how such projects should be operated, and whether they can feasibly provide firm capacity. Participants from Georgia said there is an active debate in the state between developers and utilities regarding the operation of solar plus storage assets, specifically regarding how much of the battery's charge must come from the attached solar, and how the battery component would be dispatched. Staff from the Georgia Public Service Commission suggested that it may help to stop thinking of solar plus storage as a subset of solar, and redefine solar and storage hybrid facilities as a new asset class with its own operational characteristics.

The second potential application discussed was transmission. As noted above, MISO has an ongoing proceeding to incorporate energy storage into the transmission planning process. But it is a complicated matter; the California Independent System Operator (CAISO) suspended a similar proceeding earlier this year when it identified several foundational issues that needed to be addressed first.

Attendees acknowledged the regulatory challenges associated with reconfiguring transmission planning and operational procedures to accommodate energy storage, but also said that strong drivers for non-wires transmission resources justify the effort. In New Jersey, storage is being studied as a means of reducing transmission needs for planned offshore wind developments. In Georgia, public opposition to new transmission lines has parties looking for "non-wires" alternatives. In Alabama, transmission system bottlenecks are already limiting the use of existing wind facilities, and storage has been identified as a potential means of alleviating those constraints.

The third and final application discussed was resilience. As noted above, the absence of standards and metrics prevents a resource from being compensated for the resilience that it provides. Participants acknowledged that developing a whole framework for measuring and compensating resilience is a daunting challenge, but suggested that in the meantime, viewing resilience through the lens of avoided costs may be enough. For example, stronger hurricanes in recent years have prompted several Atlantic Coast states to begin placing distribution infrastructure underground, in an effort to harden the system against major disruptions. With the high costs associated with undergrounding infrastructure, some participants suggested that storage may be a lower-cost means of meeting resilience goals in some situations.

3.2 Specific Challenges

Regardless of why energy storage is deployed, participants raised several immediate issues that slow its adoption, which must be addressed before widespread usage will be possible. These challenges are not necessarily universal; some may only apply to a small subset of states. But they are instructive in scoping the range of issues with which regulators are currently wrestling and informing Equitable Regulatory Environment research and outreach efforts. This subsection will briefly present the technical challenges that participants discussed.

Pilot program design. As an increasing number of utilities move to create energy storage pilot programs, some commission staff members expressed concern that those programs do not always have a clear mechanism for studying the various applications of storage and incorporating those lessons into the resource planning process. In some states, utilities are not required to receive authorization for pilot projects, which limits the visibility that regulators have into program design and outcomes.

At the other end of the spectrum, representatives from the Maryland Public Service Commission described a robust pilot program for which the state is beginning implementation. Program design was informed by an extensive stakeholder process at the commission and codified in legislation. The program defines four different ownership models for storage, and requires utilities to pick two of them for exploration. The program will run for three years, after which each utility will be required to file detailed reports with the commission.[1]

Generation certificates. Many states require new electric generation resources to obtain a Certificate of Public Convenience and Necessity (CPCN) or similar authorization. Such certificates are a regulatory tool used to review proposed public utility facilities and determine whether they are in the public interest before they are constructed. Energy storage is not a generator, but since it injects electricity to the grid, it is unclear in some states whether CPCN requirements apply, and regulators are uncertain about how they would handle storage proposals as a result. Additionally, some states exempt small renewable generation facilities from the process, and there is some uncertainty regarding whether such exemptions also apply to energy storage, whether it is attached to a small renewable facility or built as a standalone project.

Taxation. When regulators are setting utility rates, a large part of the process involves applying the appropriate taxes to the utility's assets and building them into rates. Due to the intricacies of state and federal tax codes, this is a complex process of identifying which resource types are taxed at which rates and making sure that those rates are correctly reflected in the revenue model. It is often unclear how common tax incentives given to certain types of resources, such as transmission facilities or renewable energy generators, apply to energy storage when it is used for those purposes.

Market coordination. For states that participate in regional markets, coordinating state planning efforts with regional planning efforts can be difficult. Representatives from Arkansas, for example, said that the interconnection queue for MISO indicates several storage projects that are being proposed in Arkansas. But state regulators have limited visibility into that queue, and the lack of information about who is proposing the storage projects and how they will be used introduces uncertainty into state-regulated resource planning.

[1] See the Maryland state discussion in Appendix C for more detail.

Identifying ratepayer benefits. Workshop participants from Georgia said their commission is particularly interested in understanding how energy storage projects can be used to reduce system costs in general and benefit customers in particular. While the values of energy storage are becoming clearer in general, Georgia staff said it would be helpful to have more clarity around which of those benefits flow to customers and how projects can be designed to harness those benefits.

Implementing legislation. When state legislatures act on energy storage, they generally leave the implementation details to regulators. In most states where a legislature has adopted or authorized a procurement target, for example, regulators were tasked with determining the size of the target and designing a program and rules for reaching it. Such is the case in New Jersey, which recently adopted procurement targets of 600 MW by 2021 and 2,000 MW by 2030. Determining what types of storage systems should be pursued and how they should be used, particularly on a tight timeline, is a difficult undertaking for staff at the New Jersey Board of Public Utilities.

Carbon reduction. In some states, energy storage has been targeted as a tool for reducing carbon emissions in the electricity sector. The degree to which it can do so, however, has been a point of debate and lingering uncertainty in the industry. A study done to guide implementation of the New Jersey legislation, for example, found that storage alone had limited ability to reduce emissions. But the conclusion was based on a fairly static assumption about how storage would be used, and staff from New Jersey said additional information about how storage operated in a more dynamic fashion could be used in support of the state's decarbonization goals would be helpful.

4.0 Participant Feedback

Feedback from workshop attendees provides an important review on Energy Storage Program activities in general and the Equitable Regulatory Environment task in particular. Understanding what regulatory staff did or did not find helpful and what additional information they would like to receive in the future provides valuable insights into regulatory needs and how Energy Storage Program efforts can be tailored to meet the unique needs of this important group. Participants were given two ways to provide feedback – an informal discussion at the end of the workshop, and a formal survey circulated after the event. This section will summarize the findings of each.

4.1 In-person Feedback

At the end of the workshop, organizers asked participants for immediate feedback on the two-day event. In general, participants expressed appreciation for the event and indicated that they felt more prepared to deal with storage-related issues in their work. When asked for constructive criticism, three themes emerged in the discussion: the density of the event's agenda, a desire for more case studies from the Energy Storage Program, and suggestions for future program research.

Agenda density. The first point that participants made was that the agenda had too much content packed into it and had some duplication, particularly on the topic of valuation. Attendees also said they would have liked to have more networking breaks. The agenda for the Symposium on the first day included three keynote addresses and six panel discussions, totaling 8.5 hours of content offset by one, 30-minute lunch break and two, 15-minute coffee breaks. The agenda for the Workshop on the second day included 7 hours of presentations offset by three, 15-minute breaks.

More case studies would be helpful. While attendees expressed appreciation for the information presented and the valuation lessons that were shared, some said that most of the information was still theoretical or based on pilot projects. Some participants said that more practical examples of lessons learned from storage deployed on a competitive basis would be more helpful. Examples of a utility proposing energy storage because it was identified as the most economical option – and details about how the utility came to that conclusion – would be particularly useful, they said.

Suggestions for future program research. When asked for suggestions about useful research that the Energy Storage Program could do in the future, all the responses revolved around the topic of solar plus storage. In Arkansas, a member of a utility co-op recently constructed the first solar plus storage project in the state for the primary use of reducing its peak demand (and therefore reducing its capacity and transmission payments to the co-op). Attendees from the Arkansas Public Service Commission said it would be helpful to have independent study of this use case to model the benefits and evaluate the potential for other co-op members (and utilities participating in regional markets) to do the same thing.

Another participant said that most of the Energy Storage Program's work appears to evaluate energy storage on a standalone basis, but explained that storage deployments in the southeastern U.S. are most likely going to be coupled with solar. Research into the use cases and operational characteristics of such projects would be more helpful to regulators in that region, the participant said.

4.2 Survey

Event organizers composed a 10-question, online survey that was sent to Workshop participants two weeks after the event, followed by two reminder emails. Six of 25 participants (24 percent) responded. A complete summary of survey responses is provided in Appendix D.

Because the Symposium and Workshop were aimed at different audiences and structured differently, the survey asked respondents to independently rate each day. Responses were generally positive for both days, but slightly more favorable for the Workshop than the Symposium. Three participants rated the Workshop "Excellent" and three rated it "Very Good." For the Symposium, one rated it "Excellent," two rated it "Very Good," and three rated it "Good."

Question two asked participants to rate each day in terms of how relevant it was to their work as regulators. Responses were evenly divided for the Symposium, with three saying it was "Highly Relevant" and three saying it was "Relevant." For the Workshop, five said it was "Highly Relevant" and one said it was "Relevant."

Another pair of questions asked participants to think about both days together and then rate the total amount of time devoted to each topic and the quality of the information presented on each topic. As shown in Figures 6 and 7, a majority of respondents said that each topic received the appropriate amount of time and that the right kind of information was presented:

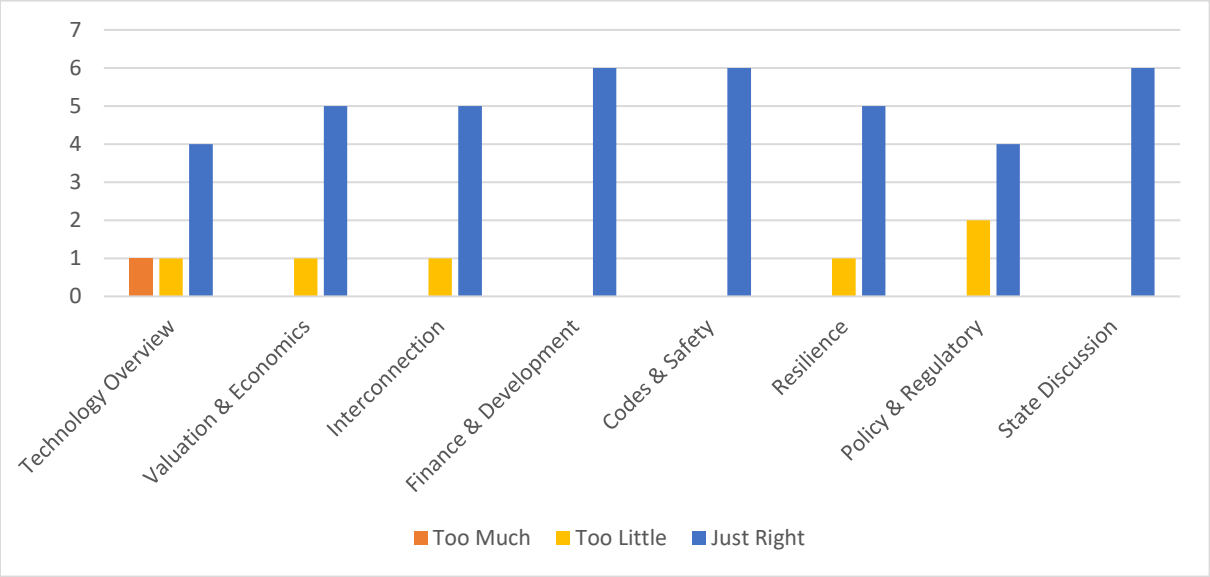


Figure 6: Responses to the Prompt, "Across the Two Days, Please Rate the Total Amount of Time Dedicated to the Following Topics."

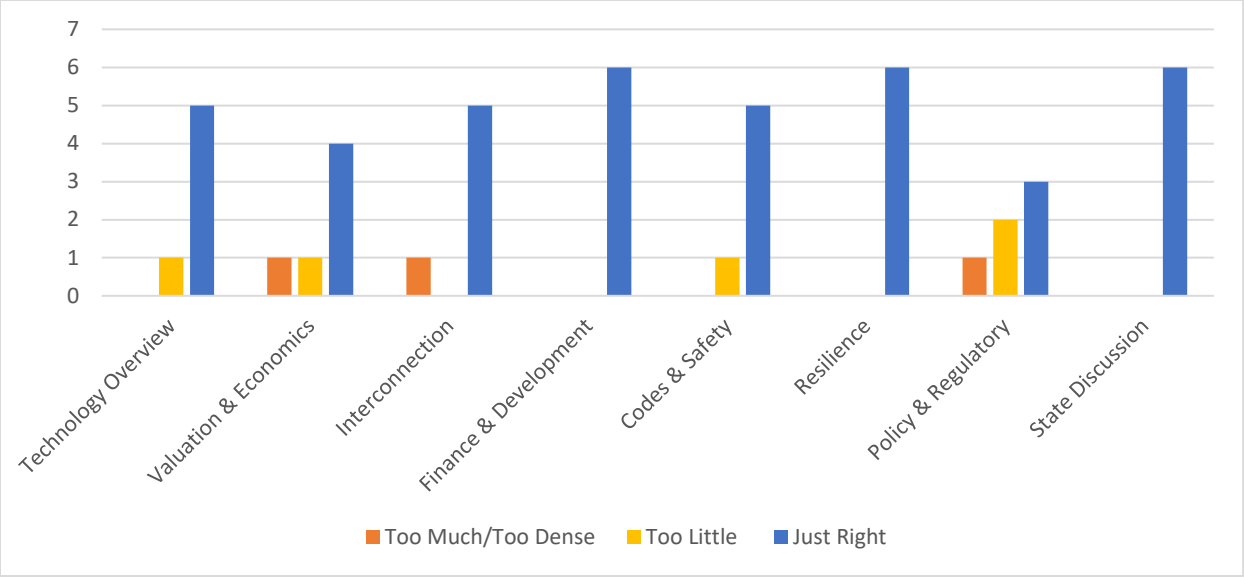


Figure 7: Responses to the Prompt, "Across the Two Days, Please Rate the Overall Quality of the Information Presented on Each of the Following Topics."

Following the previous two questions, an open-ended question asked respondents to identify the most and least valuable sessions across the two days. Five people responded; one said the event had a good flow and it was hard to identify a most or least valuable session. Sessions identified as most valuable in other responses were the Workshop session on Energy Storage Valuation, the Workshop lunch presentation, and the Workshop's State Discussion session. Sessions identified as least valuable were the Workshop session on Pumped Hydro Storage, the panel on Regulatory Perspectives, and the Workshop lunch presentation.

At the end of the survey, two open-ended questions asked respondents for any other feedback or comments about the event, and any suggestions for useful research that the Energy Storage Program could perform.

Open-ended feedback about the event was generally positive, with some participants providing logistical suggestions for future workshops. One respondent called this "the best workshop/conference" that the individual had attended. The individual praised the conference for providing an accessible, informative introduction to energy storage issues. Another individual said that the conference established the right level of technicality, and that it was helpful to see an energy storage demonstration project at SR.

Logistical suggestions given in response to the open-ended question included a request for a digital version of the binder materials, participant nametags with color coding to identify sector (i.e. regulatory, utility, national laboratory), more time for networking, and a larger meeting space.

The question about future research drew four suggestions: deeper analysis of solar plus storage technologies, more discussion about policy options in vertically integrated states, intensive discussion and demonstration of options to value energy storage in IRPs, and a methodology for developing state incentives.

4.3 Feedback Analysis

As discussed in Section 1, the design of the Southeastern Energy Storage Symposium and Workshop was informed by the previous event in Salt Lake City. Specific changes made to the format of this event based on lessons learned in Salt Lake City were: a longer event (two days instead of one), increased focus on valuation issues, reduced focus on technology overviews (with much of that content moved into the binder), and a proactive effort to obtain participant input into agenda design.

The changes appear to have been well received by event participants, as a majority of respondents indicated that the correct amount of time was devoted to each topic. A majority also agreed that the right type of information was presented on every topic except policy and regulatory issues, which only half of respondents agreed had the right type of information, while two said there wasn't enough info and one said there was too much.

Two criticisms that emerged during the in-person and survey feedback opportunities were the overall density of the event and the duplication of some topics. Both issues can be attributed to the unique nature of this event. Where the previous event in Salt Lake City was a standalone event solely for regulatory staff, the Birmingham event was co-located with an event targeted at the broader industry. Because the Symposium and the Workshop were primarily organized by different entities (SR for the Symposium and the national laboratories for the Workshop) and served different educational needs (broad industry participants in the Symposium and regulatory staff in the Workshop), serving each entity's educational objective within a single day placed significant pressure on the agenda.

The Salt Lake City report recommended that future workshops take place over at least 1.5 days. While the Birmingham event did include a second day, the laboratories had limited control over the agenda for the first day, and information presented therein had to be tailored to a broader audience. The detailed, regulatory-focused presentations were therefore effectively limited to one day, and to ensure that the detailed regulatory aspects of energy storage were addressed, some duplication of Symposium topics in the Workshop was necessary. Reducing the amount of time spent on a technology overview appears to have freed up enough time to adequately address the valuation and policy/regulatory topics that the Salt Lake City audience felt were underserved, but the overall structure and approach across the two days clearly created a slight sense of fatigue for Workshop attendees.

Other questions asked participants to rate the usefulness of the information binder (three respondents said it was "extremely useful" and three said it was "very useful") and to express their interest in attending similar DOE-sponsored events in the future (two said "extremely interested," three said "very interested" and one said "interested).

5.0 Conclusion and Recommendations

The Southeastern Energy Storage Symposium and Workshop was a strategically significant undertaking for the Energy Storage Program, and the Equitable Regulatory Environment task in particular. It provided a unique opportunity for program staff to engage in bi-directional instruction with a key stakeholder group and expand the Program's influence in a region where it has historically had a limited presence. By sharing the expertise that the program has developed through years of research and analysis of dozens of energy storage projects, the event gave the Energy Storage Program the opportunity to objectively inform storage-related regulatory proceedings throughout the region. And by engaging directly with state regulatory staff, it gave the laboratories ground-level insight into the regulatory ramifications of the growth of the energy storage industry and a clearer picture of how the Energy Storage Program can direct its efforts to support and inform regulatory agencies.

The insights gained from the Southeastern Energy Storage Symposium and Workshop suggest that energy storage has reached a point of inflection in its development. The information presented by state regulators clearly indicates that utilities are beginning to include energy storage in their future plans based on its own merits – even in states without any incentives or policy guidance in place.

These developments are straining the resources of state regulatory agencies, which are generally not structured to undertake detailed investigation into new technologies. During the State Discussion section of the Workshop, state regulatory staff identified several complex issues that storage has raised in their jurisdictions.

The lessons learned in Birmingham suggest that the Equitable Regulatory Environment task area should consider a change in its approach. To date, it has primarily focused on basic education, consisting of research and outreach detailing the basics of energy storage and how it generally fits into planning processes. But as seen in Birmingham, as more utilities begin to adopt energy storage and seek regulatory approval for specific investments, the next wave of regulatory barriers are becoming clearer. And as those needs become clearer, they signal the need for the Equitable Regulatory Environment to shift its focus toward more detailed research and technical assistance.

Based on the lessons learned from the Southeastern Energy Storage Symposium and Workshop, the Energy Storage Program should consider the following recommendations:

1. **Equitable Regulatory Environment program activities should expand to accommodate emerging business models and regulatory demands.** The 2013 DOE report that informed the current structure of the Energy Storage Program identified a need to reduce the regulatory barriers faced by energy storage. But as new energy storage technologies were still in a nascent state at that point, the report was understandably vague on what those barriers are and how the program should go about addressing them. The national laboratories should work with DOE to devise a new roadmap to guide the work done within the Equitable Regulatory Environment task area.

2. **Face-to-face, interactive events organized regionally for the benefit of states should remain a key component of the Energy Storage Program.** While the industry and regulators may be moving beyond the need for basic education on energy storage, this event demonstrated that there is still value to the program in engaging regulators and other industry professionals face to face.

That interaction allows those who work on the program to see beyond the headlines in industry press and understand the practical implications of the energy storage industry's growth and how the program should be adapting to address them. Regardless of whether the program continues to support the type of educational events done in Salt Lake City and Birmingham, it should continue to incorporate opportunities for face-to-face interaction with regulatory staff and other program stakeholders.

3. **Energy Storage Program staff should identify research gaps related to the operational characteristics and applications of solar plus storage resources.** In both the in-person discussion and survey, multiple workshop participants stated that most of the energy storage projects built in the southeastern U.S. are most likely going to be connected to solar. They added that it is unclear how the operational characteristics and applications for storage change when connected with solar projects, and suggested that additional research to clarify those questions would be helpful. Solar research belongs to other DOE programs; Energy Storage Program staff should review relevant research done by other research programs to understand what work has been done and identify remaining knowledge gaps, and multidisciplinary efforts between the solar and storage programs should be undertaken.

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Appendix A: Event Agendas

Second Southeast Energy Storage Symposium on Policy and Regulation (Day 1)

Date: Wednesday, July 17 (Venue: Biz Plex 757 Tom Martin Drive, Birmingham, AL)

Time	Agenda Item	Speaker
7:30-8:30	Registration and Continental Breakfast	
8:30-8:45	Welcome to Southern Research	**Watson Donald** Senior Director, External Affairs Southern Research
8:45-9:15	Keynote Address: Overview and Vision of DOE Energy Storage Research Programs and Beyond	**Alejandro Moreno** Director, Water Power Technologies U.S. Department of Energy
9:15-9:45	Keynote Address: Energy Policy and Regulation in the Southeast from a Utility Perspective	**Jeff Burleson** Senior VP, Environmental & System Planning Southern Company
9:45-10:00	Coffee Break	
10:00-11:15	Panel Discussion: Utility Perspectives on Energy Storage Technologies, Diversification, and Verification	Moderator **Gary Brinkworth** Director, Technology & Innovation Tennessee Valley Authority Panelists **Tom Fenimore** Manager, Distributed Energy Technologies Duke Energy **Howard Smith** Manager, DER & Grid Edge Policy Southern Company **Jill Dvareckas** Director, Development Florida Power & Light **Curt Kirkeby** Engineering Fellow Avista Corporation
11:15-12:15	Panel Discussion: Policy and Regulatory Perspectives on FTM and BTM Storage	Moderator **Richard Simmons** Director, Energy Policy and Innovation Center Georgia Tech

		Panelists **Jessica Harrison** Director of Research and Development Midcontinent Independent System Operator **Jeremy Twitchell** Energy Research Analyst Pacific Northwest National Laboratory **Benjamin Lavoie** Project Development Engineer Ameresco
12:15 – 12:45	Lunch and Networking	
12:45 – 1:30	Lunch Keynote: Inside Southeast Region State Perspectives on Energy Storage and Solar Policy and Regulation	**Tim Echols** Commissioner Georgia Public Services Commission
1:30 – 2:30	Panel Discussion: Energy Storage Grid Interconnection	Moderator **Charlie Vartanian** Senior Technical Advisor Pacific Northwest National Laboratory Panelists **Rich Bauer** Associate Director of Reliability and Risk Management National Electric Reliability Corporation **Eddy Lim** Senior Engineer Federal Energy Regulatory Commission, Office of Reliability **Corey Sellers** General Manager, Transmission Policy & Services Southern Company Services
2:30 – 3:30	Panel Discussion: Energy Storage System Economics and Modeling	Moderator **Steve Baxley** R&D Manager Southern Company Services Panelist **Randell Johnson** President Acelerex

		Ben Kaun Energy Storage Program Manager Electric Power Research Institute **Kevin Carden** Director Astrape Consulting
3:30-3:45	Coffee Break	
3:45 – 5:00	Panel Discussion: Energy Storage Project Development and Finance	Moderator **Russ Weed** President CleanTech Strategies Panelists **Todd Olinsky-Paul** Project Director VT Clean Energy Group, Clean Energy States Alliance **Jan Ahlen** Director, Energy Solutions National Rural Electrical Cooperative Association **Joe Gammie** Business Development Engineer PowerSecure **Dave Punch** Director, Business Development Avalon
5:00 – 6:00	Panel Discussion: Energy Storage Standards to Ensure Safety and Performance	Moderator **Michael Starke** Energy Storage Program Manager Oak Ridge National Laboratory Panelists **Ryan Franks** Global Energy Storage Manager CSA Group **Dagmar Becker** Senior Test Engineer Southern Research

		Benjamin Schenkman Senior Member of Technical Staff Sandia National Laboratories
6:00 – 6:10	Closing Remarks	**Corey Tyree** Senior Director, Energy & Environment Southern Research
6:10 – 9:00	Networking Reception, Energy Storage and Solar PV Showcase Tours	

Southeast Energy Storage Policy and Regulation Workshop (Day 2)

Date: Thursday, July 18 (Venue: 757 Tom Martin Drive, Birmingham, AL)

Time	Topic	Speaker
7:30 – 8:30	Registration and Continental Breakfast	-
8:30 – 8:45	Welcome by Southern Research	**Dr. Bert Taube** Energy Storage Program Manager, Southern Research
8:45 – 9:00	Welcome and Introduction by the U.S. Department of Energy	**Michael Starke** Power Systems Research Engineer Oak Ridge National Laboratory
9:00 – 10:30	State Introductions	**Moderator: Rebecca O'Neil** Program Manager Pacific Northwest National Laboratory
10:30 – 10:45	Coffee Break	-
10:45 – 11:15	Overview of Energy Storage Technologies	**Benjamin Schenkman** Senior Member, Technical Staff Sandia National Laboratories
11:15 – 11:45	Pumped Hydro Storage	**Rebecca O'Neil** Program Manager Pacific Northwest National Laboratory
11:45 – 12:00	Lunch Pickup	
12:00 – 12:45	Lunch Keynote: Energy Storage Potential in Alabama and Georgia	**Dr. Randell Johnson** Accelerex
12:45 – 2:00	Energy Storage Valuation – Principles and Lessons Learned from the Field	**Patrick Balducci** Chief Economist Pacific Northwest National Laboratory
2:00 – 2:30	Maximizing Storage Value in Regional Markets, and the QuESt Tool	**Alex Headley** Postdoctoral Researcher Sandia National Laboratories
2:30 – 2:45	Coffee Break	**-**
2:45 – 3:15	Energy Storage and Grid Resilience	**Vanessa Vargas** Principal Member of the Technical Staff, Economist Sandia National Laboratories
3:15 – 4:00	Emerging Policies and Planning Practices for Energy Storage	**Jeremy Twitchell** Energy Research Analyst Pacific Northwest National Laboratory
4:00 – 4:30	Wrap-Up and Next Steps	

Appendix B: Roster of State Attendees

Southeastern Energy Storage PUC Workshop – Roster of Commission Attendees		
Name	**Title**	**Organization**
Chip Beeker	Commissioner	Alabama Public Service Commission
Spears Griffin	Senior Advisor	Alabama Public Service Commission
Mary Caitlyn Montgomery	Chief of Staff	Alabama Public Service Commission
Jeremy H. Oden	Commissioner	Alabama Public Service Commission
Bert Finzer	Senior Rate Case Analyst	Arkansas Public Service Commission
Wally Nixon	Managing Attorney, Commissioners' Legal Advisor	Arkansas Public Service Commission
Jefferson Doehling	Engineering Specialist	Florida Public Service Commission
Shelby Eichler	Public Utility Analyst	Florida Public Service Commission
David Frank	Public Utility Analyst	Florida Public Service Commission
Jamie Barber	Energy Efficiency and Renewable Energy Manager	Georgia Public Service Commission
Tim Cook	Utilities Engineer, Energy Efficiency and Renewable Energy	Georgia Public Service Commission
Tim Echols	Commissioner, Vice-Chairman	Georgia Public Service Commission
Sheree Kernizan	Director, Electric Unit	Georgia Public Service Commission
Nancy Vinsel	Assistant General Counsel	Kentucky Public Service Commission

Daniel Hurley	Director, Energy Analysis and Planning	Maryland Public Service Commission
Matthew Bonikowski	Regulatory Economist	Maryland Public Service Commission
Kevin Dillon	Clean Energy Specialist	New Jersey Board of Public Utilities
Jim Ferris	Bureau Chief for New Technology	New Jersey Board of Public Utilities
Michael Hornsby	Chief Project Development Officer	New Jersey Board of Public Utilities
Darlene Peedin	Public Utilities Accountant	North Carolina Utilities Commission
David Williamson	Utilities Engineer	North Carolina Utilities Commission
Renae Carter	Legal Advisor	Virginia State Corporation Commission
Raymond Doggett	Senior Counsel	Virginia State Corporation Commission
Neil Joshipura	Senior Utilities Engineer	Virginia State Corporation Commission
Brian Pratt	Principal Utilities Analyst	Virginia State Corporation Commission

Appendix C: State Policy Memo

MEMORANDUM

State-by-State Storage Activities Overview
September 20, 2019

Assembled by Alan Cooke and Rebecca O'Neil, PNNL

1. Existing Storage

Table 1, which is derived from multiple sources, shows an estimate of the storage currently in existence in the states covered by the upcoming storage seminar for regulators in Southern states. The primary source is the U.S. Department of Energy (DOE) Global Energy Storage Database. All pumped storage hydroelectric (PSH) values are from the DOE database. Battery energy storage values are from the DOE database plus information about battery installations not contained in the database that was collected while putting this memorandum together.

Table 1 Existing Storage Facilities (number and total capacity) by State

State	Major Type	Number of Existing Facilities	Total Capacity (MW)
Alabama	PSH	0	0.0
	BES	3	1.9
Arkansas	PSH	1	28.0
	BES	1	12.0
Florida	PSH	0	0.0
	BES	8	30.1
Georgia	PSH	4	2,153.0
	BES	1	1.0
Kentucky	PSH	0	0.0
	BES	1	1.0
Louisiana	PSH	0	0.0
	BES	3	1.5
Maryland	PSH	0	0.0
	BES	4	10.5
Mississippi	PSH	0	0.0
	BES	0	0.0
New Jersey	PSH	1	400.0[(a)]
	BES	6	5.6
North Carolina	PSH	1	185.0
	BES	8	5.9
South Carolina	PSH	3[(b)]	2,286.2
	BES	0	0.0
Tennessee	PSH	1	1,652.0
	BES	3	0.1
Virginia	PSH	2	3,563.0
	BES	4	6.1

PSH = Pumped Storage Hydroelectric; BES = Battery Energy Storage; MW = Megawatt
(a) Rutgers indicates 420 MW of PSH and 477 MW of storage in New Jersey including PSH, batteries, and thermal storage (Rutgers 2019).
(b) Duke Carolinas includes, in its integrated resource plan (IRP), a proposed upgrade to the Bad Creek.
Source of data: All PSH data is from DOE Global Energy Storage Database and data compiled while writing this memorandum. Note that BES facilities shown as decommissioned in the DOE database were excluded.

2. Alabama

Alabama currently has three battery energy systems in operation totaling just under 2 megawatts (MW). No pumped storage hydroelectric (PSH) systems were identified.

A non-utility microgrid was constructed at the U.S. Army's Redstone Arsenal. The U.S. Army Office of Energy Initiatives collaborated with SunPower Corporation to construct the project, which includes 10 MW of solar generation and a 1-MW/2-megawatt-hour (MWh) battery (US Army 2018). The microgrid described below is a non-utility asset so for this discussion an "Other" category was included.

IRPs: Alabama Power's 2016 integrated resource plan (IRP) included PSH and battery storage as options that were examined but did not select either. It merits noting Alabama Power did not need new resources until 2030 (Alabama Power 2016).

Other: Alabama Power, the Electric Power Research Institute (EPRI), Oak Ridge National Laboratory, and homebuilder Signature Homes have designed an energy-efficient neighborhood to be supported by a microgrid. The neighborhood – called Reynolds Landing – has 62 homes. The microgrid includes a 330 kWh AC (alternating current) solar array, about 600 kWh of battery storage, and 400 kWh of natural gas backup generation. The homes are designed to be 35 percent more efficient than standard homes built today (Gerdes 2019). The microgrid construction was completed in December 2017, by Southern Company subsidiary PowerSecure, and the microgrid has been tested for multiple functions, including islanded mode. A research objective is to evaluate how a combination of distributed energy resources and energy-efficient construction can help the grid serve customers (Ingram et al. 2019). According to a video on the Southern Company website, construction of the homes was expected to be complete by the end of 2018 (Southern Company 2019). Various news articles indicate additional neighborhoods are in various stages of planning in the Southern Company's operating utilities' territories.

3. Arkansas

Arkansas had one battery system of 12 MW and one PSH system of 28 MW in existence when research for this memorandum began. In addition, a new project—a joint effort of the City of Fayetteville, the Ozarks Electric Cooperative Corporation (OEC), and Today's Power, Inc. (TPI)—came online in September 2019. The joint project combines 10 MW of solar generation and a 12 MW/24 MWh lithium-ion battery. The project was built on City of Fayetteville properties. TPI will own the storage facility (TPI 2019; Gill 2019).

Entergy has proposed a 100 MW battery and solar power acquisition.

Legislation related to storage: In 2019, Senate Bill (SB) 145 was passed and signed into law to revise state statutes related to net metering. Among other change, SB 145 amended the definition of net metering facility to allow such facilities to include energy storage designed to receive electric energy from the net metering facility with a provision that the capacity of the storage device shall not be used when calculating the capacity of the net metering facility. SB 145 also allows third-party ownership of solar panels, expands the size cap for net metered solar projects

from 300 kW to 1 MW for non-residential customers, and amended the provision allowing the Arkansas Public Service Commission (PSC) to approve net metering that exceeds the generating capacity limits. The legislation added a limit of 20,000 kW. Notably, this legislation was supported by Walmart, which has an aggressive renewables goal and prefers to lease solar resources in 1 MW increments. Previously existing limitations on solar power made such acquisitions difficult in Arkansas (Morehouse 2019).

A state-run revolving loan program called the Arkansas Energy Technology Loan Program includes energy storage among the technologies that can be financed. This program has been in existence for several years, and no online documentation has been found to identify whether the program was legislatively or administratively established (ADEQ n.d.). Currently, this program appears to be the only mechanism available in Arkansas providing incentive funding in support of storage (CNEE 2018).

Regulatory proceedings: Two dockets relate to the Fayetteville/OEC/TPI facilities. In Docket 19-018-P, OEC asked the Arkansas PSC to approve an energy management agreement between OEC and Fayetteville. In support of this request, OEC used four California Cost Tests[1] to quantify the benefits to itself and its customers, and to Fayetteville. Savings to Fayetteville stem from reduced on-peak demand charges under the OEC Large Power Off-Peak Rate. The reduced charges are based on using the solar project, the battery storage, and Fayetteville's existing backup generation. With the solar and storage project, Fayetteville would not have an economic justification for running the backup generation. However, savings to OEC arising from reduced demand costs from OEC's wholesale power supplier could be achieved through the operation of the backup generation, even after accounting for payments from OEC to Fayetteville for running the generation. OEC was able to show using the Ratepayer Impact Test (RIM) and other cost tests that the project is beneficial to all OEC customer classes. The Arkansas PSC found that the energy management agreement was in the public interest for OEC customers (Arkansas PSC 2019b). In Fayetteville's docket (19-003-U), the Arkansas PSC found the evidence supported approval of the operation of the Fayetteville solar facilities as net-metering facilities (despite each of the two solar facilities exceeding the then-existing 300 kW size cap for net-metering facilities), and grandfathering the facilities under the current net-metering schedule for 20 years (Arkansas PSC 2019a).

In the ongoing Docket No. 19-019-U, Entergy Arkansas, LLC (EAL) submitted a request for approval of a 100 MW solar and energy storage project. The project is a build-own-transfer agreement with NextEra for a project located near Searcy, AR. In their request, EAL asked the Arkansas PSC to approve a certificate of public convenience and necessity (CCN)[2] and for rate recovery from retail customers through proposed Rate Schedule No. 57, Renewable Assets Rider (EAL 2019).

[1] The California Cost Tests are widely-used benefit-cost tests referred to as the California tests because perhaps the earliest and the best known descriptions of such tests were published in a document entitled the *California Standard Practice Manual* in 1983. The 2001 edition of the *California Standard Practice Manual* is available at https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy_-_Electricity_and_Natural_Gas/CPUC_STANDARD_PRACTICE_MANUAL.pdf.

[2] The Arkansas documents use the abbreviation CCN, while other states, e.g., North Carolina, use CPCN.

IRPs: The Southwestern Electric Power Company's (SWEPCO's) 2018 IRP does not include any battery energy storage resources in the preferred plan, having found it to be too costly. PSH does not appear to have been included because the major sites for hydroelectric generation have been used and new sites would entail significant environmental issues (SWEPCO 2018).[3]

Entergy Arkansas' 2018 IRP selected a block of battery storage in 2032 in future A and C. The graphics appear to show a 100 MW block (EAL 2018).

4. Florida

Florida has no PSH systems, and eight battery systems totaling approximately 30 MW. Several other projects, totaling over 500 MW, have been proposed.

Regulatory actions related to storage: In its 2018 10-year site plan[4], Florida Power & Light (FPL) included 53 MW of research projects – 3 MW of which were existing and 50 MW of which were proposed as a result of a settlement agreement in a previous rate case (FPL 2018a; Florida PSC 2016).[5] Duke Energy Florida (DEF) is currently implementing a 50 MW battery storage pilot project. The project was part of a settlement agreement accepted by the Florida Public Service Commission (PSC) in an earlier rate proceeding. The DEF settlement agreement also included an assumption that the cost of batteries would be reasonable and not exceed $2,300 per kilowatt—alternating current (Florida PSC 2017).[6] Thus, the battery storage pilots were included in settlement agreements for FPL and DEF. When evaluating a settlement agreement, the Florida PSC evaluates whether the agreement—in its entirety—addresses the outstanding issues and is in the public interest. The Florida PSC and does not evaluate specific pieces of the agreement such as the economics or cost recovery for a line item such as the battery storage (Florida Supreme Court 2018). The settlement agreement process in Florida provides little or no visibility into how an item like battery energy storage was inserted into the settlement agreements. Thus, a reviewer cannot identify the stakeholder that proposed adding batteries. In addition, because individual line items are not reviewed the docket provides no regulatory history of battery analyses by the utility or the regulator.

IRPs: In its 2019 10-year site plan, in addition to the previous research projects, FPL proposed 469 MW of battery storage, including a 409 MW energy storage project in Manatee County (FPL 2019b). As noted in an FPL press release, the proposed facility would be the world's largest

[3] In this case and in others throughout this memorandum, searches of document were conducted using the search function built into the applicable software package (e.g., Adobe Acrobat or Microsoft Word). In most cases multiple searches were performed with permutations of the words storage, battery, batteries, pumped storage, and hydroelectric.

[4] A site plan is an IRP submitted to the Florida PSC. Site plans are legislatively required for utilities with more than 250 MW of generating capacity. The Florida PSC does not approve site plans. In 2018, four investor-owned utilities, six municipal utilities, and one rural electric cooperative were required to submit site plans at a minimum every two years (FPSC 2018).

[5] In a presentation to the Florida PSC, FPL indicated it had 3.9 MW of small battery pilots in-service, two larger solar plus storage projects (Babcock Ranch – 10 MW, and Citrus – 4 MW) in-service, a 10 MW project (Wynwood) scheduled to be in-service in mid-2019, and a vehicle-to-grid project of under 1 MW scheduled for early 2019. FPL indicated all 50 MWs would be in-service by 2020 (FPL 2018b).

[6] DEF recently announced three battery projects totaling 22 MW – an 11 MW project near Gainesville, a 5.5-MW project near Panama City, and a 5.5-MW project near the Florida-Georgia border (DEF 2019).

battery storage facility – roughly four times the size of the largest system currently in operation (FPL 2019a). The proposed project is intended to enable the accelerated retirement of some 1970s vintage gas-fired power generating units, a move FPL estimates will reduce emissions by over 1 million tons of carbon dioxide emissions and save ratepayers over $100 million (FPL 2019a).

In its 2019 10-year site plan, DEF did not mention storage (DEF 2019).

The 2019 Jacksonville Electric Authority (JEA) 10-year site plan includes a 4 MW storage system associated with the 5 MW SunPort Solar facility—scheduled for Q4 2019 commercial operation. JEA supports the Florida Alliance for Accelerating Solar and Storage Technology Readiness project and is identifying potential strategies for applying the study results from that project. JEA also operated a Battery Incentive Program. Since its April 1, 2018 inception, JEA has had more than 25 applications for residential storage systems (JEA 2019).

Tampa Electric Company (TEC), in its 2019 10-year site plan, stated it would install a 12.6 MW lithium-ion battery at the Big Bend Solar site after all approvals were received (TEC 2019).

Other site plans on the Florida PSC website do not mention storage as new resources. However, municipal utilities' forecasts appear to show the utilities do not need new resources over most of, or the entire, 10-year period – the caveat being that early retirements of existing facilities for economic or other reasons, changes in load characteristics, or other factors could change this result in the future.

5. Georgia

Georgia is home to four PSH projects totaling over 2,150 MW, and a 1 MW lithium-ion battery system that the Southern Company and EPRI have been testing (DOE 2019; T&D World Magazine 2015).

IRPs: The Georgia Power Company's (Georgia Power's) 2019 IRP included 50 MW of battery energy storage for investigating batteries independently and in tandem with intermittent resources (Georgia Power 2019a). In response to data requests from the Georgia PSC staff, Georgia Power indicated there were no models or work papers supporting its specific proposal for the battery storage (Tait 2019). In the IRP docket a stipulation agreement was worked out by Georgia Power and numerous stakeholders—including Georgia PSC staff—and filed June 24, 2019. Under the stipulation agreement, Georgia Power would be granted authority to develop, own, and operate up to 80 MW of battery projects for demonstration purposes (Georgia Power 2019b). The Georgia PSC approved the stipulation agreement with no published PSC comments specifically addressing the 80 MW battery project. The PSC did note the "record reflects the necessity and need for further development for energy storage capability," but this statement was contained in a paragraph discussing a pilot program related to grid-connected electric vehicles (Georgia PSC 2019). The stipulation did include provisions that offer some protections to ratepayers, including provisions requiring Georgia Power to (1) procure batteries through request for proposal processes, (2) file plans before undertaking construction and acquisition, and (3) perform a transmission evaluation and to describe the objectives and other details for each project. The stipulation provides Georgia PSC staff 60 days to review the plans prior to Georgia

PSC approval (Georgia PSC 2019). The stipulation included provisions related to the use of the Renewable Cost-Benefit (RCB) framework for evaluating bids for utility-scale solar resources but was silent about evaluating bids for storage. The RCB discussion illuminated a disagreement between Georgia Power and the Georgia PSC's Public Interest Advocacy (PIA) staff, with PIA staff questioning some components of the RCB and indicating a desire to treat solar plus storage as its own technology. The stipulation called for Georgia Power and PIA staff to work to resolve issues (Georgia PSC 2019).

6. Kentucky

Kentucky has no PSH projects and one battery system of 1 MW installed in a testing facility. Louisville Gas & Electric (LG&E), Kentucky Utilities (KU), and EPRI have developed a research center for testing storage systems at the EW Brown Generating Station. The center features three testing bays, each able to hold and test 1 MW of storage. The facility is currently being used to test a 1 MW, 2 MWh lithium-ion battery (KU and LG&E 2018).

IRPs: The KU and LG&E 2018 IRP reviewed storage technologies. In the screening analysis that precedes the detailed resource planning analyses, PSH was considered but eliminated because PSH land-use requirements make PSH unsuitable in the KU and LG&E service territories (KU and LG&E 2018). Batteries were included in the detailed analyses, but do not appear to have been selected in the preferred portfolio. Unless generating resource retirements occur that are not included in the main resource portfolio cases, the utility does not appear to need new resources for the 15-year planning horizon. The IRP did analyze the possibility of early retirements for economic reasons, and evaluated a case to replace retired resources with storage combined with renewables, but found the approach to be uneconomic (KU and LG&E 2018).

Duke Energy Kentucky's (DEK's) 2018 IRP analyses included battery energy storage as a resource but excluded PSH. The IRP's preferred resource plan proposed the acquisition of 10 MW of solar and 2 MW of battery storage in each year of the plan, starting in 2019. The information presented in the IRP appears to show that DEK has enough resources to meet its requirements over the analysis period in the utility's business as usual case (DEK 2018). The solar plus storage acquisition is explained as a means of meeting the requirements of customers looking to partner with DEK for meeting sustainability goals (DEK 2018). The attorney general's data requests (Kentucky Attorney General 2018) asked some pointed questions about the proposed purchase of solar and storage. The IRP docket is ongoing, though it should be noted that Kentucky statutes require the PSC to accept and review IRPs, and for PSC staff to issue a report summarizing its review and providing suggestions and recommendations for subsequent filings (Kentucky PSC 2019).

7. Louisiana

Louisiana currently has three battery systems totaling 1.5 MW and no PSH projects.

Legislation related to storage: House Resolution No. 133, in the 2017 session, requests that the Louisiana PSC study the Customer Lowered Electricity Price (CLEP) battery pilot and the feasibility of implementing it in Louisiana. The CLEP battery pilot program was sized to meet a

residential customer's needs for a day allowing the customer to buy electricity in off-peak periods and sell excess energy in high-usage periods (NCSL 2018) The Louisiana PSC does not appear to have responded to the request.

IRPs: Entergy Louisiana, LLC's (ELL's) 2019 IRP states battery storage is currently still too expensive to rely on extensively. The public version of the IRP indicates 100 MWs of batteries will be installed in the preferred resource portfolio case, although a graph of the resource portfolio shows such installation not starting until 2033. In other resource portfolios, batteries are selected in greater numbers and starting in earlier years. The near-term action plan calls for ELL to continue to explore opportunities to expand upon and develop the technology (ELL 2019).

Entergy New Orleans (ENO) is still working on its 2019 IRP. In a recent presentation, graphical presentations of its draft capacity expansion plan show a similar story, namely that in the preferred case batteries are selected but starting in 2033 (ENO 2019). ENO currently operates a 1 MW solar project with a 0.5 MW lithium battery (EEI 2019; ENO 2019)

Both ELL and ENO include graphs in their IRP packages showing rapidly falling prices for battery energy storage technology.

SWEPCO's last IRP was submitted in 2015 and did not include storage (SWEPCO 2015).

8. Maryland

Legislation related to storage: SB 758 in the 2017 session established income tax credits for energy storage systems. The bill established a $750,000 total annual tax credit limit and provides credits of the lesser of 30 percent of the installed cost of the storage system or $5,000 on residential properties and $75,000 on commercial properties (Maryland General Assembly 2017b).

In 2017, House Bill (HB) 773 funded a study by the Maryland Department of Natural Resources (DNR) to investigate approaches such as regulatory reforms and financial incentives to increase the use of energy storage devices in Maryland (Maryland General Assembly 2017a). The Maryland DNR issued a report in 2018. Due to constraints including time and funding, the Maryland DNR was largely inconclusive with respect to policy options like storage targets and incentives (Maryland DNR 2018).

In May 2019, Maryland enacted SB 573, the Energy Storage Pilot Project Act, which requires each of the state's four investor-owned utilities (i.e., Potomac Edison; Baltimore Gas and Electric; Delmarva Power and Light; and Potomac Electric Power) to propose two energy storage systems by 2020, with anticipated operation date by 2022. Together the two systems will be between 5 and 10 MW, and at least 15 MWh. The Maryland PSC will design the implementation framework for the program. Utilities must select two of the following four legislatively determined ownership models for storage: a utility-only ownership model; a utility and third-party model; a third-party ownership model; and a virtual power plant. Extensive data regarding the operation and use of the facility is required to be submitted. These storage projects will also help resolve regulatory questions about the limits of utility ownership of storage assets,

which can function as generation as well as support transmission and distribution (Maryland General Assembly 2019).

Regulatory actions related to storage: SB 573 appears to be the result of a Maryland PSC energy storage working group that is a part of the Maryland PSC's Administrative Docket PC44—transforming the distribution system. The working group developed an energy storage regulatory concept extremely similar to the concept included in SB 573 (Maryland PSC 2019b). The Maryland PSC issued Order No. 89240 to implement SB 573. The Maryland PSC ordered investor-owned utilities to solicit offers to develop storage projects and to submit them for approval following the guidelines in SB 573. The Maryland PSC established a new docket [Case No. 9619] to evaluate the offers and ordered that by December 31, 2019 the energy storage working group propose metrics for evaluating environmental and clean energy objectives and impacts on the retail market, including a detailed list of the types of values streams to be considered. Proposals for energy storage projects are due to the Maryland PSC by mid-April 2020 in accordance with a May 2019 proposal by the energy storage working group and an August 2019 follow-up letter from the working group. It should be noted that Maryland is a deregulated state, meaning investor-owned utilities are distribution utilities and not allowed to own energy generation. The Maryland PSC noted this fact but also noted SB 573 will obviate the need to address concerns related to this fact and to cost recovery (Maryland PSC 2019a).

9. Mississippi

At present, research has turned up no utility-owned storage resources, or any planned in the immediate future.

At the Naval Construction Battalion Center in Gulfport, the Southern Company and Mississippi Power are working with the Department of Defense (DoD) on an installation which includes solar generation (the output of which will be purchased by Mississippi Power) and a microgrid to be owned by the DoD's contractor, CB Energy. The microgrid will include the solar generation, a 1 MW battery, and 3 MW of diesel generation. An expansion of the microgrid is being explored so the storage capacity is subject to change (Rickerson et al. 2018).

10. New Jersey

Legislation related to storage: Assembly (Bill) No. 3723 in 2018 [known as the Clean Energy Act] called for the New Jersey Board of Public Utilities (New Jersey BPU) to work with other stakeholders including the PJM Interconnection to identify energy storage needs and opportunities in New Jersey. The bill also called on the New Jersey BPU to institute a proceeding to establish a process and mechanism to achieve goals of 600 MW by 2021 and 2,000 MW by 2030 goal (NJ Assembly 2018).

Regulatory actions related to storage: In June 2019 the New Jersey BPU published its *Draft 2019 New Jersey Energy Master Plan, Policy Vision to 2050*. The draft plan included several possible tools to accelerate the installation of battery energy storage. Tools included in the draft plan include transitioning to a successor solar incentive program, looking for opportunities to use storage to open circuits that are currently restricted from accepting new requests for integration

of distributed energy resources (DERs), and mandating non-wires solutions on state-funded projects. The draft plan is much broader than simply a plan to accelerate the installation of storage, so many tools cut across multiple goals, such as calling for the development of offshore wind and the infrastructure needed to bring the energy to New Jersey and integrate it—an element of the plan which could include, if not require, the use of battery storage to implement. The New Jersey BPU draft plan highlights an ambiguity in the Clean Energy Act – whether the goal of 600 MW of storage by 2021 is for the total amount of storage in the state or for new storage installations. In the draft plan's discussion of goal 2.3.5, developing mechanisms to reach 600 MW of storage, the New Jersey BPU notes that the state already has 477 MW of storage, and implying that the New Jersey BPU is interpreting the goal as a total and not an incremental goal. That said, achieving this goal still requires an addition of 123 MW of storage by 2021. The New Jersey BPU draft plan indicates the BPU has contracted for an energy storage analysis (ESA) and conducted a stakeholder process, and that the New Jersey BPU will complete the development after reviewing the ESA (New Jersey BPU 2019).

To support the obligation to develop pathways to meet the energy storage goal, BPU contracted with Rutgers University to produce the ESA. Rutgers published the ESA in May 2019 (Rutgers 2019).

11. North Carolina

North Carolina currently has one PSH project of 185 MW and eight battery systems totaling approximately 6 MW. At least 14 MW of battery energy storage are currently in proposal stages and the state utilities' IRPs include placeholders for 290 MW.

Legislation related to storage: HB 589 called for and funded an energy storage study, which has since been conducted by the North Carolina Policy Collaboratory (Collaboratory) at the University of North Carolina at Chapel Hill (North Carolina General Assembly 2017). The study was submitted to the North Carolina General Assembly in December 2018. The study provided numerous deliverables including a benefit-cost spreadsheet, spreadsheets to calculate benefits including behind-the-meter benefits for customers, distribution services, frequency regulation, energy time shifting and peak capacity deferral. It also compiled a list of policy options including those designed to prepare for storage by identifying gaps and uncertainties, to facilitate storage by helping to either increase the value or decrease the cost of storage, and to accelerate the pace of energy storage deployment (North Carolina State Energy Storage Team 2018).

Executive action related to storage: Governor Roy Cooper issued Executive Order No. 80 in 2018, committing the state to address climate change. Among steps ordered by Governor Cooper, the state Department of Environmental Quality was directed to develop a Clean Energy Plan encouraging utilization of renewable resources and energy storage (Cooper 2018).

Regulatory actions related to storage: Duke Energy Progress (DEP) submitted a request in late 2018 for a certificate of public convenience and necessity (CPCN) for a microgrid known as the "Hot Springs Microgrid," which will include a 4 MW lithium-based battery. In 2019, the North Carolina Utilities Commission granted the CPCN for the solar generation component of the microgrid. The NCUC noted in its findings that DEP had included the microgrid in its 2018 IRP (DEP 2018b), that the microgrid was consistent with the Commission's Western Carolinas

Modernization Project Order (NCUC 2016), and that the confidential capacity cost estimate was reasonable. NCUC's Order did not appear to grant a CPCN to the storage portion (NCUC 2019c). DEP's request for the CPCN indicates that DEP also intends to construct approximately 9 to 10 MW of solar generation and additional storage in the Asheville, North Carolina area, and that it is still evaluating sites (DEP 2018a). No further filings have been noted in which DEP again requested a CPCN or other approval for the storage component of the microgrid.

Three ongoing dockets will potentially influence future levels of non-utility ownership of energy storage. Docket E-100, Sub 101 is examining treatment of energy storage added to existing solar projects. In 2015 the North Carolina Utilities Commission (NCUC) approved a revised version of North Carolina's Interconnection Standard included a provision calling for a review after two years to determine if the interconnection standard needed to be revised. The review commenced in 2017. A June 2019 NCUC order adopted a Stipulated Redline of the interconnection standard. At that time, an important remining issue was designing a streamlined process for re-studying an existing generating facility for the addition of energy storage. In the June 2019 Order the NCUC directed Duke (the combined DEC and DEP) to host stakeholder meetings and on or before September 3, 2019 to file a streamlined process for studying the addition of storage (NCUC 2019b). Duke has since asked for and been granted an extension of this deadline to September 30, 2019 (NCUC 2019d).

Docket E-100, Sub 158 relates to an update to avoided cost calculations, payments to qualifying facilities (QFs), potential charges for ancillary services, and changes to terms and conditions of the contracts. Duke proposed an updated schedule of energy and capacity charges as well as an integration service charge for intermittent solar QFs. Dominion Energy North Carolina (Dominion Energy) proposed charges for re-dispatching resources for dealing with intermittency. An alternative proposal for dealing with ancillary services was put forth by the North Carolina Sustainable Energy Association (NCSEA), and Public staff and Duke proposed a stipulation of partial settlement, all of which had parties to the docket divided (NCUC 2019f). The NCSEA proposal would enable QFs to avoid Duke's system integration charge by providing ancillary services themselves. The NCSEA proposal raises issues aout the lack of a market for such services in North Carolina and the lack of a requirement for utilities purchase ancillary services under the Public Utility Regulatory Policies Act. Other issues in the docket related to energy storage include Duke's proposed modifications to standard terms and conditions including a provision under which upgrades to a facility to increase energy output (e.g., re-paneling) or adding energy storage at the facility can trigger default of the existing PPA, at the utility's option (NCUC Public Staff 2019). The final order in this docket could have significant implications for payments received by qualifying facilities as well as charges assessed to those facilities by utilities.

The third set of ongoing dockets involves the Duke competitive procurement of renewable energy (CPRE) programs. In September 2018, DEC and DEP both filed updates to their CPRE programs as attachments to their 2018 IRP reports. Based on the evidence collected and revisions in Dockets E-2, Sub 1159 and E-7, Sub 1156 since the initial filings, the NCUC issued an order in July 2019 accepting the CPRE program plan as reasonable for planning purposes. The NCUC Order revised the schedule for the CPRE Tranche 2 Request for Proposals solicitation in part to allow time for a final ruling in the avoided costs docket since such will impact the evaluation of proposals. The NCUC required Duke to continue meeting with stakeholders with a goal of

reaching consensus on unresolved issues relevant to the Tranche 2 solicitation while the CPRE process moves forward into the solicitation of proposal phase. A key unresolved issue is Duke's operational restrictions in their energy storage protocol. In discussions at a workshop held as part of the CPRE proceedings, stakeholders and Duke had serious differences concerning how to capture the operational benefits of storage and who has operational control over the storage. The NCUC indicated it is prepared to address these issues if they cannot be resolved by stakeholders (NCUC 2019e).

IRPs: Duke Energy Carolina's (DEC's) 2018 IRP includes what DEC called 150 MW storage "placeholders" in most scenarios modeled, and 60 MWs of battery energy storage installed by 2023 (DEC 2018a). DEP's 2018 IRP included 140 MW placeholders.

DEP also included a summary of the battery proposals discussed earlier plus the microgrid serving the Great Smoky Mountains National Park, which includes 10 kilowatts (kW) of direct-current solar photovoltaic generation and a 95 kilowatt-hour (kWh) zinc-air battery (DEP 2018b).

As discussed in the Virginia section, below, the Dominion Energy 2019 IRP includes up to 30 MW of batteries under a pilot program established by legislation in Virginia, and Dominion Energy is investigating potential PSH sites in Virginia.

In an August 2019 Order, the NCUC accepted the DEP, DEC, and Dominion North Carolina IRPs as adequate for planning purposes for 2019 and 2020. The Order also directs DEC, DEP, and Public Staff to file responses to information requested by the NCUC in an appendix to the Order, including a request for additional analyses of Portfolio 7 of the DEC and DEP IRPs which included battery storage and high renewables. The NCUC seeks additional information on the cost of battery storage at additional resource sites compared to DEP's expected cost of their market solicitation, and whether the results of Portfolio 7 can be extrapolated to a broader analysis (NCUC 2019a).

12. South Carolina

South Carolina currently has three PSH projects operational within the state with a total generating capability of 2,286 MW. Additionally, DEC is upgrading the Bad Creek Hydroelectric Station (DEC 2018). While no regulatory dockets approving the upgrade costs have been identified in South Carolina (or North Carolina), the upgrade has been included in DEC IRPs dating to the 2016 IRP. DEC's 2018 IRP puts the expansion at 260 MW (DEC 2018c). No battery energy storage systems were identified in South Carolina.

Legislation related to storage: HB 3659 was passed in the 2019 session. The bill includes several provisions intended to reform the way renewable resources are analyzed and acquired by South Carolina utilities. Among its provisions, the bill extended net metering until June 2021, directed the South Carolina PSC to revise the way avoided cost rates are used for solar projects, required utilities to file voluntary renewable resource programs for review and approval by the South Carolina PSC, and revised language related to requirements for IRPs filed by utilities (South Carolina General Assembly 2019).

Regulatory actions related to storage: The commission opened docket ND-2019-11-E to consider the substance of HB 3659 and to establish guidance including schedules for the utilities covered by the legislation.

IRPs: DEC's 2018 IRP includes 60 MWs of battery energy storage installed by 2023, and what DEC called 150 MW "placeholders" in most scenarios modeled (DEC 2018c).[7] The South Carolina DEC IRP docket is ongoing.

13. Tennessee

Tennessee currently has one operational PSH project with total capacity of over 1,650 MW and three operational batteries totaling 1 MW (DOE 2019).

IRPs: In June 2019, the Tennessee Valley Authority (TVA) released its 2019 IRP. TVA projects adding up to 2,400 MW of storage by 2028 and 5,300 MW by 2038. The projections include both utility-scale storage and distributed additions. TVA modeled five planning strategies for meeting expansion needs. The base-case strategy, which fared well in the analyses, does not include incremental storage additions. Strategy B, which promotes DER capacity and which also fared well, adds 0.1 to 1.3 gigawatts of storage. Other strategies add greater amounts of storage, and the IRP indicates the exact amount to be added will depend on the evolution of storage technologies. The near-term plans call for TVA to evaluate demonstration battery storage projects (TVA 2019).

14. Virginia

Virginia currently has two operational PSH projects, totaling 3,563 MW (including the Bath County Pumped Storage Station, which is over 3,000 MW).

Legislation related to storage: SB 996 established a pilot program, authorizing utility investments in storage, up to either 10 MW or 30 MW, depending on the utility's classification. The Grid Transformation and Security Act (as it is known), or the GTSA, also requires utilities to submit an annual Electric Distribution Grid Transformation Project, identifying energy storage and other investments that the utility proposed to integrate DERs and increase grid reliability and security. It also provides an incentive rate of return to the utility for such projects (Virginia General Assembly 2018). As of the date of the Southeast Regulator Workshop, the Virginia State Corporation Commission (SCC) had not yet seen a battery storage pilot program proposal from the state's utilities. Virginia Electric and Power Company, d.b.a. Dominion Energy Virginia (Dominion Energy) subsequently filed a pilot program proposal in August 2019.[8]

[7] DEC's IRPs submitted in North and South Carolina proceedings include the same language concerning the 150 MW battery placeholders. At the time this memorandum was compiled it was not possible to determine what share would be allocated to each state, or if 150 MW was earmarked for both states.

[8] In early August 2019 Dominion Energy submitted an application to participate in the battery energy storage pilot program established by the GTSA. Dominion Energy proposed three projects. Battery Energy Storage System (BESS)-1 is to be a 2-MW/4 MWh system to prevent solar backfeeding into the transmission grid at a specific substation. BESS-2 is a 2 MW/4 MWh system to be used to study non-wires solutions to transformer loading. BESS-3 is to be a 2 MW/8 MWh system to study solar plus storage at the existing Scott Solar Facility. The pairing of BESS-3 with solar would make BESS-3 a generating facility (Dominion Energy 2019).

HB 1760/SB 1418 (2017) streamlines the regulatory approval process for pumped storage hydro projects and potentially favors conversions of abandoned coal mines into PSH facilities (Virginia General Assembly 2017a). In 2019, SB 1707 established the Southwest Virginia Energy Research and Development Authority to promote opportunities for energy development in Southwest Virginia, with one of their mandates being to support development of PSH and storage in general and another being to support the development of PSH in brownfield sites, including abandoned coal mine sites. While SB 1707 did not appropriate funds, the Authority was granted powers such as receiving grants and donations from governmental or private entities, to hold and administer such moneys for the purpose for which the Authority was established, and to enter into agreements with governmental authorities, lenders and other parties for purposes of financing or assisting in the financing of projects (Virginia General Assembly 2019).

SB 1258 (2017) renamed the Virginia Solar Energy Development Authority as the Virginia Solar Energy Development and Energy Storage Authority. The agency is tasked with promoting the growth of solar and energy storage technologies in the state (Virginia General Assembly 2017b).

IRPs: In Virginia, utilities submit IRPs, but the Virginia SCC does not approve them. In its 2018 IRP, Dominion Energy included a 30 MW battery energy storage demonstration project to be pursued under the GTSA. Otherwise, Dominion Energy did not consider batteries in its busbar analysis due primarily to cost. In response to SB 1418, Dominion Energy is conducting feasibility studies to identify potential pumped storage sites in western Virginia (Dominion Energy 2018).

In its 2019 IRP, Appalachian Power Co. (APCo) included a 10 MW battery pilot for installation by 2021 to meet the requirements of GTSA. Additionally, APCo is examining opportunities to use batteries and microgrids to support portions of the grid with reliability problems. APCo and Greensmith Energy are currently testing a 4 MW system for providing ancillary services to the grid and has APCo has a 2 MW sodium-sulfur battery originally installed to defer construction of a substation and now placed in the PJM market for frequency regulation (APCo 2019).

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