SEPTEMBER 2015

Batteries ~~Not~~ Included

Identifying and Approaching Barriers to Batteries on the Grid

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NC SUSTAINABLE ENERGY ASSOCIATION

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The NC Sustainable Energy Association (NCSEA) is a 501(c)(3) nonprofit membership organization of individuals, businesses, government, utility providers and nonprofits interested in North Carolina's sustainable energy future. NCSEA drives public policy and market development to create energy jobs, economic opportunities and affordable energy to benefit North Carolina.

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TABLE OF CONTENTS

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EXECUTIVE SUMMARY

In North Carolina, renewable energy has faced and overcome many barriers while growing its market share. However, one barrier has persisted: intermittency. Solar and wind generation, standing alone, is intermittent, which leads to consequences for the grid such as ramping traditional generation up and down to compensate for intermittent renewable generation. However, this intermittency can be largely mitigated by strategically integrating large and small-scale batteries into the grid. While batteries are not an all-encompassing solution for integrating more renewable energy into the grid, the technical and economic potential of batteries as a grid resource should be considered for use in advancing North Carolina's clean energy economy.

NCSEA synthesized the findings and recommendations of six publications by leading thinkers on batteries:

- *Electric Power Industry Needs for Grid-Scale Storage Applications*, Sandia National Laboratories (December 2010);[1]
- *Evaluating Utility Procured Electric Energy Storage Resources: A Perspective for State Electric Utility Regulators*, Dhruv Bhatnagar and Verne Loose, Sandia National Laboratories (November 2012);[2]
- *Market and Policy Barriers to Energy Storage Deployment*, Dhruv Bhatnagar, Aileen Currier, Jacquelynne Hernandez, Ookie Ma, and Brendan Kirby, Sandia National Laboratories (September 2013);[3]
- *Grid Energy Storage*, United States Department of Energy (December 2013);[4]
- *Envisioning State Regulatory Roles in the Provision of Energy Storage*, Tom Stanton, National Regulatory Research Institute (June 2014);[5] and
- *Deploying Distributed Energy Storage: Near-Term Regulatory Considerations to Maximize Benefits*, Sky Stanfield and Amanda Vanega, Interstate Renewable Energy Council (February 2015).[6]

This paper is intended to serve as an introduction to the legal and regulatory issues facing batteries in the United States. It begins by identifying and summarizing the barriers to the widespread use of batteries most frequently mentioned by the publications. Next, it identifies and summarizes the publications' most frequently mentioned recommendations for overcoming barriers to battery integration. Finally, it evaluates where North Carolina stands on the identified key barriers and recommendations.

Ultimately, this paper concludes that, given the breadth and complexity of the barriers and approaches, North Carolina's stakeholders interested in realizing the technological and market opportunities presented by batteries should seriously consider convening, either formally or informally, to discuss policies surrounding batteries and to develop consensus recommendations for future policy actions.

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[1] *Available at* http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/Utility_12-30-10_FINAL_lowres.pdf.
[2] *Available at* http://www.sandia.gov/ess/publications/SAND2012-9422.pdf.
[3] *Available at* http://www.sandia.gov/ess/publications/SAND2013-7606.pdf.
[4] *Available at* http://www.sandia.gov/ess/docs/other/Grid_Energy_Storage_Dec_2013.pdf.
[5] *Available at* http://energystorage.org/system/files/resources/nrri_14-08_energy_storage.pdf.
[6] *Available at* http://www.irecusa.org/wp-content/uploads/2015/03/Deploying-Distributed-Energy-Storage-2-27-15-IREC-FINAL-Secure-1-1.pdf.

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INTRODUCTION

Energy storage has the potential to benefit many different aspects of the electric industry. While there are numerous energy storage technologies, batteries have been the primary focus of research in recent years, and technological innovations and cost decreases have allowed batteries to become commercially viable. Batteries are capable of providing services to the generation, transmission, and distribution sectors of the electric grid.[7] Two of the most discussed services that batteries can provide is the ability to integrate intermittent renewable energy generation to the grid and the ability to provide ancillary services that support the grid, such as regulation, voltage support, and reserve capacity.[8] Batteries also have the potential to allow end-users, be they small residential consumers or large industrial consumers, to reduce electric costs, reduce peak demand, and reduce demand charges.[9]

This paper is intended to serve as an introduction to the legal and regulatory issues faced by batteries. It distills the findings and recommendations of six publications by leading thinkers on batteries, and begins by identifying and summarizing the barriers to the widespread use of batteries most frequently mentioned by the publications. It next identifies and summarizes the publications' most frequently mentioned recommendations for overcoming barriers to battery integration. Finally, it evaluates where North Carolina stands on the identified key barriers and recommendations.

HISTORICAL CONTEXT

Batteries are one of several forms of energy storage. North Carolina has played an important role in the development of energy storage technologies. In 1956, the Tennessee Valley Authority installed the first utility-scale reversible pump and turbine for pumped hydroelectric energy storage at its Hiwassee Dam in Murphy, North Carolina.[10] In 1987, the Crescent Electric Membership Corporation became the first utility in the nation to use batteries for peak shaving. Crescent's battery operated for 15 years, nearly double its warranty period of 8 years.[11] While the Crescent battery has been decommissioned, there are several batteries larger than 200 kW in North Carolina. Duke Energy Carolinas operates three batteries at various locations in North Carolina, and Duke Energy Carolinas, Dominion, and the Department of Defense have all installed microgrid demonstration projects that incorporate batteries.[12]

North Carolina's renewable energy market has grown significantly since the state's Renewable Energy and Energy Efficiency Portfolio Standard was adopted in 2007. In 2014, North Carolina was second in the nation for solar installations and in 2015 construction began on the state's first wind farm.[13] While wind and solar have

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[7] U.S. DEP'T OF ENERGY, GRID ENERGY STORAGE 21 (2013).

[8] *Id.* at 21 and 25-26. DHRUV BHATNAGAR & VERNE LOOSE, SANDIA NAT'L LAB., EVALUATING UTILITY PROCURED ELECTRIC ENERGY STORAGE RESOURCES 19-20 (2012). SANDIA NAT'L LAB., ELECTRIC POWER INDUSTRY NEEDS FOR GRID-SCALE STORAGE APPLICATIONS 1 (2010). TOM STANTON, NATIONAL REGULATORY RESEARCH INSTITUTE, ENVISIONING STATE REGULATORY ROLES IN THE PROVISION OF ENERGY STORAGE 2 (2014).

[9] STANTON, *supra* note 8, at 3-4. U.S. DEP'T OF ENERGY, *supra* note 7, at 21.

[10] ARGONNE NAT'L LAB., PUMPED STORAGE HYDROPOWER 3 (2014).

[11] ABBAS A. AKHIL ET AL., DOE/EPRI 2013 ELECTRICITY STORAGE HANDBOOK IN COLLABORATION WITH NRECA G-2 (2015).

[12] Drew Brooks, *New Power Grids to Keep Fort Bragg Running*, FAYETTEVILLE (N.C.) OBSERVER (June 22, 2014), *available at* http://www.fayobserver.com/military/new-power-grids-to-keep-fort-bragg-running/article_d6818d29-e861-5893-8930-376ae7d694ee.html. John Downey, *Duke Energy Learning to Store Power From Sun*, CHARLOTTE BUS. J. (Nov. 9, 2012), *available at* http://www.bizjournals.com/charlotte/print-edition/2012/11/09/duke-learning-to-store-power-from-sun.html. Duke Energy, *McAlpine Creek Demonstration Substation and Circuit*, available at http://aee-ncpc.org/docs/mcalpine_fact_sheet.pdf (last visited June 11, 2015). *Virginia Electric and Power Company d/b/a/ Dominion North Carolina Power's Smart Grid Technology Plan*, at 3, N.C. Util. Comm'n Docket No. E-100, Sub 141 (Oct. 1, 2014).

[13] John Downey, *N.C. Finishes Second for U.S. Solar Construction in 2014*, CHARLOTTE BUS. J. (March 11, 2015), *available at* http://www.bizjournals.com/charlotte/blog/energy/2015/03/n-c-finishes-second-for-u-s-solar-construction-in.html. John Downey, *North Carolina to Get*

faced and overcome many barriers to grow their market share, standing alone, they are intermittent. North Carolina has relied upon traditional generation to smooth the generation profile of renewable energy resources, but strategically integrating large and small scale batteries can also smooth an intermittent generation profile.[14] While batteries are not an all-encompassing solution, they are a grid resource that can integrate more renewable energy into the grid and allow homeowners to take full advantage of rooftop solar photovoltaic (PV) systems.

SYNTHESIS

BARRIERS

The analysis of the publications examined reveals that barriers to the implementation of batteries fit into five general categories: modeling, technological, financial, market, and regulatory. Within these general categories the publications typically identified more specific barriers. However, as shown in Table 1, some barriers were noted more frequently than others.

Examining the identified barriers exposes patterns in how barriers shift over time. Discussions in earlier publications focus more heavily on technological and financial barriers to batteries. In comparison, discussions in later publications focused more heavily on regulatory barriers that only became apparent when technological improvements and cost decreases allowed batteries to be commercially deployed.

The barriers to implementation of batteries identified in the examined publications are discussed in detail below. Barriers are presented according to how frequently they were identified in the examined publications.

Industry Acceptance (Technological Barrier) – The most commonly identified barrier is acceptance of batteries, particularly by utilities and regulators. A barrier is present when stakeholders do not understand the benefits of batteries due to a lack of exposure.[15] This lack of acceptance can also lead to a lack of the real-world usage necessary to validate the benefits of batteries.[16] A lack of acceptance can also keep regulators from considering issues surrounding batteries, which can lead to further barriers as discussed below.[17] Furthermore, a lack of acceptance can lead to excessive, and often unnecessary, caution regarding the installation of batteries.[18] This barrier thus slows technological development, and is also likely to slow or limit advancements and opportunities that would reduce soft costs, such as marketing, installation, and interconnection.

South's First Utility-Scale Wind Farm, CHARLOTTE BUS. J. (July 13, 2015), *available at* http://www.bizjournals.com/charlotte/blog/energy/2015/07/north-carolina-to-get-south-s-first-utility-scale.html.

[14] SKY STANFIELD & AMANDA VANEGA, INTERSTATE RENEWABLE ENERGY COUNCIL, DEPLOYING DISTRIBUTED ENERGY STORAGE 10-11 (2015). BHATNAGAR & LOOSE, *supra* note 8, at 19-20. SANDIA NAT'L LAB., *supra* note 8, at 17. STANTON, *supra* note 8, at 2.

[15] DHRUV BHATNAGAR ET AL., SANDIA NAT'L LAB., MARKET AND POLICY BARRIERS TO ENERGY STORAGE DEPLOYMENT 32 (2013). BHATNAGAR & LOOSE, *supra* note 8, at 11. SANDIA NAT'L LAB., *supra* note 8, at 24. U.S. DEP'T OF ENERGY, *supra* note 7, at 30.

[16] SANDIA NAT'L LAB., *supra* note 8, at 24-25.

[17] *Id.* at 25.

[18] BHATNAGAR ET AL., *supra* note 15, at 30.

Table 1. Barriers to the Implementation of Batteries [19]

Barrier Category	Specific Barrier	Sandia (2010)	Sandia (2012)	Sandia (2013)	U.S. DOE (2013)	NRRI (2014)	IREC (2015)
Modeling	Generally	✓		✓		✓	
Technological	Maturity	✓					
	Efficiency					✓	
	Scale					✓	
	Validated Performance	✓			✓	✓	
	Industry Acceptance	✓	✓	✓	✓	✓	
Financial	Cost	✓		✓	✓	✓	
	Incentives		✓			✓	✓
	Measuring and Monetizing Value		✓	✓		✓	✓
Market	Market Design / Business Model			✓		✓	✓
	Price Signals			✓			✓
Regulatory	Generally			✓	✓	✓	✓
	Classification	✓	✓	✓		✓	
	Long-Term Planning					✓	
	Deployment and Location					✓	✓
	Jurisdiction		✓	✓		✓	✓

The most commonly identified barrier, shown in green, is industry acceptance, having been cited by five of the six publications examined. The next most frequently identified barriers, shown in gray, include cost, measuring and monetizing value, general regulatory barriers, classification, and jurisdiction, which were each cited by four of the publications. Finally, identified in blue are the barriers cited by three of the publications, which include modeling, validated performance, and market design / business model.

Cost (Financial Barrier) – The examined publications noted that battery costs can be a barrier for regulators, utilities, and consumers, even though the unique services provided by batteries do not lend themselves easily to cost comparisons with traditional technologies.[20] Costs for some batteries may be elevated or unpredictable if the technologies are still in early stages of commercialization.[21] Costs are also identified as a barrier because

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[19] BHATNAGAR & LOOSE, *supra* note 8. BHATNAGAR ET AL., *supra* note 15, at 21. SANDIA NAT'L LAB., *supra* note 8. STANFIELD & VANEGA, *supra* note 14. STANTON, *supra* note 8, at 11. U.S. DEP'T OF ENERGY, *supra* note 7.

[20] BHATNAGAR ET AL., *supra* note 15, at 34. SANDIA NAT'L LAB., *supra* note 8, at 24.

[21] STANTON, *supra* note 8, at 8.

life cycles may not be known, making the total lifetime value of a battery unpredictable.[22] Finally, hardware components and soft costs beyond the battery itself may also be barriers.[23]

Measuring and Monetizing Value (Financial Barrier) – Batteries are capable of providing multiple services to the electric grid and stacking services, which is providing multiple services simultaneously.[24] However, the inability to measure these services and monetize the values they provide can be a barrier because it prevents battery owners from earning a return on their investment.[25] This barrier is closely interrelated with industry acceptance and cost, because larger scale deployment of batteries will enable reductions in hardware costs due to economies of scale and will address soft costs, thus making it easier for battery owners to monetize the services their systems provide.

General Regulatory Barriers – While specific regulatory barriers were identified in the examined publications and are discussed further, the general category of regulatory barriers was also identified. Examples of general regulatory barriers include procedural issues, such as slow adoption of new regulations and discrepancies in regulations between various markets.[26]

Classification (Regulatory Barrier) – In deregulated markets, assets must be classified as generation, transmission, or distribution to allow participation in the appropriate wholesale market.[27] However, batteries are capable of providing services to all three markets.[28] Therefore, classification of batteries is a barrier because it may limit the markets in which batteries may sell services.

Jurisdiction (Regulatory Barrier) – Jurisdictional barriers exist when there are discrepancies in regulations between various markets.[29] Such jurisdictional barriers become apparent when businesses or utilities operate in multiple states. However, these jurisdictional barriers are present for most aspects of energy regulation and are not unique to batteries. A second form of jurisdictional barrier is present when there is uncertainty as to whether a particular issue falls within the jurisdiction of the Federal Energy Regulatory Commission (FERC) or the state utility commission.[30]

Modeling – Utilities rely on complex modeling software that assesses load and evaluates options for new generation when developing long-range plans. To most efficiently integrate batteries into the grid, they should be modeled when utilities are developing these plans. However, modeling batteries is extraordinarily complex because they provide quantifiable benefits to multiple segments of the grid.[31] No current model properly quantifies these benefits, which keeps utilities from incorporating the full potential of batteries into their long-range plans.[32] Organizations are developing models that better incorporate the costs and benefits provided by batteries to improve how utilities incorporate them into their long-term plans.[33]

Validated Performance (Technological Barrier) – A lack of validated performance data is a technological barrier to batteries. Data is necessary to validate the performance, benefits, and lifespan of batteries, and

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[22] BHATNAGAR ET AL., *supra* note 15, at 34.
[23] U.S. DEP'T OF ENERGY, *supra* note 7, at 30.
[24] *Id.* STANTON, *supra* note 8, at 6.
[25] BHATNAGAR & LOOSE, *supra* note 8, at 11. STANTON, *supra* note 8, at 6. U.S. DEP'T OF ENERGY, *supra* note 7, at 30.
[26] BHATNAGAR ET AL., *supra* note 15, at 21-23.
[27] SANDIA NAT'L LAB., *supra* note 8, at 23.
[28] *Id.* BHATNAGAR & LOOSE, *supra* note 8, at 11. BHATNAGAR ET AL., *supra* note 15, at 22.
[29] BHATNAGAR ET AL., *supra* note 15, at 23.
[30] BHATNAGAR & LOOSE, *supra* note 8, at 11.
[31] BHATNAGAR ET AL., *supra* note 15, at 33. STANTON, *supra* note 8, at 5.
[32] BHATNAGAR ET AL., *supra* note 15, at 32. SANDIA NAT'L LAB., *supra* note 8, at 24. STANTON, *supra* note 8, at 9.
[33] BHATNAGAR ET AL., *supra* note 15, at 32. STANTON, *supra* note 8, at 9-10.

demonstrations, pilot projects, and large-scale installations are necessary to obtain this data.[34] This barrier is further complicated by the lack of a uniform industry standard practice for measuring battery performance.[35]

Market Design / Business Model (Market Barrier) – Currently, third parties may not have access to a market for ancillary services that would provide owners with compensation for services provided to the grid.[36] While a market for frequency regulation services has been created in Independent System Operator (ISO) and Regional Transmission Organization (RTO) territories, there are not markets for other ancillary services, such as black start, reactive power, and reserves.[37] Access to a market would allow battery owners to earn a greater return on their investment. However, the design of such a market is complicated by the fact that batteries can stack services.[38] In jurisdictions that require a minimum capacity of generation to participate in the market for ancillary services, market design is further complicated for owners of distributed batteries because in most cases they must aggregate services to participate in the market.[39]

Other Barriers – As many battery technologies are still being developed and commercialized, there are **technological barriers** to batteries relating to technological maturity, efficiency, and scaling demonstration projects to utility applications.[40] The presence of few incentives has been noted as a **financial barrier** to the deployment of batteries.[41] Identified **market barriers** include a lack of the price signals necessary to measure and monetize values provided by storage, such as time-varying rates and demand charges that would provide an economic incentive for owners of distributed batteries to operate their systems in a manner most beneficial to the grid.[42] Finally, **regulatory barriers** were identified as a general barrier, without specificity, in that existing regulations do not always address issues presented by batteries.[43]

APPROACHES

The examined publications also make suggestions for policymakers to address the identified barriers. These suggested approaches fall into five general categories: (i) demonstrate an interest in batteries; (ii) clarify how existing regulations apply to batteries; (iii) stimulate the market for batteries; (iv) include batteries in future planning; and (v) provide an appropriate economic environment for batteries. While these approaches were suggested for use across the states, this primer attempts to distill their application to North Carolina's legal and regulatory framework.

Demonstrations and Pilot Projects – While some energy storage technologies have been in use for decades, new battery technologies are continuously being developed and new uses for batteries are being examined. Demonstrations and pilot projects can validate battery performance in various applications and the data and analytics that they provide can prove cost-effectiveness to regulators, utilities, and other potential owners.[44]

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[34] SANDIA NAT'L LAB., *supra* note 8, at 23. U.S. DEP'T OF ENERGY, *supra* note 7, at 30.
[35] U.S. DEP'T OF ENERGY, *supra* note 7, at 30.
[36] BHATNAGAR ET AL., *supra* note 15, at 26. STANTON, *supra* note 8, at 7.
[37] BHATNAGAR ET AL., *supra* note 15, at 27. STANFIELD & VANEGA, *supra* note 14, at 29.
[38] STANFIELD & VANEGA, *supra* note 14, at 29. STANTON, *supra* note 8, at 7.
[39] STANFIELD & VANEGA, *supra* note 14, at 30.
[40] STANTON, *supra* note 8, at 6-7.
[41] BHATNAGAR & LOOSE, *supra* note 8, at 33. STANFIELD & VANEGA, *supra* note 14, at 23-24. U.S. DEP'T OF ENERGY, *supra* note 7, at 12.
[42] SANDIA NAT'L LAB., *supra* note 8, at 11. STANFIELD & VANEGA, *supra* note 14, at 29-30. STANTON, *supra* note 8, at 10-11. U.S. DEP'T OF ENERGY, *supra* note 7, at 27-28.
[43] SANDIA NAT'L LAB., *supra* note 8, at 23. STANTON, *supra* note 8, at 9-10.
[44] BHATNAGAR & LOOSE, *supra* note 8, at 35. BHATNAGAR ET AL., *supra* note 15, at 32. SANDIA NAT'L LAB., *supra* note 8, at 29. STANTON, *supra* note 8, at 7. U.S. DEP'T OF ENERGY, *supra* note 7, at 50-51.

Coordinate Oversight – Because batteries can fall within the jurisdiction of multiple regulatory bodies for differing issues, these regulatory bodies should coordinate oversight to ensure they are not imposing duplicative or conflicting requirements.[45] Batteries are not unique among electricity resources in needing the coordination of regulatory bodies, but their status as an emerging technology increases the importance of this approach.

Table 2. Approaches to Integrating Batteries [46]

Approach Category	Specific Approach	Sandia (2010)	Sandia (2012)	Sandia (2013)	DOE (2013)	NRRI (2014)	IREC (2015)
Demonstrate an Interest in Batteries	Generally						✓
	Studies & Research	✓		✓	✓		
	Demonstrations and Pilot Projects	✓	✓	✓	✓	✓	
	Stakeholder Engagement	✓		✓	✓		
Clarify Existing Regulations	Generally			✓	✓		✓
	Interconnection						✓
	Net Metering						✓
	Coordinate Oversight	✓	✓	✓	✓		✓
Stimulate the Market	Generally						✓
	Incentives		✓				
	Mandates		✓			✓	
	RFPs					✓	
Include in Future Planning	Generally					✓	✓
	IRPs				✓	✓	
	Distribution Planning						✓
	Microgrids					✓	
Provide an Appropriate Economic Environment	Rate Design			✓		✓	✓
	Cost Recovery			✓		✓	
	Market for Ancillary Services		✓	✓	✓		✓

As shown in green, the most commonly suggested approaches implement batteries are to utilize demonstrations and pilot projects and to coordinate oversight, both of which were discussed by five of the six publications examined. Shown in gray, four of the publications suggested creating a market for ancillary services. Finally, shown in blue, three of the publications suggested studies and research, generally clarifying existing regulations, and rate design.

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45 STANFIELD & VANEGA, *supra* note 14, at 5.

46 *Id.* at 4-5. BHATNAGAR ET AL., *supra* note 15, at 21-36. BHATNAGAR & LOOSE, *supra* note 8, at 34-41. SANDIA NAT'L LAB., *supra* note 8, at 27-30. STANTON, *supra* note 8, at 9-13. U.S. DEP'T OF ENERGY, *supra* note 7, at 30-34 & 38-39.

Market for Ancillary Services – The Public Utility Regulatory Policies Act of 1978 (PURPA) requires utilities to purchase energy generated by certain independent small power producers located in their service area.[47] However, PURPA's application to the sale of ancillary services is still being examined. In 2001, FERC issued an order requiring RTOs and ISOs to compensate third parties for frequency regulation services.[48] Two years later FERC issued an order allowing RTOs and ISOs to fulfill certain requirements with ancillary services procured from third parties.[49] By opening markets for ancillary services to independent batteries, FERC has created a method for owners of utility-scale batteries to earn a return on their investment. In comparison, while the capability of individual distributed batteries to provide ancillary services is minimal, the cumulative capability of numerous distributed batteries working in conjunction is substantial.[50] However, as of yet there is no market for distributed batteries to cumulatively provide ancillary services to the grid.

Studies and Research – Continued studies and research of batteries will make them more reliable, efficient, and affordable.[51] By making them more affordable, batteries will also become more cost-competitive with other technologies and resources.[52] Studies and research can also lead to new battery technologies, better understanding of applications and better understanding of consumer demand.[53]

Stakeholder Engagement – Stakeholder engagement promotes technological development, which leads to increased efficiency and reliability while lowering costs.[54] Groups, including the Department of Energy, are currently engaging stakeholders to pursue technological advances.[55] Furthermore, stakeholder engagement in reforming policy may lead to regulations, incentives, and rates that are beneficial for the broadest spectrum of users.

Generally Clarify Existing Regulations – Numerous regulations governing the utility industry are applicable to batteries. However, the majority of these regulations were developed prior to batteries becoming commercially viable or widely adopted. As such, and because of batteries' unique ability to perform multiple functions for the grid, their application to batteries is often unclear. The two most common regulatory issues that arise with batteries center on interconnection and net metering. Additionally, a regulatory barrier arises when there are multiple agencies overseeing an industry, and as such, these agencies should coordinate oversight as to not hinder the development of batteries. Accordingly, leading commentators have suggested that regulatory bodies clarify how existing regulations apply to batteries and work together to ensure that regulations are not duplicative or contradictory.

Rate Design – **Rate tariffs** can be crafted to encourage consumers to implement distributed batteries.[56] The most efficient method for consumers to operate distributed batteries is for them to charge their systems during off-peak periods and then consume or discharge electricity from their systems during peak periods. A properly designed rate tariff can send pricing signals to consumers to encourage them to operate their batteries in a manner that most benefits the grid.[57]

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[47] Public Utilities Regulatory Policy Act, Section 210(a), 16 U.S.C. 824a-3(a). 18 C.F.R. 292.303(a).
[48] FERC Order No. 758, 137 FERC ¶ 61,064, ¶ 3 (Oct. 20, 2011).
[49] FERC Order No. 784, 144 FERC ¶ 61,056, ¶ 13 (July 18, 2013). BHATNAGAR ET AL., *supra* note 15, at 38.
[50] STANFIELD & VANEGA, *supra* note 14, at 5 & 29-31.
[51] SANDIA NAT'L LAB., *supra* note 8, at 27-28.
[52] U.S. DEP'T OF ENERGY, *supra* note 7, at 34.
[53] SANDIA NAT'L LAB., *supra* note 8, at 27-28. STANTON, *supra* note 8, at 14.
[54] SANDIA NAT'L LAB., *supra* note 8, at 29-30 & 32.
[55] BHATNAGAR ET AL., *supra* note 15, at 32.
[56] STANTON, *supra* note 8, at ii and 9.
[57] STANFIELD & VANEGA, *supra* note 14, at 5 & 28-29.

Time-varying rates generally provide the best pricing signals and economic incentives for consumers to operate their batteries in an efficient manner.[58] Time-varying rates can be as simple as existing time-of-use rates.[59] However, current residential time-of-use rates generally do not include demand charges and have a relatively small price difference between peak and off-peak periods.[60] As such, existing residential time-of-use rates alone may not make batteries cost effective.[61]

In response, commentators have suggested two variations of existing residential time-of-use rates that make batteries more attractive to consumers. The first variation includes a larger **price difference between peak and off-peak periods** that would encourage battery system owners to charge their systems during off-peak periods.[62] The second variation, referred to as **super off-peak pricing**, adds a third pricing period that provides very low prices during periods of very low demand, allowing batteries to charge efficiently, often during the middle of the night.[63] Some utilities have already begun creating special rates akin to super off-peak pricing for consumers who own electric vehicles to encourage them to charge their vehicles during off-peak periods.[64] The methodology used in crafting these rates for electric vehicles could also be applied to distributed batteries.[65]

Finally, **demand charges** can be used to reveal the avoided costs that batteries save.[66] For commercial and industrial customers currently subject to demand charges, distributed batteries can both reduce their energy bills and reduce strain on the grid.[67] While most residential rate tariffs do not currently include demand charges, the inclusion of them in the future could prompt residential consumers to adopt distributed batteries for the same reasons.

Other Approaches

Demonstrating an interest in batteries can serve as a precursor to future policy action.[68] Interest can be shown through studies and research, demonstration and pilot projects, and stakeholder engagement through workshops, advisory groups, or other methods.[69]

Many states have established **interconnection standards** for non-utility owned generation resources to connect to the electric grid pursuant to PURPA. However, unless interconnection standards address batteries, they will serve as a barrier to widespread implementation.[70] As they relate to batteries, commentators have suggested that interconnection standards should address how to calculate generation capacity, whether systems that do not generate should go through the same interconnection process as those that generate, and how to address necessary upgrades to the distribution system.[71] Because most states have established interconnection standards, amending the existing regulations to address batteries can be easily accomplished.

State regulatory bodies must determine whether owners of distributed batteries may participate in **net**

[58] *Id.* at 28-29. STANTON, *supra* note 8, at 10.
[59] STANTON, *supra* note 8, at ii.
[60] STANFIELD & VANEGA, *supra* note 14, at 28-29.
[61] *Id.*
[62] *Id.*
[63] *Id.*
[64] *Id.*
[65] *Id.*
[66] STANTON, *supra* note 8, at 10.
[67] *Id.* STANFIELD & VANEGA, *supra* note 14, at 29.
[68] STANFIELD & VANEGA, *supra* note 14, at 20.
[69] *Id.* SANDIA NAT'L LAB., *supra* note 8, at 28-30.
[70] STANFIELD & VANEGA, *supra* note 14, at 31-33.
[71] *Id.*

metering offerings. When batteries and generation are installed behind the same meter, there is no easy way to determine whether energy being stored was generated behind the meter or by the utility. This is especially problematic in jurisdictions that limit the aggregate capacity of net metering participation. Batteries can reduce the number of systems eligible to participate in net metering because it may be selling grid-generated energy back to the utility.[72] Suggestions from commentators on how to address issues surrounding net metering include utilizing a second meter attached to the battery, estimating the impact of a battery based on its size, establishing a de minimis size below which a battery is deemed not to have an impact on net metering, and limiting eligibility to batteries that do not exceed a certain percentage of the distributed energy generation capacity.[73]

Commentators have suggested three general methods to **stimulate the market** for batteries: incentives, mandates, and requests for proposals. Carefully crafted **incentives** can encourage the deployment of batteries.[74] Incentives can encourage utilities to install batteries, encourage third parties to install batteries, or encourage the design and manufacture of battery technologies and components.[75] A **mandate** is a simple way to increase adoption of batteries.[76] Mandates can require utilities install a minimum capacity of batteries or invest a set amount in batteries.[77] Some states have mandated batteries by including them in renewable portfolio standards.[78] Mandates guarantee deployment, necessitate addressing barriers, and create economies of scale. **RFPs** can be used to encourage the deployment of batteries.[79] When utilities identify specific or discrete needs, regulators can direct them to issue RFPs for battery projects that will meet these needs.[80]

Batteries cannot be deployed in a cost effective manner without knowing when and where the services they provide will be needed. Therefore, batteries must be included when utilities are **planning for the future**. Many state regulatory bodies oversee **integrated resource planning** where utilities analyze load growth and proposed generation portfolios to meet future demands.[81] Inclusion of batteries as a generation resource in this process would place the technology on the same level as both traditional and renewable generation resources for planning purposes.[82]

The traditional grid is premised on distributing energy from a central generating facility to distributed consumers. However, the increasing prevalence of distributed generation runs counter to this paradigm. This shift is prompting some states to reexamine how they plan for the distribution of electricity, and several have directed utilities to develop plans for how their distribution systems will incorporate distributed generation.[83] Reexamination of **distribution planning** provides an ideal juncture to include batteries in any new process. **Microgrids** are small-scale electricity grids that can operate independently of larger utility electricity grids. Microgrids are frequently discussed as a cornerstone component of future utility business models and, because batteries are necessary to allow them to operate when disconnected from the grid, including microgrids in future planning necessitates consideration of batteries.[84]

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[72] *Id.* at 33-35.
[73] *Id.*
[74] *Id.* at 23.
[75] *Id.* at 23-24.
[76] STANTON, *supra* note 8, at 11.
[77] *Id.*
[78] *Id.* at 27-28. BHATNAGAR & LOOSE, *supra* note 8, at 33.
[79] STANTON, *supra* note 8, at 10.
[80] *Id.*
[81] *Id.* at 9.
[82] *Id.* at 10. BHATNAGAR & LOOSE, *supra* note 8, at 22. U.S. DEP'T OF ENERGY, *supra* note 7, at 39.
[83] STANTON, *supra* note 8, at 35-36.
[84] *Id.* at 11.

The lack of a robust **economic environment** for batteries is a critical barrier to its widespread adoption. Three primary issues must be addressed to create an economic environment that allows consumers, utilities, and third parties to properly deploy batteries. First, rate tariffs must provide consumers with appropriate economic indicators that allow them to operate distributed batteries in an efficient manner. Second, before they will be willing to make large scale investments in batteries, utilities must be confident that they will be able to recover costs. Finally, there must be a market for third parties to provide ancillary services before third parties will invest in batteries to provide services to the grid.

DISCUSSION

BARRIERS IN NORTH CAROLINA

Several of the key barriers identified in the literature review are universal in nature and affect North Carolina as they would any other jurisdiction. Issues, including **cost**, **modeling**, and **validated performance** are universal in nature and do not affect North Carolina any differently than other states. **Industry acceptance** of batteries is another universal barrier. While North Carolina's utilities are beginning to gain valuable experience with batteries through pilot projects, industrial, commercial, and residential consumers have even less experience with batteries.

In most of North Carolina, there is not a market for third parties to provide ancillary services to the grid. However, there must be such a market before barriers such as **measuring and monetizing value** and **market design and business models** can be addressed. Some **regulatory barriers** are beginning to be addressed in North Carolina. For example, the Utilities Commission recently approved amendments to the state's interconnection standards that clarified the requirements for batteries to connect to the grid.[85]

Because of North Carolina's regulated market structure, other key barriers may prove less burdensome than in other states. Because the Utilities Commission is the primary regulatory body and FERC has less oversight in the state, issues of **jurisdiction** conflicts are less likely than in deregulated states. Similarly, because the state has a regulated market with vertically-integrated utilities, the **classification** of batteries is not a barrier in North Carolina.

APPROACHES FOR NORTH CAROLINA

North Carolina is already executing some of the key approaches discussed in the literature review. The state is already home to several **demonstrations and pilot projects**. As discussed above, Duke Energy Carolinas and Dominion both have pilot projects in North Carolina that include batteries. North Carolina's REPS allows utilities to recover up to $1 million annually for "research that encourage[s] the development of renewable

[85] *Order Approving Revised Interconnection Standards*, Attachment 1, p. 2, N.C. Util. Comm'n Docket No. E-100, Sub 101 (May 15, 2015).

energy, energy efficiency, or improved air quality[.]"[86] Dominion used this provision to fund **research** related to its Kitty Hawk microgrid pilot project that incorporated batteries.[87]

The Utilities Commission has also begun to **clarify existing regulations** that apply to batteries. North Carolina state law requires the Utilities Commission to establish interconnection standards for non-utility owned generation of less than 10 megawatts.[88] A recently approved revision to these standards included a new definition of "generating facility" that encompasses energy storage, providing regulatory certainty and a known working environment for developers.[89] Furthermore, net metering is not as significant a barrier for customers of investor-owned utilities in North Carolina as in other jurisdictions because the state does not impose a limit on the aggregate capacity of net metering tariffs.[90] Because there is not a limit on the aggregate capacity of net metering tariffs in North Carolina, less clarification regarding net metering regulations is necessary.

While Duke Energy Carolinas and Duke Energy Progress do not participate in a RTO or ISO, Dominion participates in PJM Interconnection (PJM), the RTO operating in the Mid-Atlantic states. Accordingly, the Utilities Commission should **coordinate oversight** with PJM and FERC to ensure that they are not imposing conflicting requirements for batteries. At the state level, the Utilities Commission can also coordinate with the North Carolina Building Code Council to ensure that building codes address batteries appropriately.

Because of its regulated market, creating a **market for ancillary services** provided by third parties may be more difficult here than in deregulated states. Only Dominion, due to its participation in PJM, is bound by FERC's orders to compensate third parties for ancillary services. It remains in the purview of the Utilities Commission to require Duke Energy Carolinas and Duke Energy Progress to compensate third parties for ancillary services, which would create a market in a majority of the state.

Current **rate design** options in North Carolina provide commercial and industrial customers with time-varying rates, demand charges, peak pricing, and other economic indicators that incent customers to operate batteries in a manner that is both efficient for the customer and beneficial to the grid. In contrast, rate tariffs for residential customers are limited to only time-of-use pricing, which alone may not be sufficient to incent efficient and beneficial operation of batteries. Therefore, new rate tariffs may be necessary to provide residential customers with appropriate economic indicators.

Stakeholder engagement on technical issues can promote technological development, increasing efficiency and reliability while lowering costs, and entities such as the Department of Energy are currently working to engage stakeholders.[91] Similarly, stakeholder engagement on regulatory issues can lead to regulations that are beneficial for the broadest spectrum of users.

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[86] N.C. Gen. Stat. § 62-133.8(h)(1) & (2) (2015).
[87] *Order Approving REPS and REPS EMF Riders and 2013 REPS Compliance*, N.C. Util. Comm'n Docket No. E-22, Sub 514 (Dec. 11, 2014).
[88] N.C. Gen. Stat. § 62-133.8(i)(4) (2015).
[89] *Order Approving Revised Interconnection Standards*, Attachment 1, p. 2, N.C. Util. Comm'n Docket No. E-100, Sub 101 (May 15, 2015).
[90] While the Utilities Commission initially limited participation in net metering tariffs to 0.2% of a utility's peak load, the limit was removed when the standards were amended in 2009. *See*, *Order Adopting Net Metering*, p. 3, N.C. Util. Comm'n Docket No. E-100, Sub 83 (Oct. 20, 2005); *Order Amending Net Metering Policy*, pp. 11-12, N.C. Util. Comm'n Docket No. E-100, Sub 83 (March 31, 2009). The Utilities Commission does not have jurisdiction over electric membership corporations or municipal electric suppliers.
[91] BHATNAGAR ET AL., *supra* note 15, at 32. SANDIA NAT'L LAB., *supra* note 8, at 29-30 & 32.

NC SUSTAINABLE ENERGY ASSOCIATION

CONCLUSION

North Carolina is home to one of the most robust solar markets in the nation and reliance on renewable energy is expected to increase in the coming years. Solar is intermittent, but when paired with batteries its generation profile can be smoothed. While battery storage will not solve every issue facing our electric grid, they are a tool that should and, as costs continue to decline, increasingly will be used in advancing North Carolina's clean energy economy. Accordingly, North Carolina should begin preparing its legal and regulatory framework to allow both utilities and consumers to begin installing batteries.

One of the most basic approaches to facilitating the installation of batteries by both utilities and consumers is to demonstrate an interest in batteries through a working group of interested stakeholders. A working group is one of the simplest, and least cost, methods of demonstrating an interest in batteries and, if a working group is not convened, it is highly probable that issues affecting batteries will be handled piecemeal in different Utilities Commission dockets and at the General Assembly. Furthermore, while this primer focuses on legal and regulatory barriers, a working group could address technical and market barriers that are not discussed here.

While aspects of North Carolina's legal and regulatory environment are beginning to prepare for the widespread deployment of batteries, there is much work still to be done and many barriers to be addressed. Accordingly, this paper recommends that a working group of interested stakeholders be convened to examine these challenges and propose solutions to the legal, regulatory, and other barriers to battery storage in North Carolina.

GLOSSARY

Dominion	Dominion North Carolina Power One of three investor-owned utilities operating in North Carolina, primarily serving northeastern parts of the state.
Duke Energy Carolinas	One of three investor-owned utilities operating in North Carolina, primarily serving western parts of the state.
Duke Energy Progress	One of three investor-owned utilities operating in North Carolina, primarily serving central and southeastern parts of the state.
FERC	Federal Energy Regulatory Commission The federal regulatory body with oversight of utilities engaging in interstate commerce
General Assembly	North Carolina General Assembly. The legislative branch of state government.
ISO	Independent System Operator An organization that coordinates the operation of the electric power system for a given area
PJM	PJM Interconnection The RTO covering all or parts of thirteen states and Washington D.C., from North Carolina in the south, to New Jersey in the north, to Illinois in the west
PURPA	Public Utility Regulatory Policies Act of 1978 Federal energy legislation which, among other policies, requires utilities to purchase electricity from most small power producers
RTO	Regional Transmission Organization An organization that coordinates the operation of the electric power and transmission systems for a given area