PPES-MRPS-2018
DNR 12-110218-103

PPRP

INTERIM REPORT CONCERNING THE MARYLAND RENEWABLE PORTFOLIO STANDARD AS REQUIRED BY CHAPTER 393 OF THE ACTS OF THE MARYLAND GENERAL ASSEMBLY OF 2017

December 2018

MARYLAND POWER PLANT RESEARCH PROGRAM

Larry Hogan, Governor

Mark Belton, Secretary
Maryland Department of Natural Resources
Power Plant Research Program
580 Taylor Avenue
Annapolis, MD 21401
dnr.Maryland.gov
410-260-8660

Additional Contact Information
Toll free in Maryland: 1-877-620-8DNR x8660
Outside Maryland: 1-410-260-8660
TTY users call via the Maryland Relay
www.dnr.Maryland.gov

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Acknowledgments

This report was prepared by Exeter Associates, Inc., under the direction of the Power Plant Research Program of the Maryland Department of Natural Resources. Kevin Porter of Exeter Associates was the project manager. Important contributions to the report were made by Laura Miller, Stacy Sherwood, Rebecca Widiss, Matthew Hoyt, Katherine Fisher, William Cotton, Nick DiSanti, Cali Clark and Angela Richardson. The authors thank the members of the Maryland Renewable Portfolio Standard Work Group (see Appendix B) for their contributions. The authors also thank the Maryland Public Service Commission, the Maryland Energy Administration, the Maryland Office of People's Counsel, PJM Interconnection, LLC and the Maryland Department of Natural Resources for their review of several drafts.

The Maryland Public Service Commission provided technical feedback in the preparation and accuracy of this report. The Commission takes no position with respect to any of the regulatory or policy options or recommendations presented.

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Abstract

The *Interim Report Concerning the Maryland Renewable Portfolio Standard* (Interim Report) is a statutory requirement enacted by Chapter 393 of the Acts of the Maryland General Assembly of 2017. The statute calls on the Maryland Department of Natural Resources Power Plant Research Program to prepare a comprehensive study of the Maryland Renewable Portfolio Standard. The purpose of this Interim Report is to update the General Assembly on the focus of program's efforts to date and to document the steps for completing the final report.

Executive Summary

The *Interim Report Concerning the Maryland Renewable Portfolio Standard* (Interim Report) is required by Chapter 393 of the Acts of the Maryland General Assembly of 2017. Under Ch. 393, the Maryland Department of Natural Resources (DNR) Power Plant Research Program (PPRP) is directed to conduct a comprehensive study of the Maryland Renewable Portfolio Standard (RPS) in cooperation with the Maryland Energy Administration (MEA), the Maryland Department of the Environment, the Maryland Public Service Commission (PSC), and other state and local units, encompassing the economic, socioeconomic, environmental and reliability impacts of the Maryland RPS. More specifically, Ch. 393 requires a comprehensive review of whether there are sufficient renewable energy resources to meet the Maryland RPS, the overall costs and benefits, and the effectiveness of the Maryland RPS as well as what changes might be necessary to improve the performance of the Maryland RPS or to alleviate any unintended consequences.

In October 2017, PPRP issued a Request for Proposal (RFP) seeking companies to perform the RPS study and PPRP subsequently selected Exeter Associates Inc. (Exeter) of Columbia, Maryland. PPRP's contract with Exeter was approved by the Board of Public Works in May 2018 and commenced in June 2018. To assist in the study and to ensure a diverse set of opinions, PPRP formed the RPS Work Group consisting of stakeholders from electric utilities, power generators, environmental groups, state and local governments, and community representatives.

One of the primary requirements of Ch. 393 is to determine whether there are sufficient renewable energy resources to meet current and projected RPS targets in Maryland and within the PJM Interconnection, LLC (PJM) service area. This determination will serve as a foundation upon which to build the analysis in the study. To make this determination, this study will draw upon the forthcoming *2017 Inventory of Renewable Energy Generators Eligible for the Maryland Renewable Energy Portfolio Standard* (2017 Inventory Report). The Executive Summary of the 2017 Inventory Report is incorporated as Appendix A to this Interim Report. Based on the 2017 Inventory Report, this Interim Report finds that, from known renewable energy projects under development and projected growth, there is sufficient non-carve-out Tier 1 renewable energy generation to meet the current (as of October 2018) requirements of state RPS policies within PJM, including Maryland, through 2030 except for small deficits from 2022 through 2025. In addition, the present solar carve-out of 2.5 percent within Tier 1 of the Maryland RPS is expected to be met every year through 2030.

While this Interim Report covers some preliminary results of required tasks from Ch. 393, many tasks are currently being prepared for the final report. An example of analysis required by Ch. 393 that is not in this Interim Report but will be in the final report is the ratepayer impact associated with long-term contracts tied to clean energy projects. Some of the data provided in this Interim Report include:

- Renewable energy capacity and generation presently in Maryland as compared to 2004 (the RPS initial year);
- Use of renewable energy credits (RECs) and solar renewable energy credits (SRECs) as compliance tools;
- Geographic and technology sources of RECs and SRECs used for meeting the Maryland RPS;
- Cost trends for RECs and SRECs; and
- Costs of the Maryland RPS in general.

Ch. 393 provides requirements for this Interim Report, including an assessment of any change in SREC prices over the 24-month period leading up to the date this Interim Report is submitted to the Maryland General Assembly; i.e., up to December 1, 2018. This Interim Report also assesses non-carve-out Tier 1 REC prices as well as SRECs. Further, this report finds that non-carve-out Tier 1 REC and SREC prices have dropped significantly since 2016 due to a sharp increase in the development of renewable energy projects, especially solar, both in Maryland and within the PJM service area.

Finally, Appendix C of this Interim Report presents analyses concerning issues regarding RPS policies in other states and the Maryland RPS in particular. The policy options were assessed using a strategic analysis technique known as SWOT (Strengths, Weaknesses, Opportunities and Threats). The options assessed were the following:

- Not changing the Maryland RPS at all;
- Increasing the Maryland RPS to 50 percent by 2030;
- Removing black liquor as an eligible Tier 1 resource;
- Providing state support for energy storage;
- Moving hydro from Tier 2 to Tier 1;
- Increasing the Tier 1 solar carve-out to 14.5 percent;
- Requiring long-term contracts;

- Lowering the alternative compliance payment level for non-carve-out Tier 1 and solar resources;
- Restricting geographic eligibility to within PJM; and
- Instituting subsidies for nuclear power via zero emission credits or a power purchase agreement.

I. Introduction

The Maryland General Assembly enacted the Maryland Renewable Portfolio Standard (RPS) in 2004, and it took effect in 2006. Since then, the Maryland RPS has been amended 10 times, and presently, the standard peaks at 25 percent in 2020 with 22.5 percent coming from non-solar Tier 1 resources and 2.5 percent from solar. Until the end of 2018, there is a Tier 2 standard of 2.5 percent, limited to hydro facilities other than pump storage plants.

This report is statutorily required by the General Assembly's enactment of House Bill 1414 (Ch. 393) in 2017 that directs the Power Plant Research Program (PPRP) of the Maryland Department of Natural Resources (DNR) to conduct a study of the Maryland RPS, with the *Interim Report Concerning the Maryland Renewable Portfolio Standard* (Interim Report) due to the General Assembly by December 1, 2018, and the final report by December 1, 2019. Specifically, Ch. 393 calls for an analysis of the following:

- The availability of all clean energy sources at reasonable and affordable rates, including in-state and out-of-state renewable energy options.
- The economic and environmental impacts of the deployment of renewable energy sources in the state and in the surrounding areas of the PJM Interconnection, LLC (PJM) region.
- The effectiveness of the standard in encouraging development and deployment of renewable energy sources.
- The impact of alterations that have been made in the components of each tier of the RPS, the implementation of different specific goals for particular sources and the effect of different percentages and alternative compliance payment (ACP) levels for energy in the tiers.
- An assessment of alternative models of regulation and market-based tools that may be available or advisable to promote the goals of the RPS and the energy policies of the state.
- The potential to alter or otherwise evolve the RPS in order to increase and maintain its effectiveness in promoting the state's energy policies.
- The role and effectiveness that the RPS may have in reducing the carbon content of imported electricity and whether existing or new, additional, complementary policies or programs could help address the carbon emissions associated with electricity imported into the state.

- The net environmental and fiscal impacts that may be associated with long-term contracts tied to clean energy projects, including:
  - Ratepayer impacts that resulted in other states from the use of long-term contracts for the procurement of renewable energy for the other states' standard offer service, and whether the use of long-term contracts incentivized new renewable energy generation development.
  - Statewide ratepayer impacts that may result from the use of long-term contracts for each energy source in the state's Tier 1 and whether, for each of the sources, the use of long-term contracts would incentivize new renewable energy generation.
- Whether the RPS is able to meet current and potential future targets without the inclusion of certain technologies.
- Which industries are projected to grow and to what extent as a result of incentives associated with the RPS.
- Whether the public health and environmental benefits of the growing clean energy industries supported by the RPS are being equitably distributed across overburdened and underserved environmental justice communities.
- Whether the state is likely to meet its existing goals under the RPS and, if the state were to increase those goals, whether electricity suppliers should expect to find an adequate supply to meet the additional demand for credits.
- Additional opportunities that may be available to promote local job creation within the industries that are projected to grow as a result of the RPS.
- System flexibility that the state would need under future RPS goals, including the quantities of system peaking and ramping that may be required.
- How energy storage technology and other flexibility resources should continue to be addressed in support of renewable energy and state energy policy, including:
  - Whether the resources should be encouraged through a procurement, a production or an installation incentive;
  - The advisability of providing incentives for energy storage devices to increase the hosting capacity of increased renewable on-site generation on the distribution system; and
  - Discussion of the costs and benefits of energy storage deployment in the state under future goal scenarios for renewable generation.

- The role of in-state clean energy in achieving greenhouse gas (GHG) emission reductions and promoting local jobs and economic activity in the state.
- An assessment of any change in solar renewable energy credit (SREC) prices over the immediate 24 months preceding the submission of the Interim Report to the General Assembly on December 1, 2018.

This report serves as the Interim Report required by Ch. 393. The report is organized as follows: a background section on the Maryland RPS is presented first, followed by a project status report. The status report includes results from the *2017 Inventory of Renewable Energy Generators Eligible for the Maryland Renewable Energy Portfolio Standard* (2017 Inventory Report), the Executive Summary of which is included as Appendix A. These results detail current renewable energy generation and capacity projects and the availability of renewable energy generation to meet current and future requirements of the Maryland RPS and other state RPS policies within the PJM service area. A section on future activities reveals the work that will be performed between now and when the final report is submitted. A discussion of renewable energy credit (REC) and SREC price trends in recent years concludes the Interim Report. An appendix (Appendix C) is provided that discusses the strengths and weaknesses of various policy options that have either been brought forward in recent sessions of the General Assembly or have been raised in other states.

Emerging Issues

This Interim Report and the upcoming final report are based on the requirements in Ch. 393, which directed the study of 23 specific aspects of the Maryland RPS. Two additional consequential topics, system planning and land use, arose during the data collection phase. In addition, a third issue arose as a result of PJM proposing to overhaul its capacity market to address, at least in part, the impacts of subsidized generation, including generators under state RPS policies. The potential impacts of the capacity market overhaul will not be known until the process is complete. All three of these issues will be addressed qualitatively below and in the final report, but a more thorough examination is warranted to understand the potential impact on the Maryland RPS going forward.

System Planning: In 2014, PJM completed a *Renewable Integration Study* to assess the potential impacts on grid operations of increased levels of wind and solar. General Electric Energy Consulting (GE), PJM's contractor, prepared a transmission study to address any reliability issues raised by adding variable renewable energy resources and any significant transmission congestion issues. GE assessed 10 different scenarios with different levels of offshore wind, onshore wind, distributed solar photovoltaic (PV), and central station PV. GE determined that additional transmission investments ranging from $3.7 to $13.7 billion would be necessary to accommodate the range of renewable energy scenarios GE studied. Furthermore, transmission congestion costs could add between $3.3 and $6.3 billion.[1] It is important to note that the PJM study did not include any analysis of the distribution system (voltages below 230 kV); therefore, the impacts of large-scale deployment of solar and wind on distribution systems across PJM and the state are generally uncertain. Depending on the location of deployed renewable energy resources, transmission and distribution upgrade costs may make some proposed renewable energy projects uneconomic and the time to complete upgrades may delay others, hampering the state's ability to meet a higher Maryland RPS. Should the General Assembly opt to increase the Maryland RPS, other changes to the Maryland RPS may be warranted to mitigate potential adverse impacts. Those changes could include lowering the ACP for solar and Tier 1 resources, delaying the implementation of an increased non-carve-out Tier 1 (solar carve-out and/or offshore wind carve-out) or allowing load-serving entities (LSEs) to request waivers from the Maryland PSC if certain conditions are met, such as inadequate supplies of RECs or SRECs.

Land Use: Land use concerns have become more prominent as utility-scale solar has been deployed across the state. One of the main concerns expressed at utility-scale solar public hearings for Certificates of Public Convenience and Necessity (CPCNs) held by the Maryland PSC is the impact on local industry and culture of siting solar projects on land historically used for agriculture. Land use concerns also extend to the ability of the state to meet a higher solar carve-out in the face of county regulations that restrict or cap solar development. Currently, the Maryland PSC, through its CPCN authority, can pre-empt county zoning regulations to site energy generation facilities like solar, although there is a requirement that local ordinances and master plans be given due consideration by the PSC. However, if the PSC's authority is restricted or rescinded, it could be difficult to site renewable energy facilities such as utility-scale solar in counties with more restrictive regulations than in other counties. The final report will include a qualitative and high-level discussion of this critical issue. However, a comprehensive analysis is necessary to fully assess the impact of land use issues on Maryland's ability to meet any increase in its RPS.

[1] *PJM Renewable Integration Study – Task 3A Part C – Transmission Analysis*, GE Energy Consulting, 2014, pjm.com/-/media/committees-groups/subcommittees/irs/postings/pjm-pris-task-3a-part-c-transmission-analysis.ashx?la=en.

PJM Capacity Market: PJM requires electricity providers that meet customer electric demand to have sufficient resources in order to meet electricity demand at all times, plus a reserve to handle any contingencies that might occur such as an outage of a generating plant or transmission line. Electricity providers can meet that requirement with generating capacity they own, with capacity purchased from others under contract or with capacity obtained through PJM capacity market auctions known as the Reliability Pricing Model or RPM.

Under the RPM, PJM holds annual, and as needed, incremental auctions for electric capacity to ensure sufficient resources are procured to meet forecasted electricity demand three years into the future. A variety of resources can bid into the RPM, such as planned and existing generators (renewable, thermal and nuclear), upgrades for existing generators, demand response (consumers reducing electricity use in exchange for payment), energy efficiency and transmission upgrades. Winning bidders in the RPM receive payments based on a market clearing price, but they must deliver during their contracted period or face significant penalties for non-performance.

The Federal Energy Regulatory Commission (FERC) is the principal regulatory agency having jurisdiction over PJM. In a FERC order issued June 29, 2018 (June 29 Order) in Docket No. EL18-178-000 (Consolidated), it concluded that the integrity and effectiveness of PJM's RPM "have become untenably threatened by out-of-market payments provided or required by certain states for the purpose of supporting the entry or continued operation of preferred generation resources that may not otherwise be able to succeed in a competitive wholesale capacity market." Such out-of-market payments include the revenues available to renewable energy generators from the sale of RECs. Moreover, FERC found that PJM's existing Minimum Offer Price Rule (MOPR) does not adequately address the price suppressive effect of resources receiving out-of-market payments (RECs) to ensure a just and reasonable rate. As a result, FERC found PJM's existing MOPR rules unjust and unreasonable. However, FERC rejected PJM's proposed capacity market rule changes because the filed set of rule changes did not meet FERC's objectives. FERC's two key objectives in this proceeding are (1) ensuring that uneconomic capacity resources that cannot offer into the capacity market competitively without subsidies do not degrade competitive clearing prices in the capacity auctions; and (2) accommodating state resource policies.

On October 2, 2018, PJM submitted a filing with two proposals to FERC to address the directives contained in the June 29 Order. PJM's first proposal would set minimum prices for subsidized power generators to bid into the capacity market, essentially at the price those generators would have bid into the PJM capacity market without the subsidies. PJM's second proposal would permit states to select a capacity market carve-out, where subsidized generators count towards capacity requirements but are not involved in the auctions. PJM would not pay subsidized generators for capacity, as is the case currently. Other parties to the case have submitted their own proposals. The affected generators may enter into bilateral contracts for capacity payments outside of the PJM capacity market. Depending on the FERC ruling, (1) renewable generators could experience a loss of revenue; (2) the clearing price for the capacity market could rise; and (3) fossil-fuel resources that previously would not have cleared the market could potentially clear the redesigned market. Intervenors also filed comments in October; reply comments were filed in early November. A FERC order in this proceeding is expected in early 2019. Certain intervenors, such as the Organization of PJM States, of which Maryland is a member, have requested that FERC vacate its June 29 Order, which was issued on a 3-to-2 vote.

FERC has authorized PJM to postpone its Base Residual Auction, the annual capacity auction that is normally conducted in May, until August 2019 in order to enable PJM to incorporate the FERC market design requirements that will emerge from the final order in this proceeding. The final order may affect certain energy policies pursued by states within PJM or impact the implementation of particular state policies.

These three topics—system planning, land use and major reform of the PJM capacity market—were not anticipated by the General Assembly to be significant issues and were consequently not listed as topics of study in Ch. 393. However, since the launch of this study, all three topics have emerged as important issues that warrant a more thorough examination in order to understand the potential impact on the Maryland RPS. Completing this study and examining these emerging issues will allow PPRP to provide the General Assembly with a more complete and thorough understanding of how to ensure the continued success of the Maryland RPS.

II. Background on the Maryland RPS

Maryland is one of 29 states and the District of Columbia with RPS requirements. The Maryland General Assembly enacted the Maryland RPS in 2004, and the law took effect in 2006. The Maryland RPS requires that 25 percent of electric sales in the state be matched with RECs from eligible renewable energy sources by 2020. Of that 25 percent, 22.5 percent comes from Tier 1 resources and 2.5 percent comes from Tier 2 resources.[2] Qualified renewable energy technologies for Tier 1 include anaerobic digestion, biomass (including black liquor), fuel cells using renewable fuels, geothermal electric and heat pumps, hydroelectric power (hydro or hydropower) under 30 MW, landfill gas, municipal solid waste (MSW), ocean thermal, onshore and offshore wind, solar PV, solar water heat and thermal electric, tidal, and wave. The Tier 2 requirement expires at the end of 2018. Hydropower of any capacity is the only technology that is eligible for Tier 2.

There are two carve-outs in Tier 1: 2.5 percent comes from solar, and up to 2.5 percent comes from offshore wind. The offshore wind tier is different from the rest of the Maryland RPS in that the Maryland PSC must approve the issuance of offshore RECs (ORECs). The PSC can only approve the issuance of ORECs under several conditions: if the net rate impact was less than $1.50 per month; if projected rate impacts on non-residential customers would not exceed 1.5 percent of their annual electric costs; and if OREC prices would not be greater than $190/MWh (in 2012 dollars). In 2017, the Maryland PSC approved two offshore wind projects totaling 368 MW, including 248 MW for U.S. Wind, part of a larger, 750-MW project, and 120 MW for Skipjack, a subsidiary of Deepwater Wind Holdings, LLC. Ørsted, a Danish energy company, recently announced plans to purchase Deepwater Wind Holdings.

Compliance with the Maryland RPS, like most other states with RPS policies, is through the acquisition of RECs or SRECs. A REC is equal to one MWh of renewable energy generation, while an SREC is equal to one MWh of solar generation. RECs and SRECs, also referred to as certificates, are traded separately from energy. This is sometimes referred to as "unbundling" RECs and SRECs from the underlying energy. For compliance with state RPS policies, including Maryland's, LSEs retire RECs and SRECs with the PJM Generation Attribute Tracking System (PJM-GATS). PJM-GATS is a regional tracking system developed in 2005 to address the needs of those PJM states with fuel and emission disclosure requirements and state RPS policies. PJM-GATS is administered by PJM Environmental Information Services, Inc. (PJM EIS), a subsidiary of PJM, which was formed because REC tracking was not a service that PJM could offer under its

[2] Note that electricity sales over 300,000 MWh to an industrial process load are exempt from the Maryland RPS.

FERC-approved tariff. PJM-GATS assigns each REC and SREC a unique serial number to avoid double counting. RECs and SRECs can be bought, sold, traded or transferred between parties until the REC or SREC is retired. After three years or once retired, whichever comes first, the REC or SREC cannot be used for compliance with the Maryland RPS.

LSEs can also make an ACP in lieu of retiring RECs and SRECs. Maryland's ACP for Tier 1 is $37.50/MWh and remains at that level perennially. The solar ACP is $175/MWh in 2018 and drops by $25/MWh per year to $75/MWh in 2022. The solar ACP falls to $60/MWh in 2023 and settles at $50/MWh in 2024 and beyond. ACPs serve as a *de facto* cost cap, since LSEs will not pay more than the ACP for RECs or SRECs. Because REC and SREC prices have been low in recent years, as discussed further below, the use of ACPs for the Maryland RPS has been low. According to the Maryland PSC, ACP payments totaled $24,515 in 2015 and $33,933 in 2016.

General information on renewable energy capacity and generation in Maryland, RECs and SRECs, and the prices of RECs and SRECs are presented below.

Renewable Energy Capacity and Generation in Maryland

1. According to the U.S. Energy Information Administration (EIA), installed nameplate, utility-scale renewable energy capacity in Maryland in 2004 was 641 MW and grew to 1,090 MW as of 2017. (Note: this does not include behind-the-meter facilities such as rooftop solar.)

2. Also, according to EIA, generation from non-hydro, utility-scale renewable energy in Maryland more than doubled between 2004 and 2017, from 589,208 MWh in 2004 to 1,364,717 MWh in 2017.

3. According to EIA, renewable energy generation accounted for about 10 percent of Maryland's total net generation in 2017, broken down as follows: 5.8 percent from hydro; 1.6 percent from biomass; 1.5 percent from wind; and less than 1 percent from solar.

4. Maryland's combined utility-scale and rooftop solar grew from under one MW in 2008 to 975 MW as of December 31, 2017, according to PJM-GATS.

5. There are seven proposed solar projects where applications for a CPCN are under active review, and five projects where the application review is complete but the projects do not have a final order for their CPCN.

6. According to EIA, wind power in Maryland also grew from essentially zero in 2004 to 190 MW as of the end of 2017.

7. Maryland is halfway to its statutory cap of 1,500 MW of net-metered generating capacity. According to the PSC, Maryland has 772 MW of net-metered generating capacity in operation as of June 30, 2018. About 200 MW of community solar could be added under the net metering cap if the programs are fully subscribed and all of the planned solar generating capacity is developed.

Renewable Energy Credits and Solar Renewable Energy Credits

1. According to the Maryland PSC and PJM-GATS, the number of total RECs retired for compliance with the Maryland RPS has increased from 2 million in 2006 to 9 million in 2017.

2. Wind, black liquor, hydro, and MSW account for the majority of Tier 1 RECs retired for the Maryland RPS in 2017.

3. Tier 1 and Tier 2 RECs used for complying with the Maryland RPS came from 17 states, including Maryland, in 2017.

4. Although it varies from year to year, typically over 85 percent of non-solar Tier 1 RECs used for compliance with the Maryland RPS come from outside the state. Of these RECs, about 80 percent are from states within the PJM service area (Delaware, Illinois, Indiana, New Jersey, North Carolina, Ohio, Pennsylvania, Virginia and West Virginia). Other states that provided RECs for compliance with the Maryland RPS include Iowa, Kentucky, Michigan, Missouri, North Dakota, New York and Tennessee.

5. Only eligible resources and demand within PJM states were examined in the 2017 Inventory Report, but renewable energy resources that are located outside of PJM are also eligible to meet non-carve-out Tier 1 requirements in PJM. In 2016, 13.9 percent of non-carve-out Tier 1 requirements in Maryland were met using outside-of-PJM resources.

6. About 770,000 non-solar Tier 1 RECs were produced in Maryland in 2017, and over 90 percent were retired in Maryland for compliance with the Maryland RPS. That is much higher than in previous years, when it was as low as 50 percent in 2011 and 2.3 percent in 2010.

7. The sources of Tier 2 RECs are more variable, with Maryland the leading source in some years. Pennsylvania, North Carolina, West Virginia, and Tennessee also provide Tier 2 RECs.

8. In 2017, about 60 percent of the Tier 1 RECs retired for the Maryland RPS were from black liquor, waste-to-energy or hydro facilities that were in operation when the Maryland RPS was enacted in 2004.

9. The percentage of black liquor used to comply with Tier 1 of the Maryland RPS has declined from 38 percent in 2008 to 24 percent in 2017. According to data from PJM-GATS, the percentage of black liquor RECs provided by Maryland facilities dropped to 6.5 percent in 2017 from 12 percent in 2008. This is, at least in part, due to the Maryland RPS requirements increasing over time, the conversion of waste-to-energy from Tier 2 to Tier 1 and the development of other renewable energy capacity such as wind and solar.

REC and SREC Prices over Time

1. Since 2011, the total compliance cost of the Maryland RPS increased from $14.7 million in 2011 to $135.2 million in 2016 due to steadily increasing RPS requirements in Maryland and in other states in the PJM service area. However, the cost to comply with the Maryland RPS dropped sharply in 2017 to just over $72 million due to declining costs of RECs and SRECs.

2. Prices of Tier 1 RECs dropped from about $15/MWh in 2015 to about $7/MWh in 2017, according to data provided by the Maryland PSC, because of increasing Tier 1 supply from the addition of new renewable energy capacity.

3. From data provided by the Maryland PSC, SREC prices have also dropped, from $345/MWh in 2008 to $38/MWh in 2017. Similar to Tier 1 RECs, the decrease in SREC prices is also because of a substantial increase in solar energy capacity outstripping the demand created by the Tier 1 solar carve-out. Indeed, SREC prices have declined each year since 2009. According to the Maryland-D.C.-Delaware-Virginia Solar Energy Industries Association (SEIA), there are enough SRECs banked in Maryland to meet the 2.5 percent solar carve-out in Tier 1 of the Maryland RPS until 2024, even if no additional solar projects are constructed in Maryland.

4. Total compliance costs of the Maryland RPS in 2017 were about $72 million and represented about 1 percent of average retail electricity bills.

III. Progress to Date

In October 2017, PPRP issued a Request for Proposals seeking companies to perform a study of the Maryland RPS. PPRP ultimately selected Exeter Associates, Inc. (Exeter) of Columbia, Maryland, to conduct the study. The Maryland Board of Public Works approved PPRP's contract with Exeter in May 2018, and work commenced in June 2018. To minimize the costs of the study, PPRP stressed reliance on existing work, such as the *Long-Term Electricity Report for Maryland* (LTER) issued in December 2016, the 2017 Inventory Report, and PJM's *Renewable Integration Study* that was issued in March 2014.

PPRP organized the Maryland RPS Work Group (RPS Work Group), consisting of representatives from the renewable energy industry, electric utilities, environmental and consumer organizations and consultants. Additionally, county and state government officials from the Maryland Office of People's Counsel, Maryland PSC, Maryland Energy Administration (MEA), Montgomery County Department of Environmental Protection, Maryland Department of Agriculture and Maryland General Assembly were also part of the RPS Work Group. A full list of the RPS Work Group representatives is provided in Appendix B. A webinar was held on April 26, 2018 and in-person meetings were held on June 18 and August 29, 2018. Additional webinars or in-person meetings will be held bimonthly until the final report is submitted to the General Assembly.

PPRP's initial priority upon commencing this study was to determine whether there are sufficient renewable energy resources within the PJM service area to meet Maryland's current and future RPS requirements, as well as the RPS requirements of other states in PJM. PPRP concluded that there are sufficient solar resources in Maryland to meet the solar carve-out requirement of the current Maryland RPS (see Table III-1 and Figure III-1). PPRP also found that there is sufficient solar power ("excess solar") above the solar carve-out that could be used to meet non-carve-out Tier 1 standards in Maryland and in other states in PJM. PPRP also concluded that there are sufficient non-carve out Tier 1 resources in the PJM service area to meet all PJM state RPS requirements, including Maryland's RPS, through 2030. Although PPRP concluded that there are sufficient non-carve-out Tier 1 resources to meet all requirements through 2030, PPRP does predict that there will be small deficiencies in the amount of renewable energy resources to meet RPS requirements between 2020 and 2025 (see Table III-2 and Figure III-2).

Table III-1. Solar RPS Requirements in Maryland Compared to Projected Solar Energy Generation in Maryland (2018-2030) (GWh)

Year	Generation Requirement	Projected Generation	Difference
2018	916	2,055	**1,139**
2019	1,189	2,231	**1,042**
2020	1,528	2,407	**879**
2021	1,529	2,768	**1,239**
2022	1,532	3,183	**1,651**
2023	1,536	3,661	**2,125**
2024	1,540	4,210	**2,669**
2025	1,543	4,841	**3,298**
2026	1,547	5,567	**4,021**
2027	1,550	6,402	**4,853**
2028	1,553	7,363	**5,810**
2029	1,556	8,467	**6,911**
2030	1,559	9,737	**8,178**

Figure III-1. Solar RPS Requirements in Maryland Compared to Projected Solar Energy Generation in Maryland (2018-2030)

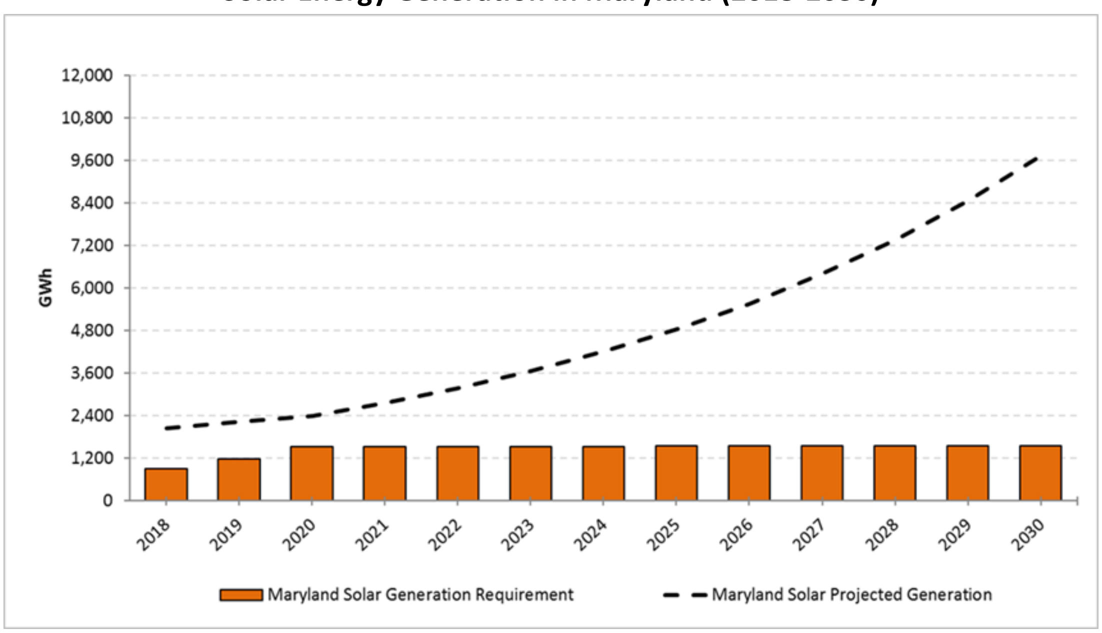
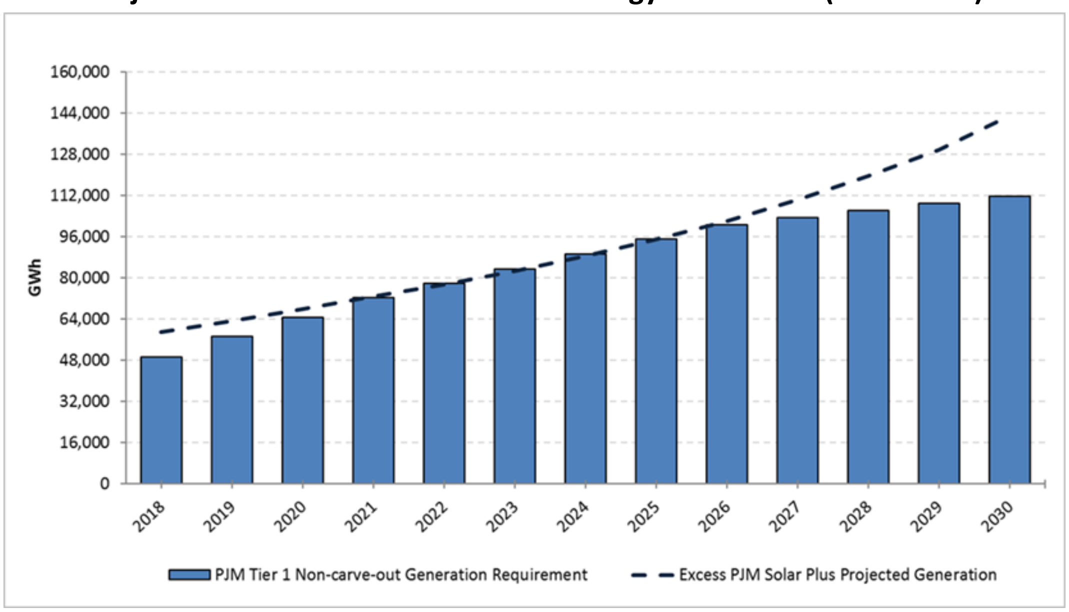


Table III-2. Non-carve-out Tier 1 RPS Requirements in PJM Compared to Projected Available PJM Renewable Energy Generation (2018-2030) (GWh)

Year	Generation Requirement	Projected Generation	Excess Solar	Net
2018	49,354	51,065	7,971	**9,681**
2019	57,207	53,563	9,798	**6,154**
2020	64,797	56,061	11,936	**3,200**
2021	72,394	58,362	14,430	**398**
2022	77,820	59,749	17,575	**(496)**
2023	83,347	61,591	21,220	**(536)**
2024	89,324	62,978	25,607	**(739)**
2025	95,132	64,365	30,580	**(186)**
2026	100,697	65,752	36,452	**1,508**
2027	103,467	67,139	43,261	**6,933**
2028	106,341	68,526	50,963	**13,148**
2029	109,052	69,913	59,834	**20,695**
2030	111,799	71,300	71,642	**31,143**

Figure III-2. Non-carve-out Tier 1 RPS Requirements in PJM Compared to Projected Available PJM Renewable Energy Generation (2018-2030)



Legislation was introduced during the 2018 General Assembly session, entitled the Clean Energy Jobs Act, that would raise the Maryland RPS to 50 percent by 2030, with a 14.5 percent carve-out for solar. The legislation was not enacted. A similar proposal is expected to be introduced in the 2019 session. At those levels, Tier 1 requirements of state RPS policies within PJM, including Maryland, would be met through 2020, and from 2028 through 2030, but would not be met from 2021 through 2027 (see Table III-3 and Figure III-3). A 14.5 percent solar carve-out in Maryland would not be met until 2030, as depicted in Table III-4 and Figure III-4. These projections are explained in the forthcoming 2017 Inventory Report. The Executive Summary of the 2017 Inventory Report is included in this Interim Report as Appendix A. Meeting an increased solar carve-out would require more solar development in Maryland, since the Maryland RPS requires solar to be connected to a distribution system serving Maryland customers.

Table III-3. Non-carve-out Tier 1 RPS Requirements in PJM Assuming a Maryland 50% RPS Requirement (2018-2030) (GWh)

Year	RPS Generation Requirements in PJM (a)	Projected Supply of RPS-eligible Generation in PJM (b)	Excess PJM Solar (Assuming 14.5% Solar Carve-out in Maryland) (c)	Difference Between Projected RPS Requirements and Generation (b+c)-a
2018	49,354	51,065	7,971	**9,681**
2019	57,054	53,563	7,634	**4,142**
2020	62,964	56,061	9,797	**2,894**
2021	72,168	58,362	11,830	**(1,976)**
2022	78,390	59,749	14,664	**(3,977)**
2023	85,117	61,591	17,380	**(6,145)**
2024	91,899	62,978	20,832	**(8,089)**
2025	93,885	64,365	25,024	**(4,496)**
2026	100,375	65,752	30,266	**(4,357)**
2027	104,385	67,139	36,442	**(803)**
2028	107,881	68,526	43,509	**4,154**
2029	111,840	69,913	52,365	**10,438**
2030	114,904	71,300	64,158	**20,554**

Figure III-3. Non-carve-out Tier 1 RPS Requirements in PJM Assuming a Maryland 50% RPS Requirement (2018-2030)

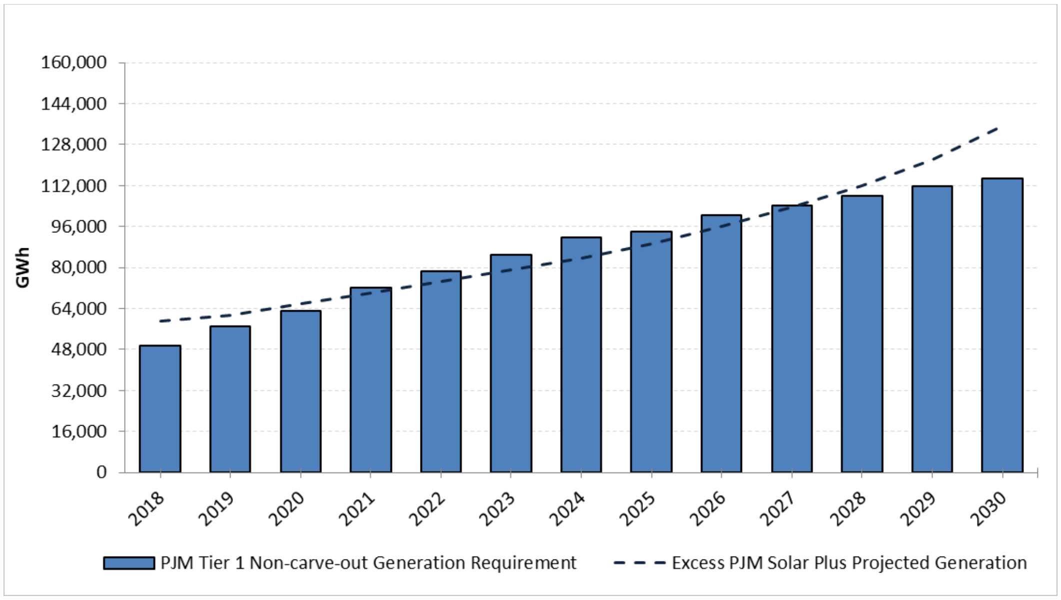
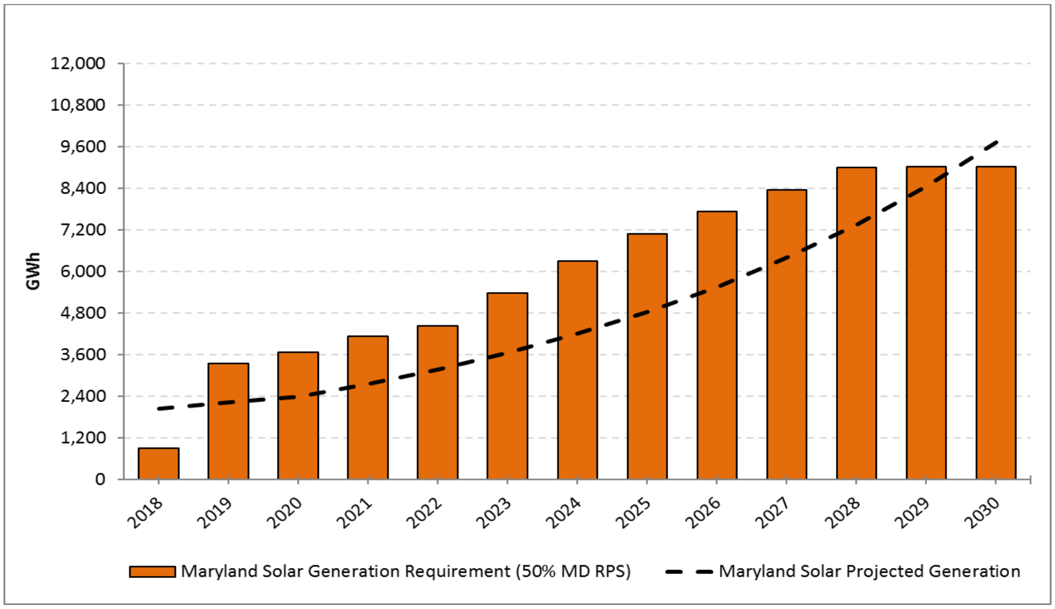


Table III-4. Scenario for 14.5% Maryland RPS Requirement for Solar Compared to Projected Maryland Solar Energy Generation (2018-2030) (GWh)

Year	14.5% Solar Carve-out Generation Requirement	Projected Generation	Difference
2018	916	2,055	**1,139**
2019	3,353	2,231	**(1,122)**
2020	3,667	2,407	**(1,261)**
2021	4,129	2,768	**(1,361)**
2022	4,443	3,183	**(1,260)**
2023	5,376	3,661	**(1,715)**
2024	6,315	4,210	**(2,105)**
2025	7,100	4,841	**(2,259)**
2026	7,733	5,567	**(2,166)**
2027	8,368	6,402	**(1,966)**
2028	9,006	7,363	**(1,644)**
2029	9,024	8,467	**(557)**
2030	9,042	9,737	**695**

Figure III-4. Scenario for 14.5% Maryland RPS Requirement for Solar Compared to Projected Maryland Solar Energy Generation (2018-2030)



It should be noted that several assumptions were made in preparing the 2017 Inventory Report. Differences from those assumptions may have a significant impact on this analysis as discussed below. The assumptions are as follows:

Changes in State RPS Policies

- States in PJM will not change their existing RPS policies, and states in PJM without an RPS remain that way during the next 12 years.
- If a state strengthens or weakens its RPS, or a state previously without an RPS enacts one, that will affect the results of this report. While it is unlikely that there will be no additional actions taken by PJM states, it is impossible to predict which states will enact which changes. Any action to increase an RPS could create short-term volatility in non-carve-out Tier 1 REC prices before either new RPS-eligible resources are developed or LSEs import additional RPS-eligible generation and RECs from outside PJM, at which point REC prices would settle at a long-term equilibrium.

Growth Rate

- The growth rate of various RPS-eligible technologies could be different from what is projected. For instance, even after the expiration of the federal production tax credit (PTC), incremental growth in onshore wind capacity could be higher than the projected 50 percent decline in capacity relied upon in the 2017 Inventory Report, based on improved performance and economics of wind power technology. Similarly, the 2017 Inventory Report projected annual solar capacity growth of 15 percent, and deviations from that will affect the results of this report.

Offshore Wind Capacity

- This report limits future offshore wind capacity to the two projects approved by the Maryland PSC. However, substantially more offshore wind capacity could be developed. New Jersey has a goal of 3,500 MW of offshore wind by 2030, for instance, and Dominion Energy recently contracted with Ørsted Energy of Denmark to construct two 6-MW turbines off the coast of Virginia Beach by 2022. States outside of PJM such as Massachusetts and New York also have ambitious offshore wind initiatives underway.[3] Further cost reductions in offshore wind could lead to additional growth.

Additional Capacity

- Several utilities plan to add more solar capacity. For example, in Virginia, Dominion Virginia Power predicts it will add 480 MW of solar capacity annually for the next 10 years, while Appalachian Power believes it will add 750 MW by 2030. This capacity is not incorporated in the 2017 Inventory Report. Should these plans come to fruition, either partially or fully, it will add to the available generation to meet solar (if located in Maryland) or non-solar carve-out Tier 1 requirements in PJM.

Load Growth

- Higher load growth than assumed will increase the demand for RPS-eligible generation within PJM. Similarly, increases in RPS requirements in individual states, whether in Maryland or elsewhere within PJM, will also increase demand for RPS-eligible generation within PJM.

[3] "New Jersey Governor Kick-Starts Race to 3.5GW of Offshore Wind by 2030," *offshoreWIND.biz*, February 1, 2018, offshorewind.biz/2018/02/01/new-jersey-governor-kick-starts-race-to-3-5gw-of-offshore-wind-by-2030/.

Other Factors

- The 2017 Inventory Report also assumed capacity factors for each renewable energy technology. Any deviations from those capacity factors will affect the available amount of renewable energy generation.
- Only eligible resources and demand within PJM states were examined in the 2017 Inventory Report, but renewable energy resources located outside of PJM but in an adjacent control area are eligible for the Maryland RPS, if the electricity is delivered into PJM. Depending on market conditions, a higher percentage of outside-of-PJM resources could conceivably be used to meet Maryland RPS requirements.

IV. <u>Future Activities</u>

Other aspects of the Maryland RPS study are underway, and a status update of the major tasks within Ch. 393, as of December 2018, is provided below. For cross-referencing purposes, each task within Ch. 393 is reproduced below, followed by a description of the associated activity that is occurring.

- Section 7-714(B)(1): *The availability of all clean energy sources at reasonable and affordable rates, including in-State and out-of-state renewable energy options.*

    - Research on the economic and technical potential of renewable energy resources in Maryland and within PJM is underway. Data sources include PJM, the National Renewable Energy Laboratory (NREL) and existing PPRP resources. Consideration is being given to technical and economic factors that affect resource availability.

- Section 7-714(B)(2): *The economic and environmental impacts of the deployment of renewable energy sources in the State and in the surrounding areas of the PJM region.*

    - Input-output modeling will be used to determine the potential economic impacts of renewable energy capacity in Maryland and within PJM. Data collection and scenario development is underway. The team's methodology and sample model runs were presented to the RPS Working Group in November 2018.

    - A review of ratepayer impacts of state RPS policies in Maryland and elsewhere is being drafted. This review incorporates analysis by the Lawrence Berkeley National Laboratory (LBNL) as well as study-specific research and analysis.

    - Research is underway on the environmental impacts of renewable energy generation in Maryland and within PJM.

- Section 7-714(B)(3): *The effectiveness of the standard in encouraging development and deployment of renewable energy sources; and* Section 7-714(B)(4): *The impact of alterations that have been made in the components of each tier of the standard, the implementation of different specific goals for* *particular sources, and the effect of different percentages and alternative compliance payment scales for energy in the tiers.*

  - Sections of the report are being drafted on all of these items. Data sources include PJM and the Maryland PSC. Maryland's experience is benchmarked against other PJM states, with special attention paid to nearby states with RPS requirements.

- Section 7-714(B)(5): *An assessment of alternative models of regulation and market-based tools that may be available or advisable to promote the goals of the standard and the energy policies of the State.*

  - Research and drafting of text to address this requirement are underway. This section covers a range of options utilized in the U.S., including both regulatory/non-regulatory policies that directly promote renewable energy deployment and those that complement renewable energy deployment. Options to be examined include, but are not limited to, grants, loans and net metering.

- Section 7-714(B)(6): *The potential to alter or otherwise evolve the standard in order to increase and maintain its effectiveness in promoting the State's energy policies.*

  - Research and drafting of text to address this requirement are underway. This section evaluates numerous changes, including raising the requirement levels of the Maryland RPS, lowering ACPs and adding or reclassifying the eligibility of specific technologies.

- Section 7-714(C)(1): *The role and effectiveness that the standard may have in reducing the carbon content of imported electricity and whether existing or new additional complementary policies or programs could help address the carbon emissions associated with electricity imported into the State.*

  - Data collection and research are in progress, and text is being drafted.

- Section 7-714(C)(2): *The net environmental and fiscal impacts that may be associated with long-term contracts tied to clean energy projects, including: (I) ratepayer impacts that resulted in other states from the use of long-term* *contracts for the procurement of renewable energy for the other states' standard offer service and whether the use of long-term contracts incentivized new renewable energy generation development; and (II) ratepayer impacts that may result in the State from the use of long-term contacts for each energy source in the State's Tier 1 and whether, for each of the sources, the use of long-term contracts would incentivize new renewable energy generation development in that source.*

  - A section on other states' experience with long-term contracts for renewable energy projects is being drafted. Meanwhile, work is underway to collect data and define a methodology for quantitatively estimating the impact of long-term contracts in Maryland.

- Section 7-714(C)(3): *Whether the standard is able to meet current and potential future targets without the inclusion of certain technologies.*

  - This requirement is addressed by the forthcoming 2017 Inventory Report. The Executive Summary of this report is provided in Appendix A to this Interim Report.

- Section 7-714(C)(4): *What industries are projected to grow, and to what extent, as a result of incentives associated with the standard.*

  - This requirement will be addressed through the input-output modeling that was referenced earlier.

- Section 7-714(C)(5): *Whether the public health and environmental benefits of the growing clean energy industries supported by the standard are being equitably distributed across overburdened and underserved environmental justice communities.*

  - Data collection and background research are underway, and a methodology for using the U.S. Environmental Protection Agency's (EPA's) EJSCREEN tool is under development.

- Section 7-714(C)(6): *Whether the State is likely to meet its existing goals under the standard and, if the State were to increase those goals, whether electricity* *suppliers should expect to find an adequate supply to meet the additional demand for credits.*

- This requirement is addressed by the 2017 Inventory Report. The Executive Summary of this report is provided in Appendix A to this Interim Report.

- Section 7-714(C)(7): *Additional opportunities that may be available to promote local job creation within the industries that are projected to grow as a result of the standard.*

  - This requirement will be addressed via the input-output modeling referenced earlier.

- Section 7-714(C)(8): *System flexibility that the State would need under future goals under the standard, including the quantities of system peaking and ramping that may be required.*

  - This requirement was addressed by PJM's 2014 *Renewables Integration Report* and PPRP's 2016 LTER. A review of both reports is being drafted.

- Section 7-714(C)(9): *How energy storage technology and other flexibility resources should continue to be addressed in support of renewable energy and State energy policy, including: (I) whether the resources should be encouraged through a procurement, a production, or an installation incentive; (II) the advisability of providing incentives for energy storage devices to increase hosting capacity of increased renewable on-site generation on the distribution system; and (III) discussion of the costs and benefits of energy storage deployment in the State under future goals scenarios for renewable generation.*

  - An assessment of the role of energy storage and other flexibility resources in promoting renewable energy and Maryland's energy policies, and whether energy storage should be incorporated into the Maryland RPS, is being drafted. A SWOT (Strengths, Weaknesses, Opportunities and Threats) on energy storage is included in Appendix C to this Interim Report, but a more comprehensive discussion of energy storage, as well as other flexibility resources, will be provided in the final report.

- Section 7-714(C)(10): *The role of in-State clean energy in achieving greenhouse gas emission reductions and promoting local jobs and economic activity in the State.*
    - Data collection has commenced and text is being drafted. This section will draw on a mixture of original analysis and existing literature on the impacts of Maryland’s RPS to date.
- Section 7-714(C)(11): *An assessment of any change in solar renewable energy credit prices over the immediate 24 months preceding the submission of the Interim Report.*
    - The data were compiled, and the analysis is included in this Interim Report.

V. Tracking Renewable Energy Credit and Solar Renewable Energy Credit Prices

Ch. 393 requires the Interim Report to include an assessment of any change in SREC prices over the past 24 months from the date this Interim Report is to be submitted to the Maryland General Assembly; i.e., since December 1, 2016. This report reviews both REC and SREC prices from September 2015 to September 2018. To provide a more comprehensive view, more than two years of SREC price data were collected for Maryland and other states within PJM. In addition, data were collected on Tier 1 and Tier 2 RECs prices.

A REC is a certificate demonstrating one MWh of energy output from a certified renewable energy generator that can be used to meet RPS compliance requirements.[4] There is an active market for the sale and purchase of RECs, with trades typically occurring as bilateral transactions. Separate REC markets exist for distinct RPS resource requirements (e.g., Tier 1, Tier 2, SRECs, and ORECs) and jurisdictions (e.g., each state in PJM that has an RPS).[5] A REC may only be used once to demonstrate RPS compliance. However, RECs may be certified for use in more than one state or resource market. Price determination in these markets is highly complex due to the interrelationships among the various markets.

There are a variety of supply and demand considerations that influence REC and SREC prices in Maryland and elsewhere in PJM.[6] These factors include: the percentages of renewable energy required; types of technologies eligible to supply RECs; geographic eligibility requirements of qualifying resources; ACP levels; demand for RECs for non-RPS purposes such as corporate RECs procurement; the duration for which RECs can be used; the potential to "bank" RECs (i.e., reserve for future use); and cost considerations for potential qualifying resources, including capital costs, operations and maintenance costs, financing costs and incentives. REC prices are also affected by intangible factors, such as expectations about how a state legislature may modify an RPS over time.

Maryland REC and SREC prices have changed considerably within the past three years (September 2015 to September 2018) compared to preceding years (see Figure V-1 through Figure V-8). From 2011 to 2015, non-carve-out Tier 1 REC prices in Maryland were increasing

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[4] A renewable energy generator (such as a wind farm) receives one REC for every one MWh of electricity it produces. A recognized certifying agency gives each REC a unique identification number. The renewable electricity can then be fed into the electric grid, while the accompanying REC can be sold separately on the open market.

[5] Note that, for ease of exposition, references to PJM states are inclusive of the District of Columbia.

[6] Note that the first offshore wind projects to receive Maryland PSC approval (Maryland PSC Order No. 88192) are not expected to come online until 2021. Consequently, ORECs are omitted from subsequent discussion.

rapidly, climbing from an average cost of $2.02/MWh in 2011 to $13.87/MWh in 2015, as demand for RECs grew quickly throughout PJM due to increasing state RPS requirements, both in Maryland and elsewhere.[7] Tier 2 RECs exhibited a similar trend, albeit at lower price levels. SREC prices during this period, meanwhile, were declining steadily, falling from an average cost of $278.26/MWh in 2011 to $130.39/MWh in 2015, but remained an order of magnitude higher than non-carve-out Tier 1 REC costs.[8] The Tier 1 non-carve-out and Tier 2 price trends reversed in 2016 as prices began declining. Additionally, SREC prices continued their decline, but at a faster rate. Although costs for all three of the above REC categories have increased somewhat in the past year (September 2017 to September 2018), REC and SREC prices remain low compared to past levels. Forward REC markets indicate a modest increase in SREC prices over the next several years, but suggest little change in non-carve-out Tier 1 REC prices.[9,10] The trends in Maryland are largely consistent with price changes in other states within PJM, indicating that many REC and SREC cost drivers stem from broader supply and demand factors within the region. The subsequent discussion is intended to characterize the exhibited price trends and assess price shifts in relationship to broader supply and demand considerations.

Figure V-1 and Figure V-2 show changes in non-carve-out Tier 1 REC prices over the past three years for Maryland and other PJM states with an RPS, respectively.[11] Prices in Maryland, Pennsylvania, Delaware and New Jersey have declined considerably over a two-year period beginning in late 2015. During this time, non-carve-out Tier 1 REC prices in Maryland fell from approximately $15.00/MWh to as low as $2.75/MWh. Prices have since increased, climbing to $7.75/MWh as recently as June 2018. However, non-carve-out Tier 1 REC trading in the months immediately preceding this Interim Report (June through September 2018) again show declining costs. The price trends in Maryland are consistent with other states in PJM that have similar resource eligibility requirements for their respective RPS policies.

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[7] *Renewable Energy Portfolio Standard Report with Data for Calendar Year 2017*, Maryland Public Service Commission, November 2018, psc.state.md.us/wp-content/uploads/FINAL-Renewable-Energy-Portfolio-Standard-Report-with-data-for-CY-2017.pdf.

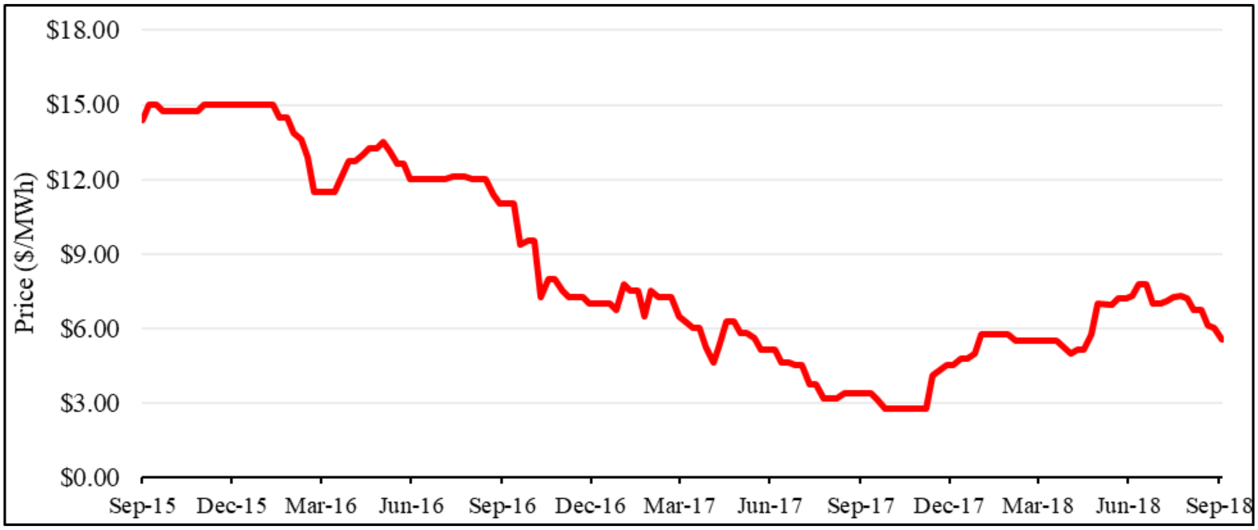
[8] Ibid.

[9] Note that the forward market for RECs is generally not very liquid, especially for dates further into the future, and therefore should not be interpreted as predictive of exact futures prices. Rather, these futures are indicative of market sentiment and expectations.

[10] Marex Spectrometer, *Spectrometer U.S. Environmental*.

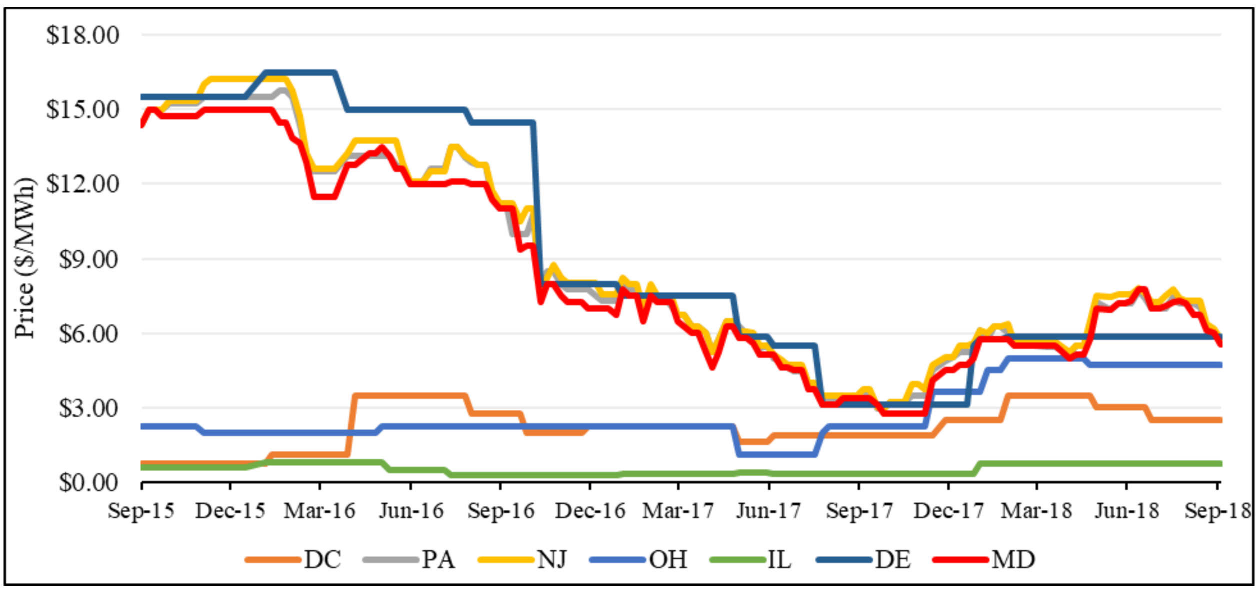
[11] Note that Figure V-2 and subsequent graphs that include REC prices for PJM states besides Maryland make the following classifications: non-carve-out Tier 1 REC prices for Delaware only reflect RECs labeled as “New” in the Marex Spectrometer reporting; and Illinois REC prices are sourced from the Midwest Renewable Energy Tracking System (M-RETS), while all other reported state REC prices are sourced from PJM-GATS.

Figure V-1. Non-carve-out Tier 1 REC Prices in Maryland (Sept. 2015 – Sept. 2018)



Source: Marex Spectrometer, *Spectrometer U.S. Environmental*.

Figure V-2. Non-carve-out Tier 1 REC Prices in PJM (Sept. 2015 – Sept. 2018)



Source: Marex Spectrometer, *Spectrometer U.S. Environmental*.

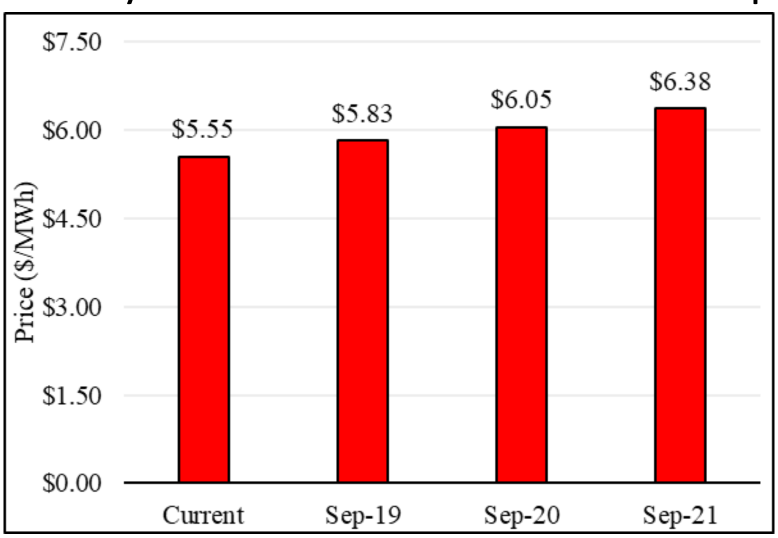
The decline in non-carve-out Tier 1 REC prices in many states between September 2015 and September 2017 primarily reflects an increase in the number of renewable energy facilities capable of providing non-carve-out Tier 1 RECs throughout PJM.[12] Although RPS requirements during this period increased as a percentage of total consumption, the impact of this change was blunted by flat or declining electric consumption in many PJM states. Many of the policy factors that influence REC supply and demand, such as adjustments to eligible technologies or

[12] "Electricity Data Browser," U.S. Energy Information Administration, eia.gov/electricity/data/browser.

geographic eligibility, went into effect before this period and therefore are already reflected in prices at the start of the time series. Federal tax incentives, including the PTC and the Investment Tax Credit (ITC), coupled with declining technology costs, are also partly responsible for the rapid expansion of renewable energy generation capacity.

Recent increases in REC prices are partially in response to preceding low prices, which induce developers to put certain renewable energy projects on hold or, in some cases, cancel projects that would have proceeded under more favorable economic conditions. This constriction of supply, coupled with growth in demand for renewable energy as states like Maryland and New Jersey increased their RPS requirements, has led to a modest rebound. Maryland REC prices as of September 2018 were not expected to climb much further going forward—assuming the Maryland RPS remains at its current level—as illustrated by non-carve-out Tier 1 REC futures shown in Figure V-3. Prices remain flat in part because there is a significant number of potential projects in the PJM Interconnection queue. This prospective supply is responsive to REC costs and will help moderate price changes going forward.

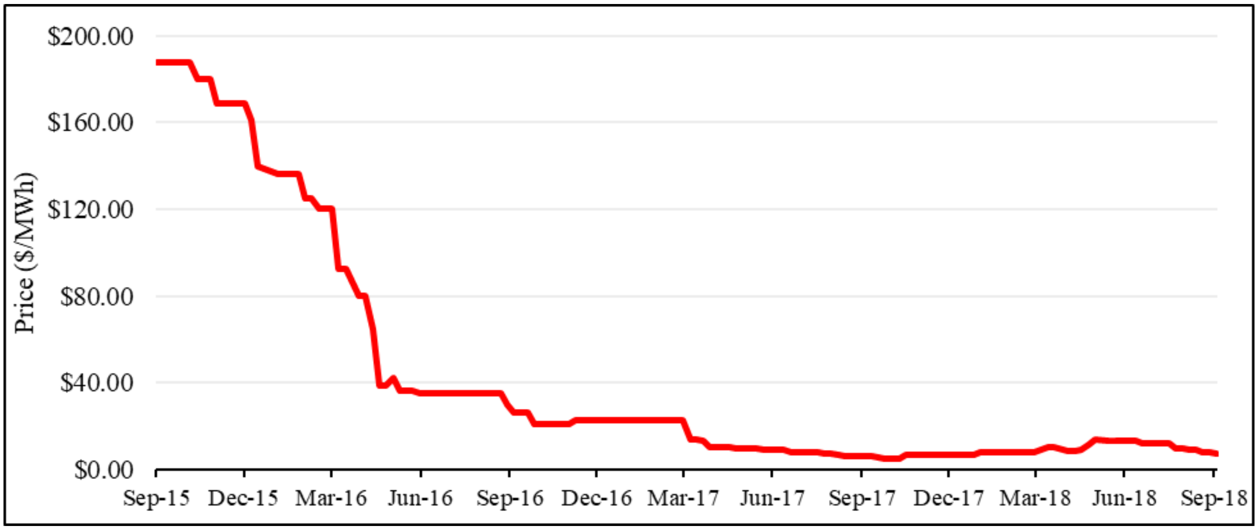
Figure V-3. Maryland Non-carve-out Tier 1 REC Futures as of Sept. 2018



Source: Marex Spectrometer, *Spectrometer U.S. Environmental*.

SREC prices in Maryland have fallen dramatically from their highs, but they are expected to increase in the coming years. Figure V-4 and Figure V-5 show changes in SREC prices over the past three years for Maryland and other PJM states with an RPS and solar carve-out, respectively. Unlike non-carve-out Tier 1 REC prices, SREC price levels vary between PJM states. This is because solar carve-outs must be met by in-state solar generation. Maryland SREC prices in late 2015 were among the highest of PJM states because at the time, demand for SRECs from the solar carve-out was higher than the supply of SRECs.[13] In the subsequent two years, Maryland SREC prices fell from approximately $187.50/MWh in September 2015 to as low as approximately $5.00/MWh in September 2017, putting Maryland SREC prices on par with all PJM states except D.C. and New Jersey. Much like non-carve-out Tier 1 RECs, SREC prices briefly rebounded in the last year, increasing to as high as $14.00/MWh as recently as May 2018. However, more recently, SREC prices in Maryland are again trending downwards.

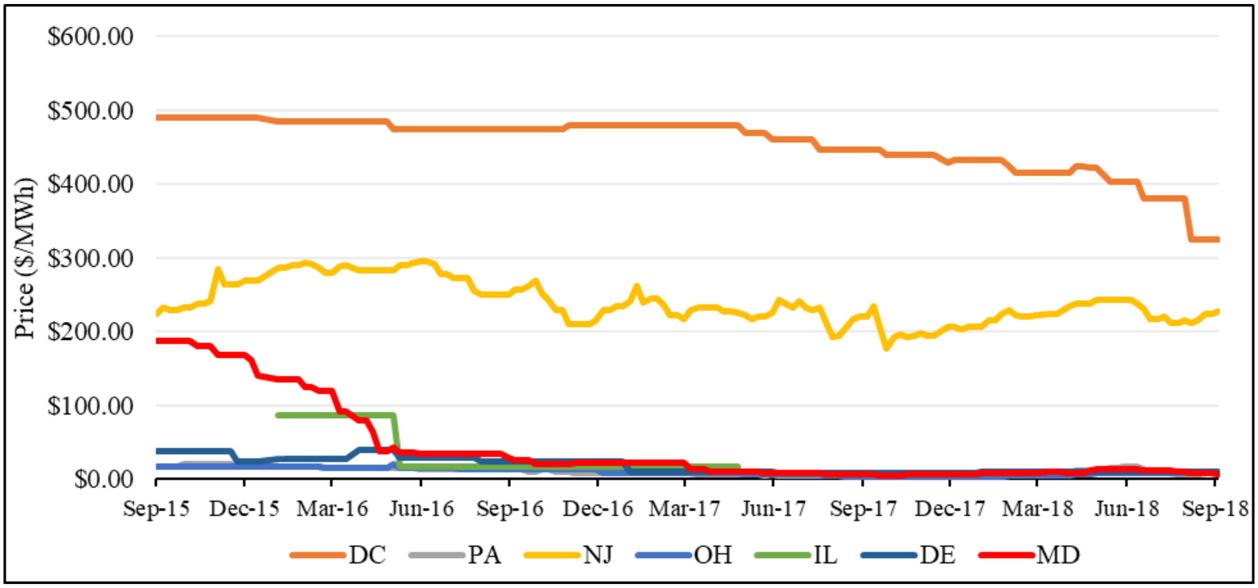
Figure V-4. SREC Prices in Maryland (Sept. 2015 – Sept. 2018)



Source: Marex Spectrometer, *Spectrometer U.S. Environmental*.

[13] Maryland's solar carve-out requirement was 0.5 percent in 2015. The only PJM participants with a higher carve-out requirement were: New Jersey, at 2.45 percent; Delaware, at 0.8 percent; and the District of Columbia, at 0.7 percent.

Figure V-5. SREC Prices in PJM (Sept. 2015 – Sept. 2018)



Source: Marex Spectrometer, *Spectrometer U.S. Environmental*.

The very steep decline in Maryland SREC prices between September 2015 and May 2016 reflects both an increase in the amount of solar capacity in Maryland and significant reductions in solar technology costs. Both distributed and utility-scale solar costs have declined as installers, developers and manufacturers have achieved economies of scale, realized new process efficiencies, and moved down the technology cost-curve. An NREL study evaluating solar during the first quarter of 2017 identified year-over-year cost declines of nearly 30 percent due to declining module and inverter prices, among other cost reductions.[14]

The drop in SREC prices has contributed to the slowdown in new solar installations in Maryland, and a corresponding decrease in solar jobs. According to the Solar Foundation's Solar Job Census, the number of solar jobs in Maryland decreased by just under 2 percent in 2017. The Foundation only predicted a small increase (0.3 percent) in solar jobs in Maryland in 2018.[15] The solar industry maintains that an increase in the solar carve-out from the current 2.5 percent is necessary to spur additional growth in solar deployment in Maryland.[16]

SREC prices are expected to increase again in the coming years, as shown in Figure V-6. Factors that could contribute to the price increase include the phase-out and eventual

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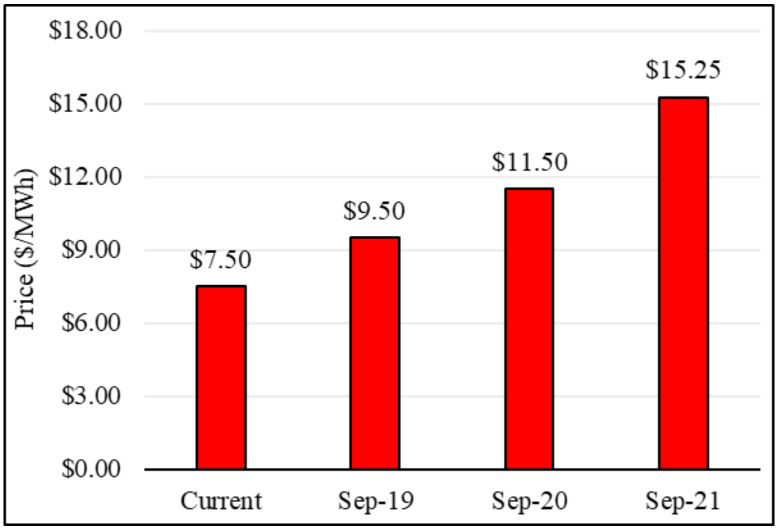
[14] Ran Fu, David Feldman and Robert Margolis, *et al.*, *U.S. Solar Photovoltaic System Cost Benchmark: Q1 2017*, National Renewable Energy Laboratory, September 2017, nrel.gov/docs/fy17osti/68925.pdf.
[15] "Solar Jobs Census 2017," The Solar Foundation, 2018, solarstates.org/.
[16] "What is the Maryland Clean Energy Jobs Act?" Utility Scale Solar Energy Coalition of Maryland, mdsolarcoalition.com/.

expiration of the federal ITC for residential solar installations, and a reduction to 10 percent for business installations, as well as a possible reduction in available SRECs. However, forecasted SREC prices are still well below previous highs.

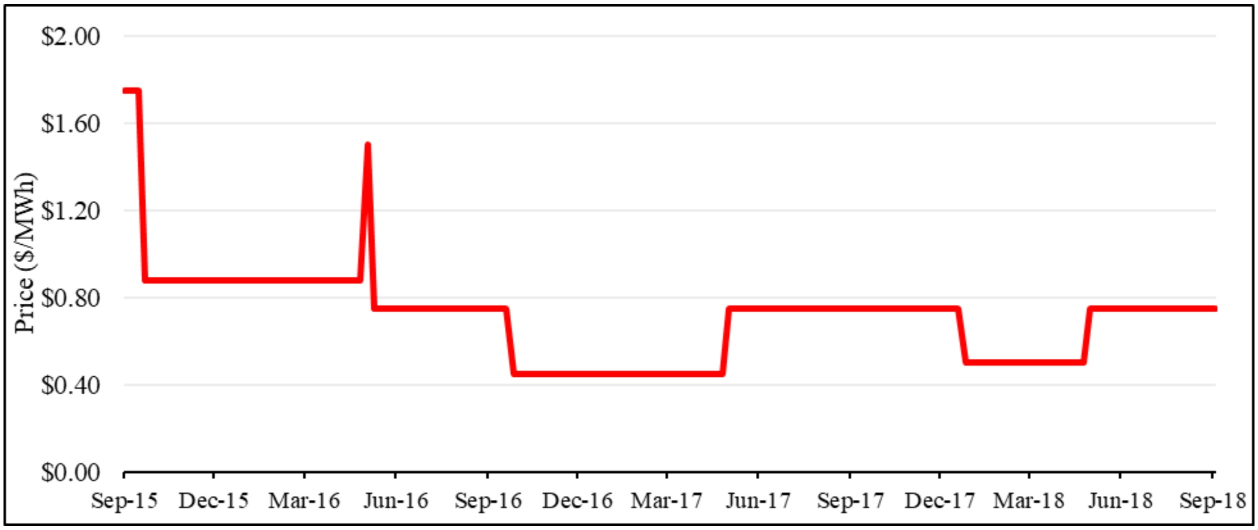
Figure V-6. Maryland SREC Futures as of Sept. 2018



Source: Marex Spectrometer, *Spectrometer U.S. Environmental*.

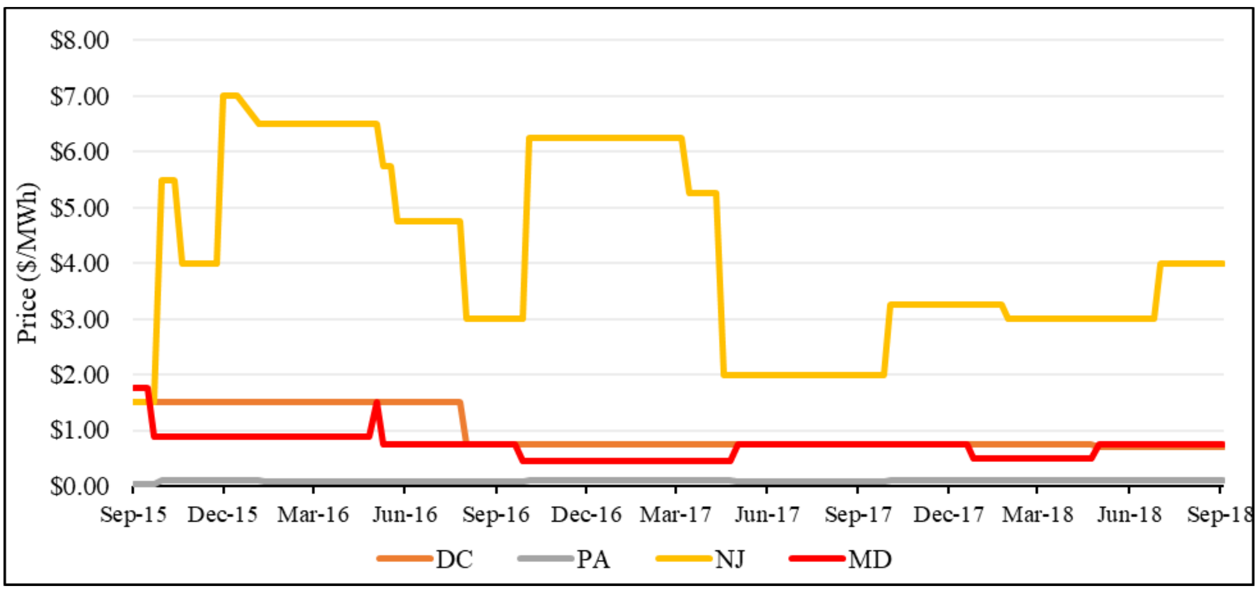
Figure V-7 and Figure V-8 show changes in Tier 2 prices over the past three years for Maryland and other PJM states with Tier 2 resource requirements, respectively. Available supply of Tier 2 resources exceeds demand and, as a result, Tier 2 REC prices are significantly lower than non-carve-out Tier 1 REC prices in Maryland. Maryland Tier 2 prices have decreased in the past several years, but exhibit minimal volatility and have remained between $0.45/MWh and $0.75/MWh since May 2016. Hydropower is the only eligible Tier 2 resource in Maryland. Tier 2 REC prices in other states vary considerably due to distinctions in eligible resources. However, prices are consistently lower than non-carve-out Tier 1 RECs. There are no futures for Maryland Tier 2 resources because the Tier 2 provision expired at the end of 2018.

Figure V-7. Tier 2 REC Prices in Maryland (Sept. 2015 – Sept. 2018)



Source: Marex Spectrometer, *Spectrometer U.S. Environmental*.

Figure V-8. Tier 2 REC Prices in PJM (Sept. 2015 – Sept. 2018)



Source: Marex Spectrometer, *Spectrometer U.S. Environmental*.

<u>APPENDIX A</u> – Executive Summary of the *2017 Inventory of Renewable Energy Generators Eligible for the Maryland Renewable Energy Portfolio Standard*

The *2017 Inventory of Renewable Energy Generators Eligible for the Maryland Renewable Energy Portfolio Standard* (2017 Inventory Report) is the third comprehensive effort by the Maryland Department of Natural Resources, Power Plant Research Program (PPRP) since 2006 to determine whether there is sufficient renewable generation capacity within PJM to meet Maryland's RPS requirements first established under the 2004 Maryland Renewable Energy Portfolio Standard and Credit Trading Act. The previous update, published in 2012, concluded that: "…Maryland's solar generation capacity must grow substantially…to meet Tier 1 solar set-aside requirements for 2022;" "…compliance with non-solar [non-carve-out] Tier 1 generation requirements will require a modest year-over-year rate of growth in eligible generation;" and "…no new Tier 2 generators will be needed to meet Maryland or other Tier 2 RPS standards in PJM."[17]

Currently, the Maryland RPS requires 25 percent of electricity consumption to come from eligible renewable energy sources by 2020, with 2.5 percent coming from solar and as much as 2.5 percent coming from offshore wind. Since the last update to the Inventory Report in 2012, the Maryland General Assembly has amended the Maryland RPS several times. These amendments include:

- Adding offshore wind, solar water-heating, thermal energy from biomass systems that primarily use animal waste, and geothermal heating and cooling as eligible technologies;
- Creating carve-outs for offshore wind within Tier 1;
- Changing the geographic eligibility of facilities to exclude RECs from states adjacent to PJM, absent an accompanying delivery of electricity into PJM;
- Increasing the percentage requirement for Tier 1 resources and accelerating the compliance schedule; and

[17] *2011 Inventory of Renewable Energy Generators Eligible for the Maryland Renewable Energy Portfolio Standard*, Maryland Department of Natural Resources, Power Plant Research Program, February 2012, msa.maryland.gov/megafile/msa/speccol/sc5300/sc5339/000113/014000/014735/unrestricted/20120571e.pdf, p. i.

- Recategorizing waste-to-energy systems as Tier 1 resources from their former classification as Tier 2 resources.

The 2017 Inventory Report reflects all changes to the Maryland RPS since May 2012 through 2017. The current and historical requirements of the Maryland RPS are displayed in Table ES-1.

Table ES-1. Maryland RPS – Percentage of Renewable Energy Required (%)

Year	Non-carve-out	Solar[i]	Offshore Wind[ii]	TIER 1 TOTAL	TIER 2[iii]
	TIER 1				
2006	1%	0%	0%	1%	2.5%
2007	1	0	0	1	2.5
2008	2	0.005	0	2.005	2.5
2009	2	0.01	0	2.01	2.5
2010	3	0.025	0	3.025	2.5
2011	4.95	0.05	0	5	2.5
2012	6.4	0.1	0	6.5	2.5
2013	7.95	0.25	0	8.2	2.5
2014	9.95	0.35	0	10.3	2.5
2015	10	0.5	0	10.5	2.5
2016	12	0.7	0	12.7	2.5
2017	11.95	1.15	0	13.1	2.5
2018	14.3	1.5	0	15.8	2.5
2019	18.45	1.95	0	20.4	--
2020	22.5	2.5	0	25	--
2021	~21.2	2.5	~1.3	25	--
2022	~21.2	2.5	~1.3	25	--
2023+	~20.5	2.5	~2.0	25	--

[i] Solar requirement began in Compliance Year 2008.

[ii] The offshore wind carve-out by law could be a maximum of 2.5 percent beginning in 2017; however, only the approved offshore RECs (ORECs) have been included here. Other PJM members do not yet have an equivalent category. Percentages provided according to Maryland PSC Order No. 88192, Table 2, "Offshore Wind Component of the RPS Obligation for Purchasers of ORECs." (The percentage fluctuates annually because the ORECs are based on MWh and energy sales every year.)

[iii] Tier 2 requirement sunsets at the end of Compliance Year 2018.

Source: Maryland Code, Public Utilities § 7-703, http://codes.findlaw.com/md/public-utilities/md-code-public-util-sect-7-703.html.

Eight states in PJM (Delaware, Illinois, Maryland, Michigan, New Jersey, North Carolina, Ohio, and Pennsylvania) and the District of Columbia have mandatory RPS requirements.[18,19] Numerous changes in state policies as well as in the amount of proposed, planned, and operating renewable energy capacity warrant a new assessment of renewable energy projects to gauge current and future resources needed to meet state RPS requirements within PJM. This report uses the current RPS requirements for these states and assumes their existing policies will not change. If a state strengthens or weakens its RPS or a state previously without an RPS enacts one, that will affect the results of this report.

This report uses data contained in the PJM-GATS to produce a dataset of available renewable energy capacity. This dataset is supplemented with geophysical, capacity, and generation data acquired from EIA. Additional research, including state RPS requirements and electricity sales projections, were also incorporated into this database, which is referred to throughout this document as the 2017 Inventory Database.

Analysis of the 2017 Inventory Database determined the current availability of renewable resources and the amount of growth needed to satisfy not only Maryland's RPS but also the RPS requirements of other states in PJM. Maryland's Tier 1 RPS requirement allows the state's electric suppliers to source ocean energy, landfill gas, biomass, onshore and offshore wind, solar, solar water-heating, and fuel cells (fueled by Tier 1 resources) from anywhere within PJM or from outside of PJM if the associated energy is delivered into PJM.[20] However, geothermal electric, geothermal heat pumps, municipal solid waste, and poultry litter plants must be connected to the distribution grid serving Maryland. Tier 1 RECs may be used to fulfill Tier 2 requirements.

Of the Maryland RPS requirements, compliance with the non-carve-out Tier 1 category appears to represent the only possible challenge going forward, as resources are not projected to be sufficient for PJM states with RPS policies to meet their requirements consistently. That said, this report projects that there would be a generation surplus through 2021, and from 2026 through 2030. This report also finds that there would be a projected generation deficit for the years 2022 through 2025, although relatively insignificant. The largest of these deficits (739 GWh) is projected to occur in 2024 (see Table ES-2 and Figure ES-1). Non-carve-out Tier 1 generation (inclusive of "excess solar" after the solar carve-outs are met) will need to grow at

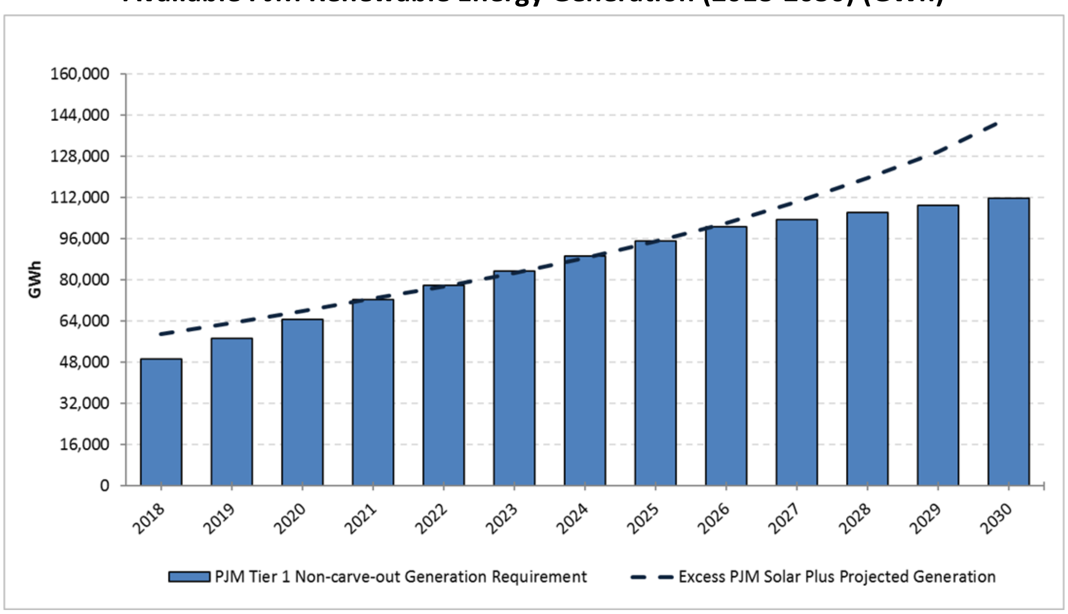
[18] Indiana and Virginia have voluntary renewable energy goals, but these goals are not included in this analysis.
[19] For purposes of this report, the states in PJM will be considered as inclusive of the District of Columbia.
[20] Excess in-state solar resources may be used for compliance with Maryland Tier 1 requirements.

approximately 6.6 percent annually to meet state (inclusive of Maryland) RPS requirements in PJM out through 2030 if all PJM states, including Maryland, rely only on renewable resources within PJM.

Table ES-2. Non-carve-out Tier 1 RPS Requirements in PJM Compared to Projected Available PJM Renewable Energy Generation (2018-2030) (GWh)

Year	Generation Requirement	Projected Generation	Excess Solar	Net
2018	49,354	51,065	7,971	**9,681**
2019	57,207	53,563	9,798	**6,154**
2020	64,797	56,061	11,936	**3,200**
2021	72,394	58,362	14,430	**398**
2022	77,820	59,749	17,575	**(496)**
2023	83,347	61,591	21,220	**(536)**
2024	89,324	62,978	25,607	**(739)**
2025	95,132	64,365	30,580	**(186)**
2026	100,697	65,752	36,452	**1,508**
2027	103,467	67,139	43,261	**6,933**
2028	106,341	68,526	50,963	**13,148**
2029	109,052	69,913	59,834	**20,695**
2030	111,799	71,300	71,642	**31,143**

Figure ES-1. Non-carve-out Tier 1 RPS Requirements in PJM Compared to Projected Available PJM Renewable Energy Generation (2018-2030) (GWh)

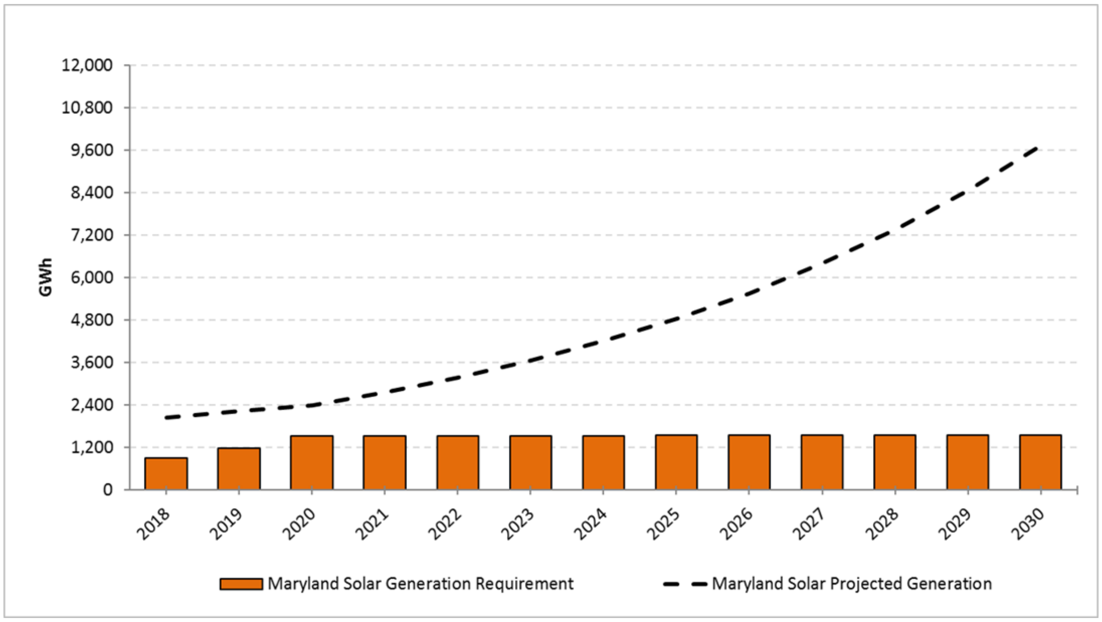


As noted earlier, the Maryland RPS has two carve-outs; one for solar and one for offshore wind. The Maryland Tier 1 solar carve-out requires that solar be connected to the distribution grid serving Maryland customers to be eligible for compliance with the Maryland RPS. Based on projections discussed later in this report, it is expected that the solar carve-out requirements in the Maryland RPS will be met throughout the forecast period (see Table ES-3 and Figure ES-2).

Table ES-3. Solar RPS Requirements in Maryland Compared to Projected Solar Energy Generation in Maryland (2018-2030) (GWh)

Year	Generation Requirement	Projected Generation	Difference
2018	916	2,055	**1,139**
2019	1,189	2,231	**1,042**
2020	1,528	2,407	**879**
2021	1,529	2,768	**1,239**
2022	1,532	3,183	**1,651**
2023	1,536	3,661	**2,125**
2024	1,540	4,210	**2,669**
2025	1,543	4,841	**3,298**
2026	1,547	5,567	**4,021**
2027	1,550	6,402	**4,853**
2028	1,553	7,363	**5,810**
2029	1,556	8,467	**6,911**
2030	1,559	9,737	**8,178**

Figure ES-2. Solar RPS Requirements in Maryland Compared to Projected Solar Energy Generation in Maryland (2018-2030) (GWh)



Eligible offshore wind facilities that are located on the continental shelf between 10 and 30 miles off the coast of Maryland in a U.S. Department of the Interior designated leasing zone potentially qualify for the Tier 1 offshore wind carve-out, pending Maryland PSC approval. On May 11, 2017, the PSC issued Order No. 88192 approving two offshore wind energy projects—the US Wind, Inc. project for 248 MW (of a total 750-MW planned project) and the Skipjack Offshore Energy, LLC project for 120 MW.

Maryland could potentially meet Tier 2 requirements with in-state resources through its final requirement year of 2018, but there are also Tier 2 generation options available from within PJM. Some states, particularly Pennsylvania, allow additional resources such as pumped storage hydropower and waste coal to qualify as Tier 2-eligible; these resources do not qualify for Tier 2 in Maryland, but they increase the total pool of eligible resources available for various state RPS requirements in PJM.

If Maryland's RPS is increased to 50 percent by 2030, there would be sufficient non-carve-out Tier 1 renewable energy generation to meet a higher Maryland RPS requirement through 2020, and from 2028 through 2030. (See Table ES-4 and Figure ES-3.) For 2021 through 2027, Maryland, as well as the other PJM states with RPS policies, will need to procure a greater portion of non-carve-out Tier 1-eligible RECs from outside PJM or more sources of Tier 1 RECs will need to be developed. If the solar carve-out in Maryland's RPS were to increase from 2.5 percent by 2020 to 14.5 percent by 2030, Maryland is expected to be able to meet that added requirement with in-state solar resources by 2030 based on anticipated growth in solar capacity, but not in the years leading up to 2030 (i.e., 2019-2029). (See Table ES-5 and Figure ES-4.)

Table ES-4. Non-carve-out Tier 1 RPS Requirements in PJM Assuming a Maryland 50% RPS Requirement (2018-2030) (GWh)

Year	RPS Generation Requirements in PJM (a)	Projected Supply of RPS-eligible Generation in PJM (b)	Excess PJM Solar (Assuming 14.5% Solar Carve-out in Maryland) (c)	Difference between Projected RPS Requirements and Generation (b)+(c)-(a)
2018	49,354	51,065	7,971	**9,681**
2019	57,054	53,563	7,634	**4,142**
2020	62,964	56,061	9,797	**2,894**
2021	72,168	58,362	11,830	**(1,976)**
2022	78,390	59,749	14,664	**(3,977)**
2023	85,117	61,591	17,380	**(6,145)**
2024	91,899	62,978	20,832	**(8,089)**
2025	93,885	64,365	25,024	**(4,496)**
2026	100,375	65,752	30,266	**(4,357)**
2027	104,385	67,139	36,442	**(803)**
2028	107,881	68,526	43,509	**4,154**
2029	111,840	69,913	52,365	**10,438**
2030	114,904	71,300	64,158	**20,554**

Figure ES-3. Non-carve-out Tier 1 RPS Requirements in PJM Assuming a Maryland 50% RPS Requirement (2018-2030) (GWh)

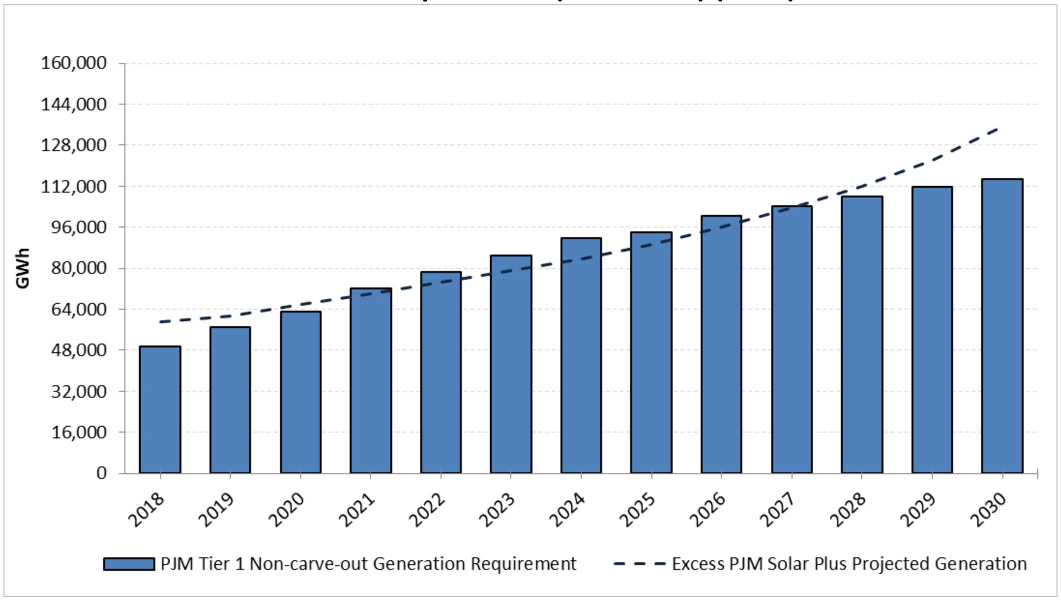
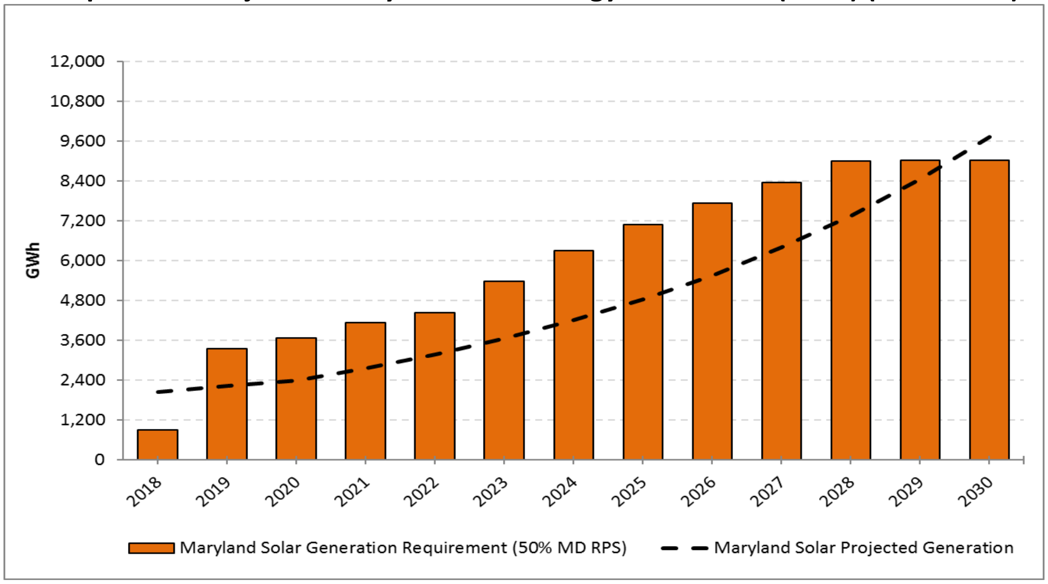


Table ES-5. Scenario for 14.5 Percent Maryland RPS Requirement for Solar Compared to Projected Maryland Solar Energy Generation (2018-2030) (GWh)

Year	14.5% Solar Carve-out Generation Requirement	Projected Generation	Difference
2018	916	2,055	**1,139**
2019	3,353	2,231	**(1,122)**
2020	3,667	2,407	**(1,261)**
2021	4,129	2,768	**(1,361)**
2022	4,443	3,183	**(1,260)**
2023	5,376	3,661	**(1,715)**
2024	6,315	4,210	**(2,105)**
2025	7,100	4,841	**(2,259)**
2026	7,733	5,567	**(2,166)**
2027	8,368	6,402	**(1,966)**
2028	9,006	7,363	**(1,644)**
2029	9,024	8,467	**(557)**
2030	9,042	9,737	**695**

Figure ES-4. Scenario for 14.5 Percent Maryland RPS Requirement for Solar Compared to Projected Maryland Solar Energy Generation (GWh) (2018-2030)



In previous years, proposals were introduced (but not enacted) in the Maryland General Assembly to remove black liquor from the Maryland RPS as an eligible Tier 1 resource. Including the District of Columbia, Maryland is one of three states within PJM to include black liquor in its RPS, although Maryland is less restrictive than the other two states in accepting black liquor. Pennsylvania counts in-state black liquor resources as a Tier 1 resource, while out-of-state black liquor RECs are classified as Tier 2. The District of Columbia categorizes black liquor as a Tier 2 resource, but the entire Tier 2 resource category expires in 2019.

Given the limited eligibility of black liquor in state RPS policies within PJM, and the importance of black liquor as a Tier 1 compliance option in Maryland, the question arises as to whether it would be more difficult for LSEs to comply with the Maryland RPS if black liquor was removed as an eligible Tier 1 resource. Although there are certainly differences in technology eligibility among state RPS policies in PJM, there are enough technologies eligible for multiple state RPS policies that the Tier 1 REC market is considered PJM-wide, not state-by-state. In addition, black liquor RECs retired in Maryland in 2016 and 2017 accounted for under 4 percent and 2 percent of all Tier 1 RECs in PJM, respectively. Black liquor's contribution to total Tier 1 RECs in PJM is expected to decrease over time in percentage terms, as it is not expected there will be development of new black liquor plants. It should also be noted that the changes to the Maryland RPS related to Tier 1 eligibility may permit other PJM states to employ RECs that would have otherwise been Maryland-eligible for their own RPS compliance, thereby freeing up RECs from those states for Maryland compliance.

It should be noted that certain state RPS policies in PJM have provisions that affect the portfolio of available resources that are not incorporated in the analysis but could affect the functioning of various state RPS policies. Some examples are below.

- Illinois Alternative Retail Electricity Suppliers (ARES) were required in previous years to satisfy at least half of the Illinois RPS requirement using ACPs. Changes to the Illinois RPS in late 2016 eliminated this requirement beginning in energy year (EY) 2018. ARES's may also use RECs from resources located anywhere in PJM or the Midcontinent Independent System Operator (MISO). Historically, this has expanded the pool of available resources and, through the ACP requirement, limited RPS demand in Illinois. However, the compliance obligation is transitioned to Illinois utilities effective June 2019. Both provisions will increase the competition for non-carve-out Tier 1 RECs.

- North Carolina gives credit for energy efficiency measures and accepts RECs from any U.S. registry. As a result, the North Carolina market is oversupplied. RECs from generators registered in PJM-GATS are not being used for compliance with the North Carolina RPS because they are worth more in PJM states.

- Some states allow resources outside of PJM to be counted, and they are intentionally excluded from the 2017 Inventory Database. For example, the District of Columbia accepts Tier 1 credits from resources located in states adjacent to PJM, and Ohio allows resources in the non-PJM portion of adjacent states.

- Banking of RECs for periods of one year or more is allowed in several states in PJM with RPS policies. Because the amount of RECs banking is hard to project, the banking of RECs was ignored in this analysis. Not incorporating banking may overstate the demand for Tier 1 non-carve-out RECs, SRECs, and Tier 2 RECs.

It should also be recognized that the market for RECs is highly complex due to similarities and differences in the RPS eligibility requirements among states (e.g., eligible technologies and locations), differences in ACPs, and differences in the "shelf life" of RECs in different states.[21] With changes in RPS requirements over time, and the potential shortfall of PJM non-carve-out Tier 1 resources to fully meet the RPS requirements of the PJM states with RPS policies, there may be upward pressure on REC prices in Maryland and in other PJM states. Those higher REC

[21] "Shelf life" refers to the amount of time a REC or SREC is available for complying with a state RPS policy. Delaware, the District of Columbia, Maryland and Pennsylvania all have a lifetime of three years for RECs and SRECs, while New Jersey allows three years for RECs and five years for SRECs, and Ohio allows five years for both RECs and SRECs.

prices will induce additional renewable resource development, changes in REC sales among the states based on differentials in REC prices, and increased imports of RECs into PJM based on more favorable economics associated with higher REC prices. Market dynamics, therefore, can be expected to resolve much, if not all, of the possible shortfalls in non-carve-out Tier 1 renewable resource availability over time.

Finally, several assumptions were made in preparing this report. Whether or not the assumptions are realized will have a significant impact on the outcomes presented in this analysis. Examples include the following:

- It is assumed that states in PJM will not change their existing RPS policies, and that states in PJM without an RPS will remain that way. If a state strengthens or weakens its RPS or a state previously without an RPS enacts one that will affect the results of this report.

- The growth rate of different RPS-eligible technologies could be different from what is projected in this report. For instance, after the expiration of the federal PTC, incremental growth in onshore wind capacity could be higher than the projected 50 percent decline used in this report, based on improved performance and economics of wind power technology. Another example is solar. Note that the analysis of the availability of solar generation for non-carve-out Tier 1 requirements relies upon the assumption that solar capacity will increase 15 percent annually. If solar growth is lower than 15 percent, there will be additional pressure on the market for non-carve-out Tier 1 RECs. If solar growth is greater than 15 percent, it will relieve pressure on the non-carve-out Tier 1 market.

- This report limits future offshore wind capacity to the two projects approved by the Maryland PSC. However, substantially more offshore wind capacity could be developed. New Jersey has a goal of 3,500 MW of offshore wind by 2030, for instance, and states outside of PJM such as Massachusetts and New York have similarly ambitious offshore wind initiatives underway.[22] Further cost reductions in offshore wind could lead to additional growth.

- Several utilities have ambitious plans to add more solar capacity. For example, in Virginia, Dominion Virginia Power predicts it will add 480 MW of solar capacity annually

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[22] "New Jersey Governor Kick-Starts Race to 3.5GW of Offshore Wind by 2030," *offshoreWIND.biz*, February 1, 2018, offshorewind.biz/2018/02/01/new-jersey-governor-kick-starts-race-to-3-5gw-of-offshore-wind-by-2030/.

over the next 10 years, while Appalachian Power believes it will add 750 MW by 2030. This capacity is not incorporated in the 2017 Inventory Database. Should these plans come to fruition, either partially or fully, it will add to the available generation to meet solar (if the solar capacity is in Maryland) or non-solar carve-out Tier 1 requirements in PJM.

- Higher load growth than assumed in this report will increase the demand for RPS-eligible generation within PJM. Similarly, increases in RPS requirements in individual states, whether in Maryland or elsewhere within PJM, will also increase demand for RPS-eligible generation within PJM.

- This report examines only eligible resources and demand within PJM states. As noted, renewable resources that are located outside of PJM and are GATS-certified are also eligible to meet non-carve-out Tier 1 requirements in PJM. In 2016, 13.9 percent of non-carve-out Tier 1 requirements in Maryland were met using outside-of-PJM resources. Depending on market conditions, a higher percentage of outside-of-PJM resources could conceivably be used to meet Maryland RPS requirements.

APPENDIX B – Maryland RPS Work Group Members

Last updated: December 7, 2018

Name	Organization
Ken Capps – Work Group Chairman	SMECO
Michael Aimone	The Roosevelt Group
Misty Allen	BGE
Bruce Burcat	Mid-Atlantic Wind Partnership
Janet Christensen-Lewis	Kent Conservation and Preservation Alliance
Gia Clark	OneEnergy Renewables
Stuart Clark	Town Creek Foundation
Josh Cohen	Business Network for Offshore Wind
Chris Ercoli	Brookfield Renewable
Colby Ferguson	Maryland Farm Bureau
Bill Fields	Maryland Office of People's Counsel
John Finnerty	Standard Solar, LLC
Andrew Gohn	American Wind Energy Association
Susan Gray	Retired, PPRP
Anne Grealy	FirstEnergy
Chris Hoagland	Maryland Department of the Environment
Brian Hug	Maryland Department of the Environment
Sally Jameson	Delegate, Retired, Maryland General Assembly
Andrew Johnston	Maryland PSC*
Andrew Kays	Northeast Maryland Waste Disposal Authority
Les Knapp	Maryland Association of Counties
Ivan Lanier	PEPCO
Matthew LaRocque	PJM
Audrey Lyke	Exelon
Kathy Magruder	Maryland Clean Energy Center
David Murray	MD, DC and VA SEIA
Cindy Osorto	Maryland Energy Administration
Alex Pavlak	Future of Energy Initiative
John Quinn	BGE
Lindsey Robinett Shaw	Montgomery County Dept. of Env. Protection
John Sherwell	Retired, PPRP
Nicole Sitaraman	Sunrun, Inc.
Abigail Sztein	American Forest and Paper Association
Cyrus Tashakkori	Utility Scale Solar Energy Coalition of Maryland
Cassie Shirk	Maryland Department of Agriculture
Emily Trawick	Sage Energy, Inc.
Harry Warren	Clean Grid Advisors, LLC
Joy Weber	Deepwater Wind

*Now Counsel to the Maryland State Senate Finance Committee, Maryland Department of Legislative Services.

Maryland DNR PPRP Staff

David Tancabel
Bob Sadzinski
Shawn Seaman

APPENDIX C – Strengths, Weaknesses, Opportunities and Threats Analyses

Given that Ch. 393 requires consideration of a long list of policy options and alternatives, and that this study is at a relatively early stage, PPRP believes that it is important to provide high-level overviews of these options as well as in-depth discussions of their merits. PPRP has adapted a strategic planning technique known as a SWOT analysis. Traditionally, SWOT analysis is used to identify internal and external factors that are important to selling a product or achieving a social objective. The term SWOT is an acronym for the four parameters that are typically considered:

- **S**trengths – the characteristics of a policy that give it an advantage over other options;
- **W**eaknesses – the characteristics that put a policy at a disadvantage relative to other options;
- **O**pportunities – external factors that could make a policy more successful or that could be exploited; and
- **T**hreats – external factors that could make a policy less successful.

Brevity and simplicity are two of the primary reasons that SWOTs are used. They provide an intuitive, table-format summary of the pros and cons of a given course of action. This high-level summary facilitates comparisons among options and provides a basis for further research and discussion. PPRP has modified the traditional SWOT format by preparing strengths and weaknesses tables for specific policy options and alternatives. PPRP has prepared a separate, overarching discussion of opportunities and threats, since the same external factors are likely to influence the success of any action taken by Maryland to promote renewable energy deployment and/or the decarbonization of electricity generated for use by Marylanders. After the opportunities and threats section, the following options are addressed via this SWOT framework:

- Not changing the Maryland RPS at all;
- Increasing the Maryland RPS to 50 percent by 2030;
- Removing black liquor as an eligible Tier 1 resource;
- Providing state support for energy storage;
- Moving hydro from Tier 2 to Tier 1;

- Increasing the Tier 1 solar carve-out to 14.5 percent;
- Requiring long-term contracts;
- Lowering the ACP level for non-carve-out Tier 1 and solar resources;
- Restricting geographic eligibility to within PJM; and
- Instituting subsidies for nuclear power via zero emission credits or a Power Purchase Agreement (PPA).

External Opportunities and Threats of Relevance to the Maryland RPS

As the Maryland General Assembly contemplates options for changing the Maryland RPS, it is important to keep in mind that several external factors, over which Maryland has no control, will likely influence the performance of the RPS and/or any related policies. This document summarizes these factors, and their potential impact on five objectives that are central to the RPS:

1. Promoting renewable energy development while keeping electricity affordable for all ratepayers;
2. Lowering the cost of renewable energy generation;
3. Promoting in-state economic development (jobs, spending);
4. Realizing environmental benefits (GHG reductions, public health); and
5. Promoting fuel diversity.

Several specific external factors could potentially enhance or detract from the success of Maryland's RPS. Thus, they are listed together on the following pages, rather than split into binary categories of "opportunities" and "threats."

External Factors

- **Technology Innovation** – The costs of certain renewable energy technologies, such as wind and solar PV, have declined markedly in recent years, and costs may decline more rapidly than projected, lowering the cost of RPS compliance. Additionally, these technologies have also improved their performance, such as higher capacity factors, which further reduces the costs of RPS compliance. Finally, energy storage costs are also declining rapidly, and combined solar/storage projects are starting to appear in other parts of the country.
- **Natural Gas Prices** – Natural gas prices have been at historically low levels over the last few years. In response, reliance on natural gas for electricity generation has risen in Maryland, PJM and the nation as a whole. Between 2013 and 2016, for example, the percentage of natural gas generation in Maryland rose 7 percent. This trend will likely continue due to the addition of three natural gas plants in the state in 2017 and 2018 totaling 2,480 MW of additional natural gas capacity.[23] While the RPS can help to hedge against rising natural gas costs, cost-savings opportunities may be limited if natural gas prices continue to fall.

[23] Capacity figures drawn from the following company websites: Competitive Power Ventures, cpv.com/our-projects/cpv-st-charles/about/; Old Dominion Electric Cooperative, oDecembercom/generation-transmission/generation-facilities/; and PSEG Keys Energy Center LLC, psegkeysenergycenter.com/.

External Factors (cont'd)

- **Electricity Demand** – Growth in electricity demand has been very low or near zero, limiting or effectively eliminating the increase in renewable energy capacity that may be required under the Maryland RPS just via growth in demand. PJM forecasts that growth in electricity demand will be very low.[24] Should demand for electricity increase unexpectedly, more renewable energy will be needed to meet the Maryland RPS.
- **Customer Demand for Renewables** – Some customers will voluntarily purchase renewable energy generation or credits to meet internal environmental or other public benefit goals. Renewable energy generation from voluntary green power demand, as it is termed, has nearly doubled since 2010.[25] Although not as much of a driver as state RPS policies, which account for roughly 50 percent of new renewable energy capacity since 2000,[26] voluntary green power demand was responsible for nearly 25 percent of new installed wind capacity in 2017.[27]
- **RPS Requirements in Neighboring States** – Because the Tier 1 REC market operates across state lines, policy changes in other states can impact RPS compliance costs in Maryland. Over the past five years (2013-2018), four PJM states and the District of Columbia have enacted changes to their RPS laws. New Jersey, Michigan, and D.C. increased their RPS requirements. Illinois created requirements for "new" solar and wind. Ohio reinstated its Clean Energy Standard, after prior legislation made it voluntary for two years. In the short term, such increases are likely to tighten the market for Tier 1 RECs, driving up prices.
- **Import Tariffs** – In response to China's subsidization of its PV panel producers, the U.S. enacted a four-year tariff on imported crystalline silicon solar panels in January 2018. Solar panel prices rose in anticipation of the tariff, only to fall to pre-tariff levels when China later slashed its subsidies for solar, creating a global oversupply of solar panels. During this period of cost uncertainty, many U.S. companies have hesitated to invest in solar. In California, for example, PV installations declined in 2017 for the first time since 2009. Cost uncertainty may continue to have a chilling effect on the PV industry, including in Maryland. For example, Wood Mackenzie Power & Renewables, a market research firm, has reduced its national forecast for 2018-2022 solar installations by 8 percent compared to its earlier forecasts.[28] Additionally, steel and aluminum tariffs are projected to increase the levelized cost of renewable energy by 3 to 5 percent.[29]

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[24] *PJM Load Forecast Report – January 2018*, PJM Resource Adequacy Planning Department, pjm.com/-/media/library/reports-notices/load-forecast/2018-load-forecast-report.ashx?la=en, 87.
[25] *2016 Green-e Verification Report*, Center for Resource Solutions, May 2018, green-e.org/docs/2016%20Green-e%20Verification%20Report.pdf.
[26] Galen Barbose, *U.S. Renewables Portfolio Standards 2017 Annual Status Report*, Lawrence Berkeley National Laboratory, July 2017, eta-publications.lbl.gov/sites/default/files/2017-annual-rps-summary-report.pdf.
[27] Ryan Wiser and Mark Bolinger, *2017 Wind Technologies Market Report*, U.S. Department of Energy, August 2018, eta-publications.lbl.gov/sites/default/files/2017_wind_technologies_market_report.pdf.
[28] Jim Puzzanghera and Don Lee, "The roiled solar power market shows how Trump's tariffs can disrupt an industry," *Los Angeles Times*, July 7, 2018, latimes.com/business/la-fi-solar-tariffs-20180707-story.html#.
[29] Julia Pyper, "Trump's Steel, Aluminum Tariffs Create 'Another Headache' for Renewables," *Greentech Media*, March 8, 2018, greentechmedia.com/articles/read/steel-aluminum-tariffs-renewables-elon-musk#gs.89S9_3o.

External Factors (cont'd)

- **Federal Tax Credits** – Two major federal incentives for renewable energy are coming to an end. The federal PTC in 2019 (although projects meeting Internal Revenue Service [IRS] criteria for beginning construction have several years to be completed) and the federal ITC are being phased down/out. For example, the ITC currently provides a 30 percent federal tax credit for residential and commercial solar investments. After 2021, the commercial ITC will drop to 10 percent and the residential credit will end (again, projects meeting IRS criteria for commencing construction have until the end of 2023 to be placed in service). When the ITC was extended in 2015, the SEIA predicted the move would cause an extra 22 GW of new solar capacity by 2022.[30] Likewise, the American Wind Energy Association credits the PTC with helping wind capacity more than quadruple since 2008.[31] The loss of these federal tax credits could increase the cost of wind, solar and other ITC-eligible projects used to fulfill Maryland's RPS.
- **Transmission Capacity in MD/PJM** – The hosting capacity of the transmission and distribution system within Maryland and/or the rest of PJM may limit the additions of distributed and utility-scale renewable energy projects, barring investment in new transmission and distribution capacity.
- **Federal Carbon Regulation** – In 2009, the EPA determined that emissions of carbon dioxide (CO_2) and other long-lived GHGs that build up in the atmosphere endanger the health and welfare of current and future generations by causing climate change and ocean acidification. The Obama Administration set limits for CO_2 emissions under Section 111(d) of the Clean Air Act. While the Trump Administration has drastically scaled back these regulations, it is possible that the federal government will again expand regulation of CO_2 emissions, either by statute or by regulation.
- **Siting Challenges** – Developing generating plants can be challenging, as developers need to obtain state approval to site a project before commencing construction, which can be costly and time-intensive. Furthermore, while public involvement is both valued and required in the siting process, recent and growing public interest has increased the complexity of siting generating plants. One proposed wind facility was blocked due to concerns over potential interference with radar facilities at the Patuxent Naval Research Center, and there are local concerns and issues that have emerged with respect to a proposed offshore wind project near Ocean City. Public concern has also been expressed over the potential loss of farmland from proposed utility-scale solar projects.

[30] "Solar ITC Impact Analysis – How an Extension of the Investment Tax Credit Would Affect the Solar Industry," Solar Energy Industries Association, seia.org/sites/default/files/ITC%20Impact%20Analysis%20Factsheet_Sep2015.pdf.

[31] "Tax Policy," American Wind Energy Association, awea.org/production-tax-credit.

External Factors (cont'd)

- **Changes in PJM's Capacity Market** – In June 2018, the FERC found that PJM's capacity market, known as the RPM, was not just and reasonable because it did not adequately account for out-of-market payments to certain preferred generation technologies. FERC instituted a paper hearing for stakeholders to propose alternatives, but ultimately determined that PJM should impose its MOPR, which would require capacity suppliers receiving some sort of state subsidy arrangement to offer capacity at a price without reflecting revenue earned from state policy arrangements. Imposing the MOPR would very likely raise the capacity price these suppliers could offer, and PJM will likely not select them in its annual RPM auction. Recognizing that customers may pay twice for capacity—once through state programs such as the RPS and once through the PJM RPM—FERC proposed a Fixed Resource Requirement Alternative that would permit generation that receives out-of-market payments to opt out of the PJM RPM with a matching amount of load.[32] FERC, however, largely left the details to be filled in by PJM and stakeholders. What FERC will accept for a revised PJM RPM is unclear at this time. It is possible, though, that resources that participate as compliance options for state RPS policies may be considered in receipt of out-of-market payments, and be subject to the MOPR, which could make these resources uncompetitive for the PJM RPM. However, these resources could qualify for FERC's Fixed Resource Requirement Alternative or a different proposal that FERC designs or accepts from petitioners. Since the details of FERC's proposal, or a different proposal that FERC might design itself or accept from others, are unknown, it is difficult to project the level of prices that a state-subsidized resource might receive. Not receiving revenues from the PJM RPM or receiving less revenues could mean higher RPS compliance costs if RPS-eligible generators are participating in the PJM RPM.

[32] *Order Rejecting Proposed Tariff Revisions, Granting in Part and Denying in Part Complaint, and Instituting Proceeding Under Section 206 of the Federal Power Act*, 163 FERC ¶ 61,236, Federal Energy Regulatory Commission, June 29, 2018, ferc.gov/CalendarFiles/20180629212349-EL16-49-000.pdf.

SWOT Analysis of Not Changing the Maryland RPS

The Maryland Legislature has made numerous alterations to the state's RPS since first enacting it in May 2004, including major changes in 2007, 2008, 2011, 2013 and 2017. These changes included creation of the solar and offshore wind carve-outs, percentage increases in the RPS requirement, adjustments to resource eligibility, alterations to the composition of the Tier 1 and Tier 2 resource categories, and revisions to the geographic eligibility requirements, among other changes. With each modification, there have been trade-offs in terms of the cost of RPS compliance, the state's ability to meet its targets, and which resources most benefit from the RPS. The Maryland RPS currently peaks at 25 percent in 2020. Legislation was introduced in past sessions to raise the RPS requirement and to make other changes, such as altering resource eligibility. Additional legislation to change the Maryland RPS will likely be introduced in the 2019 session of the Maryland General Assembly. This SWOT considers the expected outcomes of *not* changing the Maryland RPS; i.e., maintaining the status quo.

The objectives of Maryland's RPS include: helping renewable generators overcome market barriers; supporting a diverse portfolio of renewable energy resources within Maryland; reducing the costs of power from renewable resources; and capturing the benefits of emissions reductions, fuel diversity, and other economic gains from higher deployment of renewable energy.[33] Although the average cost of non-carve-out RECs increased substantially between 2011 and 2015, those costs have leveled and declined in recent years, especially since 2016. SREC prices have also dropped substantially and are approaching near parity with non-carve-out Tier 1 RECs. As an indication, the total cost of complying with the Maryland RPS increased over time, reaching $135.2 million in 2016,[34] before declining in 2017 to $72 million due to declining REC and SREC prices.[35]

In addition to REC purchases, Maryland has expanded its in-state portfolio of non-hydropower renewable resources. According to EIA, net generation from non-hydropower, utility-scale renewable energy resources increased by 142 percent from 2010 to 2017, and now comprises over 3.5 percent of net generation in Maryland.[36] The fastest growing in-state resource is solar PV, primarily due to the solar carve-out. According to PJM-GATS, Maryland has 975 MW of solar as of the end of 2017, making it the 13th leading state in terms of installed solar capacity.[37] Installed solar capacity was near zero when the Maryland RPS was enacted in

[33] Annotated Code of Maryland, Public Utilities Article (PUA), § 7-701.

[34] *Renewable Energy Portfolio Standard Report with Data for Calendar Year 2016*, Maryland Public Service Commission, January 2018, psc.state.md.us/wp-content/uploads/CY16-RPS-Annual-Report-1.pdf.

[35] *Renewable Energy Portfolio Standard Report with Data for Calendar Year 2017*, Maryland Public Service Commission, November 2018, psc.state.md.us/wp-content/uploads/FINAL-Renewable-Energy-Portfolio-Standard-Report-with-data-for-CY-2017.pdf.

[36] "Electricity Data Browser," U.S. Energy Information Administration, eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=g6&geo=00000008&sec=008&freq=A&start=2001&end=2017&ctype=map&ltype=pin&rtype=s&pin=&rse=0&maptype=1.

[37] "Solar State by State," Solar Energy Industries Association, seia.org/states-map.

2004. Today, SEIA estimates that Maryland employs 5,324 persons in solar-related jobs.[38] The Maryland RPS also contributed to the continued operation of some of the existing renewable capacity in Maryland and PJM. Based on PJM-GATS, approximately 60.6 percent of the renewable capacity used to meet Maryland's 2016 Tier 1 and Tier 2 REC compliance requirements came from resources developed before 2004. Despite the gains of some in-state resources, about 75 percent of RECs used for complying with the Maryland RPS in 2017 came from outside of Maryland; i.e., from non-Maryland renewable resources.[39]

According to the forthcoming 2017 Inventory Report, Maryland is currently meeting its RPS requirements and will likely meet the 25 percent requirement by 2020. Maryland's RPS, however, does not exist in a vacuum. Fulfillment of current or future RPS goals depends on an array of factors, including: Maryland, federal and other state policies; changes in total Maryland power consumption; economic and technical improvements in renewable energy technologies; and broader energy market supply and demand considerations.

Proponents of changing the RPS emphasize opportunities to expand Maryland's burgeoning renewable industry and supplant non-renewable resources with more environmentally friendly renewable alternatives. Opponents of changing the RPS point to ratepayer impacts, the uncertainties inherent to policy changes, the potential to utilize alternative policies to the RPS to support renewables, effects on the grid of more variable renewable energy generation and opposition to giving renewable energy technologies further policy support and/or financial incentives.

This analysis briefly summarizes the strengths and weaknesses of maintaining the status quo RPS. Important considerations include: cost, environmental impact, economic multipliers and risk tolerance.

[38] "Maryland Solar," Solar Energy Industries Association, seia.org/state-solar-policy/maryland-solar.
[39] *Renewable Energy Portfolio Standard Report with Data for Calendar Year 2017*, Maryland Public Service Commission, November 2018, psc.state.md.us/wp-content/uploads/FINAL-Renewable-Energy-Portfolio-Standard-Report-with-data-for-CY-2017.pdf.

<u>Strengths</u>	<u>Weaknesses</u>
▪ **Market certainty** – Maintaining the current Maryland RPS will avoid any disruption to REC markets. The status quo also has lower short-term transaction costs as compared to changing the RPS, which may require adjustments by market participants. ▪ **Other states can bear costs without diminishing some Maryland benefits** – Sustaining current RPS policies allows other states to pursue policies in support of renewables and bear the associated costs. Since Maryland participates in PJM, renewable development in other PJM states could help reduce Maryland's REC costs, reduce cross-state emissions and increase the amount of renewable energy generation in all PJM states. ▪ **Reduces REC prices** – Maintaining current RPS requirements will level off Maryland's demand for RECs and, if the supply of renewable energy capacity grows, put downward pressure on REC prices. ▪ **Meets RPS goals** – Maryland is currently expected to meet its RPS goals and is more likely to do so without policy changes that increase the stringency of the state's RPS requirement. ▪ **Minimizes additional ratepayer impacts** – Maintaining the Maryland RPS at its current level will reduce ratepayer impacts compared to significantly increasing Maryland's RPS.	▪ **Slows or stops renewable energy development in Maryland** – As Maryland reaches compliance with current requirements of its RPS, there may be less interest from renewable energy developers to build new renewable energy projects. ▪ **Loss of business to other states** – Future renewable energy investment may flow to other states with more aggressive targets and faster-growing markets.

SWOT Analysis of a 50 Percent RPS

Over the past few years, several states and the District of Columbia have opted to increase their RPS requirement to 50 percent renewable energy or higher. In 2015, Hawaii raised its RPS to 100 percent by 2045. In 2016, D.C. and Oregon raised their RPS requirements to 50 percent by 2032 and 2040, respectively. In 2018, New Jersey raised its RPS to 50 percent by 2030. Lastly, California raised its RPS to 60 percent by 2030, with an additional goal of 100 percent carbon-free energy (including large hydropower) by 2045.

During this time period, several efforts have been made to raise Maryland's RPS. In 2017, the General Assembly increased the RPS from 20 percent by 2022 to 25 percent by 2020. In 2018, HB 1453 would have raised the Maryland RPS requirement to 50 percent by 2030 with a 14.5 percent solar carve-out, while HB 838 would have raised the RPS to 100 percent by 2035. Neither bill passed, but discussions of legislation to require a 50 percent RPS or greater continue in Maryland.

Statistics in the table on the following page are based on the results of the Very High Maryland RPS Scenario in PPRP's most recent LTER (2016). These statistics provide comparisons to the LTER Reference Case, which reflects Maryland and federal law as of December 2016.

The LTER's Very High Maryland RPS Scenario had the following assumptions:

- 50 percent RPS by 2035, including a 5 percent solar carve-out; no changes to RPS policies in other states (New Jersey increasing its RPS to 50 percent in 2018 was not modeled.)
- RPS is fulfilled with actual generation, not ACPs.
- New wind capacity is used to fulfill all new (non-solar) RPS requirements; this new capacity is built in a PJM zone that contains Maryland (PJM-SW, PJM-Mid-E or PJM-APS).
- Load growth in Maryland follows the trends forecasted in the Maryland PSC's 10-Year Plan (2015-2023), released in August 2014, and thereafter is assumed to have a 0.70 percent compound annual growth rate from 2023-2035.
- Load growth in the remaining PJM states is based on applying regional growth rates from the most recent edition of the EIA's *Annual Energy Outlook* (Reference Case forecast) to the most-recent available state-level retail sales data.[40]

[40] *Long-Term Electricity Report for Maryland*, Maryland Department of Natural Resources Power Plant Research Program, 2016, dnr.maryland.gov/pprp/Documents/LTER-December-2016.pdf, Chapter 7.

This analysis briefly summarizes the strengths and weaknesses of increasing the Maryland RPS to 50 percent. Important considerations include cost, environmental impact, economic impact and land use.

Strengths	Weaknesses
▪ **Expanding clean energy** – A higher RPS helps increase renewable energy capacity while reducing fossil fuel capacity. For example, the LTER Very High Maryland RPS Scenario modeling resulted in: 1,100 MW of additional in-state solar PV; 6,700 MW of additional wind in PJM; and one GW less natural gas capacity added in PJM's Mid-E region, which encompasses parts of Delaware, Maryland and New Jersey, all by 2035. Lowering the carbon intensity of Maryland's economy helps to reduce the risks associated with climate change (e.g., extreme weather, sea level rise, lower crop yields, etc.). ▪ **Diversifying Maryland's power portfolio** – A higher RPS reduces the exposure Marylanders face to coal and gas price volatility, though it limits cost reduction potential if natural gas prices fall further. ▪ **Increasing in-state energy production** – Expanding the RPS potentially increases in-state renewable energy generation. The LTER Very High Maryland RPS Scenario resulted in 6 percent more renewable energy generated in Maryland and a 26,000-GWh decrease in net electricity imports by 2035. ▪ **Solar jobs and other economic benefits** – The solar carve-out has helped establish a sizable in-state industry. As of 2017, the solar industry employs 5,300 Marylanders. Forthcoming input-output modeling under this project will help to estimate the direct and indirect impacts of increasing the RPS and the solar carve-out. ▪ **Local and state government tax revenue** – The jobs and economic activity created by all segments of the renewable energy industry, including distributed and utility-scale renewable generation, add to local and state tax revenues.	▪ **Most RECs likely to come from outside Maryland** – Other than the solar carve-out, 85 percent of Tier 1 RECs have historically come from out of state, which has some questioning the local benefits of expanding the RPS. Absent statutory changes, this trend is likely to continue. ▪ **Additional costs** – Increasing the RPS would come at an additional cost, as more RECs and SRECs would have to be procured to meet the higher RPS requirements. ▪ **Little impact on in-state emissions** – In the LTER Very High Maryland RPS Scenario, raising the RPS had limited impact on Maryland emissions, and associated environmental and public health impacts, because in-state coal and natural gas plants continue to generate for the PJM-wide market. ▪ **Land-use concerns** – Localities govern many land-use decisions in Maryland. If localities determine that renewables are not compatible with agricultural land use, the level of renewable deployments in Maryland may be limited. The 2016 LTER estimated that 2.2 percent of the Eastern Shore's prime agriculture farmland would be required to meet a 5 percent solar carve-out, if all of the PV needed were located on such land. This is a high-end estimate, given that it ignores over 975 MW of current PV capacity, future rooftop solar installations and other potential sites, such as landfills.[41] However, land impacts would certainly be higher with a 14.5 percent carve-out. ▪ **Increasing renewables could raise reliability concerns** – A PJM-commissioned study indicated that the wholesale energy market can accept 30 percent renewable penetration without any reliability issues.[42] However, concerns remain about maintaining reliability at the distribution level as renewable energy penetration rises.

Strengths (cont'd)	Weaknesses (cont'd)
▪ **Possible investments in rural and environmental justice communities** – New renewable energy projects under a 50 percent RPS: (1) could be developed through collaboration with local governments and farmers to diversify rural income streams; and (2) promote jobs and career pipelines in underserved communities, while reducing the impacts of carbon, air and water pollution.	▪ **There are other approaches to increasing renewables** – While RPS laws have the advantage of being easy to understand, other policy mechanisms may be just as or more effective in increasing development of renewable energy (e.g., auctions, long-term contracts, feed-in-tariffs, etc.)

[41] *Long-Term Electricity Report for Maryland*, Maryland Department of Natural Resources Power Plant Research Program, 2016, dnr.maryland.gov/pprp/Documents/LTER-December-2016.pdf, 10-45 to 10-48.
[42] "Renewable Integration Study Reports," PJM Interconnection, March 2014, pjm.com/committees-and-groups/subcommittees/irs/pris.aspx.

SWOT Analysis of Removing Black Liquor as an Eligible Resource

Black liquor is an industrial byproduct derived from the process of converting wood into paper pulp. One prominent use for this byproduct is as an electricity source; burning black liquor in recovery boilers produces steam that can be used to generate electricity. This process also allows paper manufacturers to recover other chemical byproducts for reuse.

Black liquor is classified as "biomass" under the Maryland RPS, and electricity produced from burning black liquor qualifies for Tier 1 RECs.[43] This is a source of controversy. Proponents of maintaining black liquor as an eligible Tier 1 resource argue that burning black liquor to produce energy is an efficient process since it recycles a byproduct of the paper mill process. Proponents also note that the paper mills replenish the fuel stock by replanting trees. Opponents of the eligibility of black liquor argue that black liquor is not clean energy, as it emits as much CO_2 as a coal plant. Opponents also argue that a significant amount of the black liquor credits are subsidizing out-of-state paper mills.

Historically, black liquor RECs were used to satisfy a significant portion of the Maryland RPS requirements. In 2008, black liquor RECs satisfied approximately 38 percent of the Maryland RPS.[44] This share has declined in recent years. In 2017, black liquor RECs satisfied approximately 24 percent of the Maryland RPS Tier 1 requirements. All but one of the 11 facilities that provided black liquor RECs in 2017 are from out of state. Moreover, over 90 percent of the black liquor RECs used for complying with the Maryland RPS come from out of state.[45]

Legislation has been introduced in the Maryland General Assembly in recent years to remove black liquor from the list of eligible resources, but it has not been enacted. This analysis briefly summarizes the strengths and weaknesses of removing black liquor from the list of eligible resources under the Maryland RPS. Important considerations include: impact on Maryland RPS compliance, available alternatives, impact on Tier 1 REC prices, subsidies, economic considerations and the location and availability of RPS-eligible resources.

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[43] As stated in Code of Maryland §7–701, one applicable fuel source under the RPS is "(i) waste material that is segregated from inorganic waste material and is derived from sources including: 1. Except for old growth timber, any of the following forest-related resources: A. mill residue, except sawdust and wood shavings."

[44] *Renewable Energy Portfolio Standard Report of 2010 with Data for Compliance Year 2008*, Maryland Public Service Commission, February 2010, psc.state.md.us/wp-content/uploads/MD-RPS-2010-Annual-Report.pdf, 9.

[45] *Renewable Energy Portfolio Standard Report with Data for Calendar Year 2017*, Maryland Public Service Commission, November 2018, psc.state.md.us/wp-content/uploads/FINAL-Renewable-Energy-Portfolio-Standard-Report-with-data-for-CY-2017.pdf.

Strengths	Weaknesses
▪ **Provides opportunities for other resources for the Maryland RPS**– Eliminating a resource that satisfies a significant portion of the RPS will essentially increase the Maryland RPS without increasing the percentage. This occurs because other eligible resources will be used to fill the void. ▪ **Favors "cleaner" renewable energy technologies** – Eliminating black liquor could result in the Maryland RPS favoring non-combustion technologies, such as solar and wind, to meet demand. ▪ **Makes the Maryland RPS more compatible with other state RPS policies in PJM** – Pennsylvania and Maryland are currently the only states, along with the District of Columbia, in PJM that certify black liquor. Pennsylvania limits eligible black liquor facilities to those located within Pennsylvania. As of the 2017 compliance year, black liquor in the District of Columbia was reclassified from a Tier 1 facility to a Tier 2 facility. Tier 2 is eliminated in D.C. as of the end of 2019. ▪ **Reduces subsidies for resources that emit air pollution** – Black liquor contributes towards sulfur dioxide, arsenic and GHG emissions. ▪ **No long-term impact on REC prices** – Prices may increase slightly in the near term as markets adjust, but will eventually fall and stabilize as other qualified resources either increase over time or are imported from other states to meet RPS requirements. ▪ **Avoids subsidizing out-of-state paper mill plants** – More than 90 percent of black liquor RECs used for complying with the Maryland RPS in 2016 came from out of state. Maintaining black liquor as an eligible technology essentially subsidizes paper mills in other states that compete with the Luke Mill paper facility in Maryland.	▪ **Potential in-state job losses** – The Luke Mill paper facility, located in Western Maryland, would no longer receive RECs for black liquor and, as a result, may need to either close or lay off some of its 700 employees.[46] That, in turn, could affect jobs indirectly, such as suppliers or retail stores where employees of Luke Mill frequent. For every paper industry job, a paper mill generates 3.25 jobs in the local community and for supplier industries.[47] ▪ **Negative economic impact on a local community** – The Luke Mill paper facility contributes over $200 million in economic benefits to Western Maryland.[48] ▪ **Elimination of a carbon-neutral source** – Biomass is considered by some to be a carbon-neutral resource, as it captures the energy value of the CO_2 that would be released into the atmosphere anyway from natural decomposition and avoids additional methane production from landfilling. Methane is 25 times more potent than CO_2 as a GHG. ▪ **Increased REC prices for the near term** – The increase in demand for other Tier 1 RECs will likely drive up REC prices slightly in the near term. ▪ **Majority of RPS supply coming from outside Maryland** – It is possible that the increase in the supply of other eligible resources will come from out of state, which will limit local benefits in Maryland.

SWOT Analysis of Providing State Support for Energy Storage

System flexibility has been defined as the grid's ability to accommodate both predictable and unpredictable imbalances between supply and demand.[49] Higher amounts of wind and solar drive a need for additional system flexibility. As the penetration of these variable resources grows in a region, their impact on the grid becomes more noticeable, sometimes causing overall generation to ramp up and down more steeply on second-to-second, daily and seasonal time scales. Wind and solar jointly represented just 2.8 percent of generation in PJM in 2017,[50] and about 2.5 percent in Maryland in 2017.[51] This low penetration, combined with PJM's large footprint, suggests that wind and solar do not present a major challenge to system flexibility, and are unlikely to do so in the near future.

Numerous resources can enhance system flexibility, including fast-responding gas plants; power electronics that regulate wind and solar output; smart-devices that adjust their consumption in response to programming or price signals; and energy storage devices such as flywheels, water heaters and batteries.[52] In recognition of the importance of maintaining system flexibility, Ch. 393 calls for a discussion on "how energy storage and other flexibility resources should continue to be addressed in support of renewable energy and state energy policy." Specifically, HB 1414 asks: whether flexibility resources should be encouraged through procurement, production or installation incentives; whether it would be advisable to provide energy storage devices to increase the distribution system's ability to host on-site renewable energy generation; and what the costs and benefits of energy storage deployment in the state would be under future goal scenarios.[53]

This SWOT focuses on energy storage, which has the potential to provide a range of services that may help increase the affordability, reliability and sustainability of electricity in

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[46] "The Luke Mill at-a-glance," Verso Corporation, December 31, 2017, versoco.com/wps/wcm/connect/90262416-a618-462d-b7d5-56b694073ae2/Luke+Mill+Fact+Sheet+April+2018.pdf?MOD=AJPERES&CVID=mar1XO6.
[47] Jerry Schwartz, "Biomass Residuals Should Continue Being Recognized in Renewable Portfolio Standards," American Forest & Paper Association, March 2, 2016, afandpa.org/media/blog/bloga/2016/03/02/biomass-residuals-should-continue-being-recognized-in-renewable-portfolio-standards.
[48] "Saving Our Paper Towns One Battle at a Time," United Steelworkers, April 9, 2016, usw.org/news/media-center/articles/2016/saving-our-paper-towns-one-battle-at-a-time.
[49] Eric Gimon, "Flexibility, Not Resilience, Is the Key to Wholesale Electricity Market Reform," *Greentech Media*, October 31, 2017, greentechmedia.com/articles/read/flexibility-is-the-key-to-wholesale-electricity-market-reform#gs.hhjlo5E.
[50] *PJM State of the Market Report – 2017*, Monitoring Analytics, monitoringanalytics.com/reports/PJM_state_of_the_Market/2017/2017-som-pjm-sec3.pdf, Section 3 – Energy Market.
[51] *Electric Power Annual 2017*, U.S. Energy Information Administration, October 2018 (revised December 2018), eia.gov/electricity/annual/pdf/epa.pdf, calculated from Tables 3.7, 3.18 and 3.21.
[52] Eric Gimon, "Flexibility, Not Resilience, Is the Key to Wholesale Electricity Market Reform," *Greentech Media*, October 31, 2017, greentechmedia.com/articles/read/flexibility-is-the-key-to-wholesale-electricity-market-reform#gs.hhjlo5E.
[53] "House Bill 1414," Maryland General Assembly, 2011, mgaleg.maryland.gov/2017RS/bills/hb/hb1414E.pdf, 5.

Maryland. The list below summarizes several important applications for energy storage. Note that aggregation software can be used to coordinate behind-the-meter (BTM) storage resources, so that they can provide bulk energy and/or distribution system services. Also note that energy storage devices must often provide multiple services, staggered over time, to be cost-effective.

Bulk Energy Services

- *Regulation Services* – Fast-responding resources can offset short-duration (i.e., a few seconds to a few minutes) fluctuations in net load (i.e., electricity demand after subtracting wind and solar production). PJM solicits these services through its ancillary services markets.
- *Renewables Firming* – Alternatively, a merchant developer can use storage to make wind/solar generation more consistent and more economically attractive.
- *Peak Shaving* – Energy storage can help to "flatten" a region's peak demand, which lowers the average cost of electricity.
- *Peaker Replacement / Time Shift* – In theory, storage could be charged by a renewable resource during off-peak hours, and dispatched during on-peak hours, thus supplanting natural gas plants.
- *Black Start* – Like a traditional generator, storage can serve as a "kick-start" resource to restore the grid following power outages.

Distribution System Services

- *Infrastructure Deferral* – Strategically placed storage can decrease or defer the need to invest in traditional distribution system upgrades (e.g., those needed to maintain system reliability). Often, storage investments can be closely scaled to a current need, whereas traditional upgrades must be larger.
- *Hosting Capacity* – Storage can be placed on distribution lines with high (e.g., 30 percent of peak demand) PV penetration to address power-quality problems that may arise. For example, storage can absorb "backflows" of power from BTM PV, which would otherwise stress equipment designed for a one-way flow of electricity.[54] Alternatively, co-locating storage with BTM PV can avoid backflows.

Customer Services

- *Bill Management and Backup Power* – Customers can use demand management strategies, including storage, to shave their individual peak demand and any associated bill charges. Storage can also provide backup power for individual customers or communities when grid power is unavailable. When paired with

[54] "Renewable Integration Benefits," Energy Storage Association, energystorage.org/energy-storage/energy-storage-benefits/benefit-categories/renewable-integration-benefits.

renewable energy, storage may be able to keep critical circuits (typically 10 to 20 percent of total building load) running indefinitely.[55]

In recent years, dramatic reductions in the cost of batteries and improvements in aggregation software have begun to open new applications for energy storage. In its 2018 report on energy storage in Maryland, PPRP identified 12 key barriers to storage, some at the PJM level,[56] and some at the state level. The latter barriers include: system and financing costs; concern over whether Maryland's regulated distribution utilities should be allowed to participate in PJM markets; rate designs that mask the real-time cost of energy; questions about the level of utility review needed for BTM storage; limited mechanisms for paying storage owners to avoid distribution system costs; a lack of protocols for dispatching BTM storage to provide services to the grid; and opaque distribution system planning processes.[57] These barriers have led some stakeholders to call for subsidies for energy storage or set a target for energy storage.

Proponents of state-level subsidies and related supports for energy storage cite the long-term environmental and economic benefits of helping to expand the market for storage and increase in-state understanding of how to best utilize it. Opponents cite the risk of increasing emissions in the short term and the costs imposed by subsidies. The MEA launched a first-in-the-nation pilot program in FY 2019 to try to address some of these questions.

This analysis briefly summarizes the strengths and weaknesses of adding state-level subsidies, either by including storage in the RPS, creating a standalone storage target or developing storage incentives. Important considerations include:

- Policy design (adding energy storage as a separate tier or carve-out or adding energy storage power as an eligible technology to the Maryland RPS);
- Defining ratepayer protections and/or cost caps;
- Potential impacts on competitive electric power markets;
- Possible changes to the PJM RPM (PJM's capacity market) that may affect policy support or subsidies to renewables or other specific technologies;

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[55] *Energy Storage Roadmap for New York's Electric Grid*, New York Battery and Energy Storage Consortium, January 2016, 35.

[56] In February 2018, the FERC took steps to give storage greater access to wholesale markets. FERC Order No. 841 compels PJM and other regional transmission organizations and independent system operators to revise their market rules to facilitate the participation of energy storage resources in their energy, ancillary service and capacity markets.

[57] *Energy Storage in Maryland: Policy and regulatory options for promoting energy storage and its benefits*, Maryland Department of Natural Resources, Power Plant Research Program, 2018, dnr.maryland.gov/pprp/Documents/Energy-Storage-In-Maryland.pdf.

- Impact on the Maryland RPS overall if energy storage is added as an eligible technology; and
- Ensuring flexibility in case market conditions change.

Strengths	**Weaknesses**
Inclusion in the RPS, with or without a Storage Carve-out	
▪ **Emissions** – Focuses on storage charged by renewable energy, which eliminates the risk of storage increasing CO_2, both because some energy is always lost during charging/discharging and because charging storage during PJM's lowest-cost hours may increase reliance on coal at the expense of natural gas.	▪ **Inflexibility** – The RPS may not be a suitable policy for storage because of its focus on MWh of generation. Unlike renewable resources, the value of storage lies not in simply providing energy to the grid, but in strategically meeting grid needs at certain times and locations.
Standalone Storage Target	
▪ **Flexibility** – Provides more flexibility for applications and performance tracking (e.g., storage capacity or usage in key time periods). Can still be designed to require storage charged by renewable energy, if desired.	▪ **Emissions** – Using storage systems charged by non-renewable energy resources may increase GHG emissions, for both the reasons stated earlier—inherent losses during charging/discharging and reliance on least-cost resources in PJM's resource mix. ▪ **Costs to ratepayers** – The costs of procuring storage would be an additional cost for ratepayers.
Storage Incentives	
▪ **Flexibility** – Provides maximum flexibility. Incentives could be tied to performance of a desired activity (e.g., time shift) or to the use of a renewable resource for charging.	▪ **Results** – Cannot guarantee specific levels of storage deployment or usage.
All Forms of Support	
▪ **Jobs / economic development** – Could be designed to promote in-state storage deployments, with associated jobs in storage project development and deployment. ▪ **Potential avoided costs** – As with EmPOWER Maryland projects, it may be possible to identify and support multi-use storage projects whose cost is less than the system-wide cost savings they would otherwise realize.	▪ **Unclear need** – Given that wind and solar provide a relatively low percentage of total generation in Maryland and in PJM, it is unclear whether storage benefits to the grid would outweigh their costs in the near term. Cost-benefit modeling would provide insight. ▪ **Safety concerns** – Battery fires are a concern. New York City has just released guidelines for the outdoor deployment of batteries and plans to release indoor guidelines by the end of 2018.[58] ▪ **Decommissioning concerns** – Standards for battery decommissioning have yet to become well-established.

SWOT Analysis of Switching Hydropower from a Tier 2 Resource To a Tier 1 Resource

Hydroelectric power (hydro) has a long history in Maryland as a source of renewable energy generation. According to EIA, as of 2017 hydro plants in Maryland produced 1,963 GWh, or 5.8 percent of the state's net generation.[59] Along with waste-to-energy and poultry litter, hydro (excluding pumped storage) was classified as a Tier 2 resource when the RPS was enacted in 2004, while hydro projects less than 30 MW were considered a Tier 1 resource. In 2017, Tier 2 RECs accounted for approximately 16 percent of the total retired RECs for Maryland RPS compliance.[60] Approximately 66 percent of these RECs came from out-of-state hydro generation, with the majority from North Carolina.[61]

By 2013, the Maryland General Assembly had reclassified waste-to-energy and poultry litter as Tier 1 resources, leaving hydro as the lone Tier 2 resource. The Tier 2 classification expires at the end of 2018. Given the impending phase-out of the Tier 2 resource requirement, some have suggested reclassifying hydro, regardless of MW of capacity, as a Tier 1 resource in order to continue supporting hydro resources.

Several states in PJM allow hydro as an eligible technology for RPS policies, albeit with varying eligibility requirements. Like Maryland, New Jersey renewables are divided into Class 1 and Class 2, with Class 1 including hydro resources less than 3 MW in capacity and Class 2 containing hydro resources between 3 MW to less than 30 MW in capacity. Pennsylvania, on the other hand, classifies hydro resources as Tier 1 if less than or equal to 21 MW in capacity, and as Tier 2 if greater than 21 MW including pumped storage. Virginia, which supplied 6.2 percent of Maryland's Tier 2 RECs in 2016, has a voluntary RPS requirement without a cap on capacity for hydro resources.

Changing the qualifying status of hydro to Tier 1 would give access to higher-priced Tier 1 RECs. Tier 2 REC prices, on average, are nearly 88 percent less than Tier 1 REC prices in Maryland as of August 2018.[62] Low electric wholesale prices have also put increased pressure on generation resources, including hydro. In the face of these market conditions, some hydro companies argue that the reclassification of hydro as a Tier 1 resource is necessary to avoid shutting down hydro projects.

In addition to supporting hydro resources in the face of a less favorable wholesale market environment, access to Tier 1 RECs would also support ongoing operations,

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[58] Mark Chediak, "Boom in giant batteries hits another roadblock: Cities' fear of fire," *Los Angeles Times*, May 18, 2018, latimes.com/business/la-fi-battery-fire-20180518-story.html#.

[59] "Electricity Data Browser," U.S. Energy Information Administration, eia.gov/electricity/data/browser.

[60] *Renewable Energy Portfolio Standard Report with Data for Calendar Year 2017*, Maryland Public Service Commission, November 2018, psc.state.md.us/wp-content/uploads/FINAL-Renewable-Energy-Portfolio-Standard-Report-with-data-for-CY-2017.pdf.

[61] Ibid.

[62] Marex Spectrometer, *Spectrometer U.S. Environmental*, August 25, 2018.

maintenance and relicensing costs when it is time to renew a hydro license with the FERC. As a result, hydro plants may be required to perform significant upgrades in order to be relicensed, such as the addition of fish ladders. Hydro plants may also be required to change how they operate in order to manage, for example, sediment levels or the amount of dissolved oxygen in the water.

Supporters of moving hydropower to Tier 1 point to potential environmental and economic benefits from sustaining an existing renewable resource. Opponents argue that the reclassification of hydro as a Tier 1 resource would allow hydro generation to undercut other resources in Tier 1 REC markets, reducing the support that could be provided to the development of new renewable energy projects. Opponents also question the need for existing hydro projects for financial support and contend that allowing eligibility for Tier 1 would be a financial windfall for hydro companies. This analysis briefly summarizes the strengths and weaknesses of altering the qualification status of conventional hydro. Important considerations include: environmental and economic impacts, REC prices and the prospects for other renewable energy technologies.

Strengths	Weaknesses
▪ **Increases the supply of Maryland Tier 1 resources to meet RPS requirements** – Making hydro an eligible Tier 1 resource helps avoid or shrink a possible supply gap between the Tier 1 requirement and available Tier 1 resources that is projected over parts of the next decade, according to the forthcoming 2017 Inventory Report. ▪ **Maintains an existing renewable energy technology** – Supports a renewable energy resource that already exists and ensures that Maryland continues its progress towards meeting state environmental goals. ▪ **Supports baseload, flexible renewable resources** – Hydro can serve as an all-hours, baseload resource or as a flexible resource that can be adjusted in response to the needs of grid operators. ▪ **Incentivizes possible investment in hydro plants** – Access to higher Tier 1 REC prices could encourage investment in updating aging units, as well as supporting investments that may be needed in order to relicense existing hydro projects. ▪ **Could lower Tier 1 RPS compliance costs to ratepayers** – Should RECs from hydro projects be sold at a lower price than prevailing Tier 1 REC prices, savings to ratepayers could be realized.	▪ **Subsidization of older plants** – The large hydro resources currently in operation are old, which effects operations and maintenance costs, as well as efficiency. Maryland ratepayers will subsidize outdated resources over financing other, modern types of renewable generation. ▪ **Decreased REC prices for the near term** – The increase in supply for non-carve-out Tier 1 RECs will likely suppress Tier 1 REC prices in the near term, disincentivizing the development of new renewable resources. ▪ **Majority of RPS supply coming from outside Maryland** – It is possible that the increase in the supply of other eligible resources will come from out of state, which will limit local benefits in Maryland. ▪ **Possible windfall for hydro companies** – Although requiring more operations and maintenance, older hydro projects are generally low-cost resources. Allowing access to Tier 1 REC prices that are much higher than Tier 2 REC prices could be an economic windfall for owners of hydro projects.

SWOT Analysis of Altering the Solar Carve-out of the Maryland RPS

Maryland is one of 16 states with a solar generation carve-out that requires a designated share of the state's RPS be met by output from solar resources.[63,64] The purpose of the solar carve-out is to incentivize the development of solar generation, especially in-state. Maryland first enacted a Tier 1 carve-out for solar energy in 2007 and subsequently amended it in 2010, 2012 and 2017. The most recent changes increased the solar carve-out requirement to the new target of 2.5 percent by 2020. According to the forthcoming 2017 Inventory Report, Maryland is projected to surpass this carve-out level. In the 2018 session of the Maryland General Assembly, legislation was introduced to increase the Maryland RPS to 50 percent, with a 14.5 percent solar carve-out. Although that legislation did not pass, similar legislation is anticipated for the 2019 session.

The resources eligible for Maryland's solar carve-out include solar water-heating systems constructed on or after June 1, 2011, solar PV systems and solar thermal systems, which must be connected to a distribution grid serving Maryland to qualify for the carve-out. LSEs may demonstrate compliance using SRECs obtained via contract, purchase or self-generation. The ACP for solar resources in Maryland is higher than non-carve-out Tier 1 resources; the ACP for solar is $175/MWh as of 2018, while the non-carve-out Tier 1 resource ACP is $37.50/MWh. However, SREC prices are far lower than the ACP, ranging between $7/MWh and $15/MWh as of September 2018.[65]

Currently, all SRECs retired to meet Maryland's solar carve-out are from in-state solar resources. Within PJM, Maryland is second to only New Jersey in terms of installed solar capacity.[66] Solar makes up almost 50 percent of Maryland's renewable energy capacity. SEIA estimates that Maryland employs 5,324 persons in solar-related jobs and is home to as many as 135 solar-related companies, including manufacturers, installers and developers.[67]

The current highest solar carve-out in nearby states is New Jersey's 5.1 percent requirement by 2021. New Jersey, like Maryland, has a high number of solar facilities and a high share of solar capacity relative to other states in PJM. Attachment 1 to this SWOT lists the solar carve-out provisions in other PJM states with an RPS for comparison purposes.

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[63] Includes DC, DE, IL, MA, MD, MN, MO, NC, NH, NJ, NM, NV, OH, OR, PA and VT. Note that additional states have non-solar-specific carve-outs that support distributed generation or customer-sited resources, or utilize alternative incentives (e.g., multipliers), including AZ, CO, MI, NY and WA.

[64] "Renewable Portfolio Standards (RPS) with Solar or Distributed Generation Provisions," North Carolina Clean Energy Technology Center, February 2017, ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2017/02/RPS_carveout_4.pdf.

[65] SREC prices sourced from Marex Spectrometer, *Spectrometer U.S. Environmental*.

[66] According to the forthcoming 2017 Inventory Report, New Jersey includes 80,002 solar generating facilities with a combined capacity of 2,211 MW. New Jersey's solar carve-out was approximately 3.0 percent in 2017, as compared to 1.15 percent in Maryland.

[67] "Maryland Solar," Solar Energy Industries Association, seia.org/state-solar-policy/maryland-solar.

Although solar comprises a small share of the total Maryland RPS requirement, it contributes a higher share of the RPS compliance costs. In the latest Maryland PSC *Renewable Energy Portfolio Standard Report*, SRECs accounted for $21.3 million of the $72 million in total RPS compliance costs in 2017.[68]

Proponents of increasing the solar carve-out cite the benefits of local job creation and continued expansion of solar in Maryland. Opponents see increasing the solar carve-out as costly and inefficient as compared to other energy sources. This analysis briefly summarizes the strengths and weaknesses of increasing the solar carve-out.

[68] *Renewable Energy Portfolio Standard Report with Data for Calendar Year 2017*, Maryland Public Service Commission, November 2018, psc.state.md.us/wp-content/uploads/FINAL-Renewable-Energy-Portfolio-Standard-Report-with-data-for-CY-2017.pdf.

Strengths	Weaknesses
▪ **In-state renewable development** – An increased solar carve-out would support in-state renewable energy development with accompanying benefits including local jobs, property taxes and other economic benefits. ▪ **Additional solar market development** – Current solar carve-out policies in Maryland and other states are credited with creating a competitive market for solar development, which, in turn, has led to reductions in both the soft and hard costs of solar generation.[69] An expanded carve-out could again spur further cost reductions. ▪ **Costs may not increase** – Maryland currently has over 20 solar projects in various stages of seeking approval from the Maryland PSC.[70] Increasing the solar carve-out will provide a market signal for more of those projects to commence construction, increasing supply in concordance with increased demand.	▪ **May increase compliance costs** – SRECs are historically more expensive than non-carve-out Tier 1 RECs, although the price differences between the two have narrowed since 2016. Increased demand for SRECs may stall or reverse recent declines in SREC prices. Additionally, increased SREC requirements will reduce the level of excess solar capacity that is available for use serving general REC requirements, potentially leading to higher REC prices. ▪ **Reduced competitive pressure on solar** – Increased solar demand may undercut the current supply-side pressure to reduce soft and hard costs for solar. ▪ **Consumption of farmland** – Opposition has been expressed to some utility-scale solar projects because of concerns over the loss of farmland. These concerns could intensify if the solar carve-out is increased. ▪ **May introduce interstate commerce concerns** – Maryland's carve-out currently comprises only a small percentage of the RPS obligation. Making it larger and keeping functional eligibility requirements that favor in-state resources might be construed as economically protectionist.[71]

[69] Ran Fu, David Feldman, and Robert Margolis, *et al.*, *U.S. Solar Photovoltaic System Cost Benchmark: Q1 2017*, National Renewable Energy Laboratory, September 2017, nrel.gov/docs/fy17osti/68925.pdf.
[70] Bob Sadzinski, "Lessons Learned from Past Solar CPCN Cases," presentation before the Power Plant Research Advisory Committee, June 18, 2018, dnr.maryland.gov/pprp/Documents/PPRAC-4-Lessons-Learned-presentation.pdf.
[71] Carolyn Elefant and Edward Holt, *The Commerce Clause and Implications for State Renewable Portfolio Standard Programs – State RPS Policy Report*, Clean Energy States Alliance, ec.europa.eu/competition/consultations/2012_state_aid_environment/recs_3_en.pdf; Anne Havemann, "Surviving the Commerce Clause: How Maryland Can Square Its Renewable Energy Laws with the Federal Constitution," *Maryland Law Review*, Vol. 71, Issue 3, Article 6, 2012, http://digitalcommons.law.umaryland.edu/mlr/vol71/iss3/6; Joel Mack, Natasha Gianvecchio, Marc Campopiano and Suzanne Logan, "All RECs Are Local: How In-State Generation Requirements Adversely Affect Development of a Robust REC Market," *The Electricity Journal*, 2011.

Attachment 1 – Altering the Solar Carve-out SWOT

Solar Carve-out Provisions in PJM States

State	Overall Requirements[1]	Solar Carve-out
Delaware	25% by 2025-2026	Solar PV: 3.5% by 2025-2026
District of Columbia	100% by 2032	Solar: 100% by 2041
Illinois	25% by 2025-2026	Solar PV: 6% of annual requirement beginning in 2015-2016 and continuing until 2025-2026
Maryland	25% by 2020	Solar: 2.5% by 2020
New Jersey	21% by 2021; 35% by 2025; 50% by 2030	Solar electric: 5.1% by 2021; begins declining in 2024 and thereafter to 1.1% by 2033
North Carolina	12.5% by 2021 for investor-owned utilities; 10% by 2018 for municipal utilities and electric cooperatives	Solar: 0.2% by 2018
Ohio	25% by 2026	Solar: 0.5% by 2026
Pennsylvania	18% by Energy Year 2021	Solar PV: 0.5% by 2021

[1] The listed requirements are inclusive of alternative energy portfolio standards and multiple tiers of resources.

Source: Derived from "Table A-2. Overview of RPS Requirements of States and Territories in PJM" in the forthcoming 2017 Inventory Report. See the table for a full list of sources.

SWOT Analysis of Using Long-term Contracts to Satisfy the Maryland RPS

Many renewable energy policy experts contend that long-term contracts are key to successfully developing renewable energy projects, as such projects are capital-intensive and incur most of the costs up front before project operations begin. A long-term contract with a creditworthy entity makes financing easier to obtain. Long-term contracts are typically available in utility-regulated markets.

Maryland restructured its electricity sector in 1999. In restructured markets, long-term contracts are more difficult to secure, as LSEs face uncertainty over projected load and are reluctant to enter into long-term contracts for fear of being financially exposed to a power plant that is uncompetitive relative to market prices, and perhaps lose customers as a result. Contracts in restructured markets tend to be quite short, such as two to three years. LSEs in restructured markets often rely on short-term purchases of RECs to satisfy state RPS requirements. REC prices can be quite volatile in the short term, as evidenced by sharp decreases in non-carve-out Tier 1 REC and SREC prices in Maryland since 2016.

To avoid this price volatility, some states have instituted long-term contracting requirements, ranging between 10 and 20 years, for PPAs with renewable energy generators for purposes of RPS compliance. By 2021, California requires investor-owned utilities, in procuring renewable energy, to have 65 percent of capacity from long-term contracts.[72] Connecticut may acquire up to 4,250 GWh of renewable energy per year under long-term contracts. Rhode Island has negotiated long-term contracts with several renewable energy projects. In 2015 and 2016, Connecticut, Massachusetts and Rhode Island jointly pursued a three-state Clean Energy RFP, resulting in contracts awarded to 460 MW of renewable capacity. Massachusetts is requiring utilities to negotiate long-term contracts for 1,600 MW of wind by June 2027, and to enter into additional long-term contracts for 9.45 terawatt-hours (TWh) of clean energy generation by the end of 2022.[73]

During the 2018 Maryland legislative session, a bill was introduced that, if it had passed, would have required Maryland standard offer service (SOS) providers (i.e., distribution utilities) to procure long-term contracts for RECs and electricity of at least 10 years and up to 20 years, through a competitive bidding process, for at least 25 percent of their RPS requirements. Distribution utilities would have to submit contracts resulting from competitive bidding to the Maryland PSC, and the PSC would be required to approve such contracts if they are cost-effective as compared to the long-term projection of renewable energy costs. Supporters of the

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[72] "California Renewables Portfolio Standard," U.S. Department of Energy, energy.gov/savings/renewables-portfolio-standard-1.

[73] Pat Knight and Jason Gifford, *et al*., *An Analysis of the Massachusetts Renewable Portfolio Standard*, Synapse Energy Economics, Inc. and Sustainable Energy Advantage, LLC, prepared for the New England Clean Energy Council in partnership with Mass Energy, May 2017, necec.org/files/necec/PDFS/An%20Analysis%20of%20the%20Massachusetts%20Renewable%20Portfolio%20Standard.pdf.

bill asserted that long-term renewable energy contracts can hedge against rising fossil fuel prices and save ratepayers money. Supporters also argued that electricity prices are historically low and can only increase. Distribution utilities argued that long-term contracts could result in customers paying higher electricity prices. Furthermore, the utilities stated that procuring long-term contracts would be the opposite of energy deregulation that Maryland enacted in 1999.[74]

Whether the long-term contracts result in savings for ratepayers depends on the contract price as compared to what would have been charged otherwise, and several factors could impact electricity prices, such as prices of fossil fuels, changes to state and/or federal laws or technological changes.

The strengths and weaknesses of using long-term contracts to satisfy the Maryland RPS are provided below.

[74] Hearing on HB 967 Ratepayer Reduction for Renewable Energy Act before the Maryland General Assembly Economic Matters, March 5, 2018, Session No. 1.

Strengths	Weaknesses
▪ **Price certainty** – Long-term contracts provide predictability and price certainty, which can hedge against volatility in wholesale prices. ▪ **Lowers risk for developers** – Requiring long-term contracts as part of the RPS will lower revenue risk for developers and allow them to obtain financing at a lower cost. As such, the lower financing costs will be passed along to ratepayers through the cost of the project. ▪ **New renewable projects** – Generation projects with the backing of long-term contracts could potentially be built within the state. This will provide economic and environmental benefits directly to the state. ▪ **Economic benefits, including local jobs and taxes** – Increasing development of new renewable energy increases state and local tax revenues, creates temporary and full-time jobs and may encourage renewable energy businesses to be located and registered within the state. In turn, investment in renewable energy industries in the state can indirectly benefit other, unrelated local businesses and household incomes. ▪ **Health and environmental benefits** – Renewable energy projects built within the state or in surrounding states will increase health and environmental benefits for Maryland residents. The environmental benefits would include decreased air emissions, water pollution and GHG emissions. ▪ **Increases fuel mix diversity** – The development of renewable energy projects will diversify the fuel mix in PJM.	▪ **Renewable energy projects may be built in surrounding states** – Projects can be built in surrounding states if the power can be delivered into the Maryland distribution grid (to meet the solar carve-out) or if the power is delivered into PJM. As a result, not all projects' long-term contracts will be built in the state, reducing local economic and environmental benefits recognized by the state. ▪ **Contract review** – Should the PSC have to review and approve contracts, such a process could be time consuming and would increase the costs for procuring contracts. ▪ **Uncertainty of long-term contracts as compared to market prices** – The price of electricity under the long-term contracts may be higher or lower than market prices over time. If higher, the long-term contracts could cost ratepayers more than if the energy was procured on the open market or through the SOS process. ▪ **Risk of departing load and/or stranded asset** – If a long-term contract is above market in costs and affects customer electricity rates, then customers of distribution utilities may depart for other electric providers. If enough customers depart, the generation asset underlying the contract could be stranded. ▪ **Possible decline in number of electric retail suppliers if they are required to enter into long-term contracts** – Long-term contracts do not fit most business models of electric retail suppliers, as they usually focus on short-term procurements since it is difficult to hedge when energy and capacity markets do not go beyond three years. Electric retail suppliers may see the investment in long-term renewable energy contracts as too risky and exit the market, consequently decreasing the market of electric retail suppliers in Maryland.

SWOT Analysis of Lowering the ACP of the Maryland RPS

To show compliance with the Maryland RPS, LSEs have two options: retire the appropriate number of RECs in a tracking account or pay an ACP in lieu of submitting RECs. The ACP effectively functions as a cap on the price of RECs. If the cost of a REC exceeds the ACP, LSEs will opt to pay the ACP instead of acquiring the REC. The ACP both bounds the amount of financial support available to prospective renewable energy generators and limits RPS compliance costs that can be passed through to consumers. Given the substantial reductions in cost for some renewable energy technologies, some Maryland stakeholders have suggested lowering the ACP, both to account for these cost improvements and also to further strengthen the cost cap aspects of the ACP. In Maryland, the ACP as of 2018 is $37.50/MWh for non-carve-out Tier 1 resources and $175/MWh for Tier 1 solar carve-out resources.[75] In the 2018 session of the Maryland General Assembly, legislation was introduced to decrease the ACP to $22.50/MWh for both non-carve-out and solar carve-out resources by 2028 and 2029, respectively. Although that legislation did not pass, similar legislation is anticipated for the 2019 session.

Most states with an RPS use some form of ACP to constrain costs, and the ACP amounts differ from state to state in PJM (including the District of Columbia), ranging from $25/MWh in Delaware for the first deficient year to $50/MWh in D.C. and New Jersey for non-carve out Tier 1 resources. This variation in ACP levels influences the market price for RECs. Electricity suppliers in states with a high ACP are willing to pay more—up to the ACP amount—for RECs, providing an additional impetus to develop more renewable resources that meet the applicable state's RPS requirements. In states with a solar carve-out, the ACPs for solar RPS compliance tend to be higher than the ACPs for Tier 1 (or analogous classification) renewable energy, reflecting the higher costs of solar as compared to other Tier 1 technologies (at least at the time when the RPS was enacted).

In Maryland, funds generated from ACPs accrue to a Strategic Energy Investment Fund (SEIF) overseen by MEA. This fund is intended to provide grants and loans in support of the construction of Tier 1 resources. To date, ACP usage by Maryland LSEs has been minimal.[76] Low load growth and a large increase in the number of new renewable energy projects have resulted in more RECs than are needed to meet state RPS requirements. As a result, Tier 1 SREC and REC prices for both solar carve-out and non-carve-out resources, respectively, have plummeted. In Maryland, Tier 1 REC prices range between $5.50/MWh and $6.60/MWh, down roughly 50 percent from $12.53/MWh in 2016.[77] SREC prices have fallen even more sharply,

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[75] The current non-carve-out Tier 1 ACP is fixed, while the Tier 1 solar carve-out ACP will eventually decline to $50/MWh in 2024 and beyond.

[76] According to the November 2018 *Renewable Energy Portfolio Standard Report* from the Maryland PSC, ACPs comprised less than 0.1 percent of total RPS compliance costs in 2017. These payments were almost entirely made for Tier 1 industrial process load, which has an ACP of only $2/MWh.

[77] Marex Spectrometer, *Spectrometer U.S. Environmental*, September 7, 2018.

from \$110.51/MWh in 2016 to between \$7/MWh and \$16/MWh currently.[78] Attachment 1 to this SWOT presents a table with REC prices over the last five years as compared to the ACP. The complex interrelationships of REC prices, project development, ACP levels, and power supply imports affect Maryland's ability to meet its RPS requirement using either RECs or ACPs going forward.

Proponents of decreasing the ACP emphasize its benefit as a simple, transparent way to limit the maximum cost of Maryland's RPS. Opponents, on the other hand, see decreasing the ACP as counter to the intent of the RPS insofar as it disincentivizes renewable development. This analysis briefly summarizes the strengths and weaknesses of decreasing the ACP. Important considerations include: cost impact, effect on renewable development and short- and long-term market signals.

<u>Strengths</u>	<u>Weaknesses</u>
▪ **Controls costs** – The ACP functions as a cost cap on REC prices. Although LSEs have not relied on ACPs in recent years, a lower ACP would reduce compliance costs in the event of ACP use. This might occur if the RPS is increased, which would increase demand for RECs and potentially raise REC prices. In this scenario, a lower ACP would control costs more than the current ACP level. ▪ **Mitigates short-term spikes in REC costs** – In the face of uncertain REC availability, an ACP helps LSEs manage costs. ▪ **ACPs provide additional funding to supportive programs for renewable energy** – In Maryland, ACPs are routed to the SEIF. To the extent that LSEs use the ACP going forward, this funding can indirectly help renewable energy development through grants, loans and other funding measures. ▪ **Limited impact on short-term renewable energy deployment** – REC prices have declined considerably in the past few years and are currently well below the ACP.	▪ **Difficult to set an appropriate ACP level** – The market for RECs is difficult to forecast going forward and, as a result, it is unclear what an appropriate ACP level would be if the goal is to ensure that the ACP is high enough that LSEs focus on securing RECs rather than paying the ACP. ▪ **Reduced long-term incentive to develop renewables, especially in Maryland** – A lower ACP will discourage additional renewable energy development should REC costs reach equilibrium with the ACP. Renewable energy development will instead shift to markets with higher REC prices. In the case of the solar carve-out, development will move out of Maryland and into states with higher SREC prices. ▪ **Not responsive to actual market costs** – The ACP acts as a price ceiling and, as a result, undermines the market signal to develop additional renewable resources in the event of a REC shortage.

[78] Ibid (current figures). Historical figures from *Renewable Energy Portfolio Standard Report for Calendar Year 2017*, Maryland Public Service Commission, November 2018, psc.state.md.us/wp-content/uploads/FINAL-Renewable-Energy-Portfolio-Standard-Report-with-data-for-CY-2017.pdf.

Attachment 1 – Lowering the ACP SWOT

ACP Values and Average REC Costs per Maryland RPS Tier (2014 – present)

Year	ACP Level ($/MWh)			Average Cost of RECs ($/MWh)[1]		
	Tier 1 Non-Solar	Tier 1 Solar	Tier 2[2]	Tier 1 Non-Solar	Tier 1 Solar	Tier 2
2014	$40.00	$400.00	$15.00	$11.64	$144.06	$1.81
2015	40.00	350.00	15.00	13.87	130.39	1.71
2016	40.00	350.00	15.00	12.53	110.51	1.25
2017	37.50	195.00	15.00	7.14	38.18	0.47
2018	37.50	175.00	15.00	5.50 – 6.60	7.00 – 16.00	0.50 – 1.00

[1] REC prices from 2014 through 2016 sourced from *Renewable Energy Portfolio Standard Report with Data for Calendar Year 2017*, Maryland Public Service Commission, November 2018, psc.state.md.us/wp-content/uploads/FINAL-Renewable-Energy-Portfolio-Standard-Report-with-data-for-CY-2017.pdf. Figures from 2018 sourced from Marex Spectrometer, *Spectrometer U.S. Environmental*; 2018 costs represent the range of REC prices through Sept. 7, 2018.

[2] The Tier 2 standard expired at the end of 2018.

SWOT Analysis of Limiting Eligibility for Non-carve-out Tier 1 Eligible Resources within PJM

Geographic eligibility (i.e., whether out-of-state resources qualify for a state RPS) is an important consideration when designing and implementing state RPS policies. Restrictive geographic eligibility, such as only including resources within a particular state or bordering states, reduces the available supply of RECs and will likely result in higher REC prices unless there is a surplus of existing RECs to absorb the increased demand. More restrictive geographic eligibility requirements can also concentrate the economic and environmental benefits of the state RPS to a more localized and contained area. Conversely, more lenient geographic eligibility requirements can cause the reverse: RECs are in more plentiful supply and presumably cheaper, but the economic and environmental benefits are spread across more states.

When Maryland enacted its RPS in 2004, the geographic eligibility provisions were quite expansive; RPS-eligible resources could be sourced from within PJM, in a state that is adjacent to PJM or in a control area adjacent to the PJM region if the electricity is delivered into PJM. In 2008, the Maryland General Assembly changed this provision, limiting the eligibility of out-of-state resources to a control area adjacent to PJM, as long as the electricity is delivered into PJM.

While a substantial percentage of RECs used to comply with the Maryland RPS come from outside the state (over 80 percent in 2016), further limiting geographic eligibility to only RPS-eligible resources within PJM may be in violation of the Dormant Commerce Clause of the U.S. Constitution. This clause is generally considered to prohibit state policies that unduly burden or discriminate against out-of-state commerce for economic reasons.

This analysis briefly summarizes the strengths and weaknesses of requiring RPS-eligible generation to be located within the PJM footprint. Important considerations include: the location of renewable resources, environmental impact, effect on REC prices, economic considerations and legality.

Strengths	Weaknesses
▪ **Incentivize renewable resources within PJM** – Limiting resource eligibility to within PJM could provide additional impetus through higher REC prices for developing new renewable energy power plants in Maryland and surrounding PJM states. ▪ **Potential development of renewable energy projects in Maryland** – Restricting geographic eligibility to within PJM could not only lead to additional development of new renewable energy projects in PJM, but also to new renewable energy projects within Maryland, leading to in-state economic development and benefits. ▪ **Potential for greater environmental benefits from neighboring states** – An increase in renewable energy power plants being built within PJM may result in environmental benefits, such as a reduction of cross-state air pollution, as the fuel mix displaces pollution-emitting generators with more renewable energy resources. ▪ **Limited impact on REC prices** – If Maryland is the only state that establishes resource eligibility based on geographic location in PJM, the impact on REC supply will likely be limited, since other states may satisfy their RPS requirements with resources located outside of PJM's footprint.	▪ **Potential violation of the Dormant Commerce Clause of the U.S. Constitution** – Limiting eligibility of RECs to facilities located within PJM may result in a violation of the Commerce Clause unless the state can prove no non-discriminatory alternatives exist to promote state goals such as environmental protection, diversity of energy supply, and reliability and safety.[79] ▪ **Potentially higher REC costs** – Limiting eligibility to only states within PJM will reduce the amount of eligible supply of RECs and will presumably increase REC prices until additional RECs are available. This may increase the cost of Maryland RPS compliance for ratepayers. ▪ **Impact may be modest and may not result in the development of renewable energy projects in Maryland** – Limiting eligible resources to those within PJM does not guarantee development of eligible resources in Maryland. Of the 83 percent of Tier 1 RECs located outside of Maryland that were used to meet the Maryland RPS in 2017, over 60 percent came from within PJM.[80] New renewable energy projects that may be developed as a result of this policy could very well come from outside of Maryland.

[79] Carolyn Elefant and Edward Holt, *The Commerce Clause and Implications for State Renewable Portfolio Standard Programs*, Clean Energy States Alliance, March 2011, cesa.org/assets/2011-Files/states-Advancing-RPS/CEG-Commerce-Clause-paper-031111-Final.pdf; Anne Havemann, "Surviving the Commerce Clause: How Maryland Can Square Its Renewable Energy Laws with the Federal Constitution," *Maryland Law Review*, Vol. 71, Issue 3, Article 6, 2012, http://digitalcommons.law.umaryland.edu/mlr/vol71/iss3/6; Joel Mack, Natasha Gianvecchio, Marc Campopiano and Suzanne Logan, "All RECs Are Local: How In-State Generation Requirements Adversely Affect Development of a Robust REC Market," *The Electricity Journal*, 2011.

[80] *Renewable Energy Portfolio Standard Report with Data for Calendar Year 2017,* Maryland Public Service Commission, November 2018, psc.state.md.us/wp-content/uploads/FINAL-Renewable-Energy-Portfolio-Standard-Report-with-data-for-CY-2017.pdf.

SWOT Analysis of Implementing Zero Emission Credits or Procurement Support for Nuclear Power

The United States has 61 nuclear power plants, consisting of 99 separate reactors, in operation as of August 2017.[81] This number is declining, with six nuclear reactors closing since 2013 and another 13 reactors scheduled to shut down through 2025.[82] A recent *Bloomberg New Energy Finance* analysis determined that more than half of America's nuclear reactors are no longer profitable, incurring losses totaling approximately $2.9 billion annually.[83] Within PJM, five nuclear plants with a combined capacity of approximately 5,300 MW are slated to close by 2021.[84,85]

While nuclear power provides 20 percent of electricity generation and 54 percent of the zero-carbon generation in the U.S., some nuclear plants are financially challenged due to reduced wholesale electricity prices and low growth in electricity demand.[86,87] In PJM, energy prices have dropped by more than 40 percent since 2014, falling from $53.14/MWh to $30.99/MWh in 2017.[88] Additionally, in May 2018, approximately a third of the nuclear capacity in PJM, representing 10,643 MW, failed to clear the PJM Base Residual Auction for delivery year 2021/2022.[89,90]

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[81] "How many nuclear power plants are in the United States, and where are they located?," U.S. Energy Information Administration, eia.gov/tools/faqs/faq.php?id=207&t=3;
"Nuclear Plants in Regulated and Deregulated States," Nuclear Energy Institute, nei.org/resources/statistics/nuclear-plants-in-regulated-and-deregulated-states.
[82] "Fort Calhoun becomes fifth U.S. nuclear plant to retire in past five years," U.S. Energy Information Administration, eia.gov/todayinenergy/detail.php?id=28572.
[83] Jim Polson, "More Than Half of America's Nuclear Reactors Are Losing Money," *Bloomberg*, bloomberg.com/news/articles/2017-06-14/half-of-america-s-nuclear-power-plants-seen-as-money-losers.
[84] Planned closures include: Exelon Corporation's (Exelon's) 615-MW Oyster Creek plant, located in New Jersey, by September 2018; Exelon's 805-MW Three Mile Island plant, located in Pennsylvania, by September 2019; FirstEnergy Solutions' (FES's) 894-MW David-Besse plant, located in Ohio, by May 2020; FES's 1,240-MW Perry plant, located in Ohio, by May 2021; and FES's 1,777-MW Beaver Valley plant, located in Pennsylvania and consisting of two reactors, by October 2021.
[85] Michael Scott, "Nuclear Power Outlook," *Annual Energy Outlook 2018*, U.S. Energy Information Administration, eia.gov/outlooks/aeo/npo.php; Rod Walton, "FirstEnergy Solutions Reluctantly files First Steps to Shutting down Nuclear Plants," *Power Engineering*, power-eng.com/articles/2018/08/firstenergy-solutions-reluctantly-files-first-steps-to-shutting-down-nuclear-plants.html.
[86] Based upon U.S. electricity generation data from the EIA for 2017, nuclear generation provides 20 percent of electricity generation and 54 percent of zero-carbon generation when including solar, wind, hydropower, biomass and geothermal as zero-carbon generation resources.
[87] "What is U.S. electricity generation by energy source?," U.S. Energy Information Administration, eia.gov/tools/faqs/faq.php?id=427&t=3
[88] *State of the Market Report for PJM – 2017*, Monitoring Analytics, March 2018, monitoringanalytics.com/reports/PJM_state_of_the_Market/2017.shtml, Table 1-10.
[89] The Base Residual Auction is the first auction PJM holds as part of its capacity market (i.e., the RPM). Under the RPM, PJM holds auctions to procure capacity to meet expected electricity demand requirements three years into the future. Winning bidders in these auctions are provided capacity payments, but also have to meet various PJM performance requirements.
[90] "Exelon Announces Outcomes of 2021-2022 PJM Capacity Auction," Exelon,

These unfavorable market conditions have drawn the attention of state policymakers, with some enacting legislation or regulations to preserve nuclear plants that are otherwise not economically viable in today's electricity market. New York, Illinois and New Jersey have all implemented Zero Emissions Credit/Certificate (ZEC) initiatives and programs that require utilities or LSEs to maintain or procure a certain number or percentage of ZECs. Each ZEC represents one MWh of generation from a nuclear power plant. Connecticut has also passed legislation that allows nuclear plants to enter into long-term PPAs guaranteeing a fixed level of revenue. See the section in this SWOT, "Examples of Recently Enacted State Policies in Support of Nuclear Power," after the comparative table, for an additional overview of these four states' policies. Both the Illinois and New York ZEC programs were challenged in federal district court, but were upheld by the Seventh and Second U.S. Circuit Court of Appeals, respectively.

This matter is of importance to Maryland, as the state's only nuclear power plant, Calvert Cliffs, accounted for 44 percent of the state's net electricity generation and 84 percent of its emission-free electricity in 2017.[91] The plant, which consists of two reactors, has a combined capacity of 1,756 MW and has a 99 percent capacity factor over the last three years.[92,93] In addition, Calvert Cliffs employs 900 workers and pays $22 million annually in state and local taxes.[94] The facility is jointly owned by Exelon Corporation (Exelon) and Électricité de France and is operated by Exelon.

Proponents of nuclear subsidies cite environmental, resilience and economic benefits of maintaining zero-emission nuclear power and retaining affected in-state generators. Opponents cite concerns regarding interstate commerce, the negative impact on electric power markets and the costs imposed by the subsidies. This analysis briefly summarizes the strengths and weaknesses of adding state-level subsidies that support nuclear power either separately or as part of the Maryland RPS. Important considerations include:

- Maryland's ability to achieve GHG reductions and the costs of doing so;
- Policy design (adding nuclear power as a separate tier or carve-out or imposing a PPA requirement);
- Determination of the amount of subsidy and how it is estimated;
- Defining ratepayer protections and/or cost caps;
- Potential impacts on competitive electric power markets;

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exeloncorp.com/newsroom/exelon-announces-outcome-of-2021-2022-pjm-capacity-auction.

[91] "Calvert Cliffs Nuclear Power Plant" Exelon Generation, exeloncorp.com/locations/Documents/Calvert%20Cliffs%20Fact%20Sheet%20-%202017.pdf.

[92] "fact sheet – Maryland and Nuclear Energy," Nuclear Energy Institute, nei.org/CorporateSite/media/filefolder/resources/fact-sheets/state-fact-sheets/Maryland-state-Fact-Sheet.pdf.

[93] Ibid.

[94] Ibid.

- Possible changes to the PJM RPM that may affect policy support or subsidies to renewable energy, nuclear power or other technologies; and
- Ensuring flexibility in the event market conditions change.

Strengths	Weaknesses
▪ **Protection for ratepayers** – Ratepayer protection features are built into state nuclear support programs. Provisions in the proposed ZECs programs use financial records and projections to determine whether nuclear power plants require ZECs to avoid early retirement. Connecticut requires a state examination of the Millstone plant's financial situation before participation. In New Jersey, the amount that a nuclear plant receives will be reduced if the plant is receiving compensation under any other state or federal program for the same environmental attributes. Illinois directly caps rate increases, while New York reduces ZEC prices by any energy and capacity price increase above a reference point. ▪ **Retention of economic benefits, including local jobs** – Nuclear generation provides sizeable tax revenue for states with nuclear power plants. Calvert Cliffs employs approximately 900 workers and pays approximately $22.8 million in state and federal taxes. ▪ **Carbon-free generation and no air pollution** – The Calvert Cliffs nuclear plant generated over 15 terawatt-hours in 2017, thereby avoiding the release of almost 10.6 million metric tons of carbon dioxide equivalent. Retiring nuclear would likely be replaced with carbon-emitting sources, which would also result in increased nitrogen oxides, sulfur dioxides, and particulate matter emissions. ▪ **Helps maintain fuel diversity** – A diverse power portfolio hedges against higher fossil fuel prices should they occur.	▪ **Increased ratepayer costs** – The gross cost to ratepayers for the New York ZEC program is $7.6 billion over 12 years, net of benefits. The gross cost of the Illinois ZECs program to ratepayers is an estimated $235 million annually over 10 years. The gross cost of the New Jersey ZECs program to ratepayers will be approximately $300 million per year for an estimated seven to 10 years. By comparison, the Maryland RPS cost $135 million in 2016. ▪ **Complex and time-consuming** – ZEC requirements can be complicated to administer and implement, requiring detailed filings and reviews of plant operations and costs to ensure ratepayers are paying the minimum amount necessary to preserve existing nuclear power plants, and potentially procurements for ZECs. ▪ **Age of Calvert Cliffs** – Although the operating license for Calvert Cliffs does not expire until 2034 for Unit 1 and 2036 for Unit 2, commercial nuclear reactors to date have not operated for 50 years or more without being retired. Calvert Cliffs' two reactors are 41 and 42 years old. Therefore, it is possible that the reactors would retire within the next eight to nine years. If so, Calvert Cliffs would not be available to help Maryland meet its goal of reducing GHG emissions by 2030. ▪ **Court challenges and dormant Commerce Clause concerns** – New York and Illinois have faced challenges in federal court regarding ZEC programs, although both were upheld by the U.S. Court of Appeals for the Second Circuit and Seventh Circuit, respectively, in September 2018. It is possible that Maryland could face a comparable legal challenge should the state adopt a ZEC-type program, and could face a different ruling on appeal from the 4th Circuit Court of Appeals.

	Weaknesses (cont'd)
	▪ **Safety concerns** – Although U.S. nuclear plants have operated safely for decades, past nuclear power accidents at Three Mile Island, Chernobyl and Fukushima have raised public concerns regarding whether nuclear power is safe, and raised opposition to nuclear power more generally. ▪ **Plant is still profitable** – Using forward prices through its RPM capacity market, PJM projects that Calvert Cliffs will be profitable through at least 2021, suggesting subsidies may not be needed. ▪ **Long-term waste disposal** – No permanent long-term solution to store radioactive waste from nuclear power plants exists. Fourteen states prohibit building new nuclear plants until the issue of a long-term storage solution for the 78,000 metric tons of nuclear waste currently stored at U.S. nuclear plants is resolved.

Examples of Recently Enacted State Policies in Support of Nuclear Power

New York

In August 2016, New York became the first state to adopt a ZEC requirement. LSEs must purchase ZECs from the New York State Energy Research Development Authority annually, based on the LSE's percentage of load served in New York. ZEC payments will be made to qualifying facilities that meet public necessity criteria, which is determined by the New York PSC on a plant-by-plant basis using financial and emissions criteria. A price of $17.48/MWh was set for the ZECs for the first of six (6) two-year periods and was calculated using the social cost of carbon (SCC), minus the fixed baseline portion of that cost that is captured through the Regional Greenhouse Gas Initiative, a carbon-trading market in which 10 states (including New York) participate. The New York PSC estimates the gross costs for the first two years of the ZEC program to be approximately $965 million. The New York ZEC program is estimated to cost ratepayers $7.6 billion over 12 years.[95]

Illinois

In December 2016, Illinois enacted the Future Energy Jobs Act, which, among many other things, established a Zero Emissions Standard. Utilities are allocated ZECs equal to 16 percent of the MWh the utility sold in 2014, and the Illinois Power Authority purchases ZECs on utilities' behalf through a "Zero Emissions Procurement Plan." The ZES went into effect in June 2017 and will expire on May 31, 2027. The winning suppliers of ZECs will be based upon public interest criteria, like New York which calculates the price of the ZEC payment using the SCC. The initial base price for the ZECs is $16.50/MWh and increases $1.00/MWh annually, commencing with the 2023/2024 delivery year. ZEC prices would be reduced if electricity market prices increase. Furthermore, if the cost of ZECs would cause electricity rates to increase by more than 1.65 percent, the number of ZECs would be reduced in order to comply with the rate cap. Overall, the gross cost of the Illinois ZECs is expected to be $235 million per year.

New Jersey

In April 2018, New Jersey became the third state to enact ZEC legislation to help support the Hope Creek and Salem nuclear plants at a gross cost to ratepayers of an estimated $300 million per year. A ranking system, measuring the contribution each plant makes to minimizing air pollution emissions and the degree to which the plant is unable to cover its costs, determines the eligibility of a nuclear plant to receive ZECs. The New Jersey Board of Public

[95] State of New York Public Service Commission Order, Case 15-E-0302: "Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard;" and Case 16-E-0270: "Petition of Constellation Energy Nuclear Group LLC; R.E. Ginna Nuclear Power Plant, LLC; and Nine Mile Point Nuclear Station, LLC to Initiate a Proceeding to Establish the Facility Costs for the R.E. Ginna and Nine Mile Point Nuclear Power Plants," issued August 1, 2016, p. 127.

Utilities (NJBPU) will then select eligible plants to receive ZECs according to their ranking, capped at 40 percent of the electricity the nuclear plant produced (MWh) in the energy year before the date of enactment. Each public utility will be required to purchase ZECs from the qualifying nuclear plants at the amount determined by the NJBPU, but will be allowed to recover costs of ZEC purchases from ratepayers at a rate of $0.004/kWh beginning 90 days after enactment. This rate reflects the estimated emissions avoidance benefits associated with the continued operation of the selected nuclear power plants.

Connecticut

Connecticut took a different approach by implementing a competitive procurement process for nuclear and other zero-emission electricity sources, provided it is deemed to be in the best interest of ratepayers. The Millstone plant, Connecticut's only nuclear power plant, must undergo an assessment that evaluates the current and projected economics of the facility, as well as the impact on air emissions, the economy and the electric power markets if Millstone retires. The evaluation will take place before the competitive procurement process for new and existing zero-carbon generation and will be conducted by the Connecticut Department of Energy and Environmental Protection and the Public Utilities Regulatory Authority. If Millstone is successful in the auction, it will receive a PPA contract ranging from three to 10 years in length.

RPS

Few states have directly incorporated nuclear power as an eligible technology for their RPS. New York added a Tier 3 for nuclear power to its Clean Energy Standard. The Indiana voluntary RPS includes nuclear generation as an eligible technology, but utilities are not required to comply. Likewise, in Ohio, nuclear generation technology is included in the Alternative Energy Portfolio Standard, but only in the portion of the RPS that is not subject to ACPs or technology minimums. Arizona is the only state currently considering revising its RPS that incorporates nuclear generation and applies corresponding incentives and penalties. A proposed regulation by a member of the Arizona Corporation Commission would include the existing Palo Verde nuclear power plant in the state's "Clean Resource Energy Standard and Tariff," which would require that 80 percent of the state's electricity come from carbon-free sources, including nuclear, by 2050.[96]

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[96] Emma Foehringer Merchant, "Inside Arizona's Latest Clash Over Renewable Energy Targets," *Greentech Media*, August 13, 2018, greentechmedia.com/articles/read/arizona-clash-over-renewable-energy-targets#gs.pF8kBK0.

<u>APPENDIX D</u> – List of Acronyms

ACP	Alternative Compliance Payment
BTM	Behind-the-meter
CO_2	Carbon dioxide
CPCN	Certificate of Public Convenience and Necessity
DNR	Maryland Department of Natural Resources
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
GE	GE Energy Consulting
GW	Gigawatt
GHG	Greenhouse gas
GWh	Gigawatt-hour
HB	House Bill
ITC	Investment tax credit
kV	Kilovolt
LBNL	Lawrence Berkeley National Laboratory
LSE	Load-serving entity
LTER	Long-Term Electricity Report for Maryland
MEA	Maryland Energy Administration
MOPR	Minimum Offer Price Rule
MW	Megawatt
MWh	Megawatt-hour
MSW	Municipal solid waste
NREL	National Renewable Energy Laboratory
OREC	Offshore renewable energy credit
PPA	Power purchase agreement
PJM	PJM Interconnection, LLC
PJM-GATS	PJM Generation Attribute Tracking System
PPRP	Maryland Department of Natural Resources Power Plant Research Program
PSC	Maryland Public Service Commission
PTC	Production tax credit
PV	Photovoltaics
REC	Renewable energy credit
RFP	Request for proposal
RPM	Reliability Pricing Model
RPS	Renewable portfolio standard
SEIA	Solar Energy Industries Association
SEIF	Strategic Energy Investment Fund
SOS	Standard offer service
SREC	Solar renewable energy credit

SCC	Social cost of carbon
SWOT	Strengths, weaknesses, opportunities and threats analysis
ZEC	Zero emission credits
ZES	Zero Emissions Standard

Prepared by the Maryland Department of Natural Resources Power Plant Research Program

Tawes State Office Building, B-3
580 Taylor Avenue
Annapolis, Maryland 21401
Toll Free in Maryland: 877-620-8DNR, ext. 8660
Outside Maryland: 410-260-8660
TTY users call via the Maryland Relay
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