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MARYLAND DEPARTMENT OF NATURAL RESOURCES

PPRP

2011 Inventory of Renewable Energy Generators Eligible for the Maryland Renewable Energy Portfolio Standard

February 2012

MARYLAND POWER PLANT RESEARCH PROGRAM

Martin O'Malley, Governor ♦ Anthony G. Brown, Lt. Governor

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2011 INVENTORY OF RENEWABLE ENERGY GENERATORS ELIGIBLE FOR THE MARYLAND RENEWABLE ENERGY PORTFOLIO STANDARD

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POWER PLANT RESEARCH PROGRAM

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Abstract

The Maryland Power Plant Research Program published the *Inventory of Renewable Energy Resources Eligible for the Maryland Renewable Energy Portfolio Standard* in 2006 (2006 Inventory Report).[1] That inventory quantified resources that were eligible at the time to meet Maryland's two-tier renewable energy portfolio standard and assessed the additional renewable generating capacity needed to meet future requirements. Since the 2006 inventory was published, the original Renewable Energy Portfolio Standard and Credit Trading Act was amended. Those amendments increased the total renewable energy requirements, added a specific solar energy set-aside in Tier 1, further amended the annual requirement, modified the qualifying renewable energy sources, and altered the geographic footprint for qualifying renewable energy facilities.

The purpose of this analysis is to update the initial *2006 Inventory Report* given the Renewable Energy Portfolio Standard and Credit Trading Act's amendments and changes in renewable energy generation capacity in the now-qualifying geographic footprint. The Tier 1 solar set-aside must be met by solar facilities located within Maryland. The 2011 inventory analysis shows that Maryland's solar generation capacity must grow substantially, at a sustained annual rate of approximately 41 percent, to meet Tier 1 solar set-aside requirements for 2022.

The Tier 1 and Tier 2 RPS requirements can be met with renewable energy credits provided by eligible resources located throughout PJM. The analysis presented in this report considers both the availability of renewable resources in PJM and the various renewable requirements of the states located within PJM. The study finds that compliance with Tier 1 non-solar generation requirements will require a modest year-over-year rate of growth in eligible generation. It is expected that no new Tier 2 generators will be needed to meet Maryland or other Tier 2 RPS standards in PJM.

[1] Maryland Power Plant Research Project, *Inventory of Renewable Energy Resources Eligible for the Maryland Renewable Energy Portfolio Standard* (2006), http://esm.versar.com/pprp/bibliography/PPES_06_01/PPES_06_01.pdf.

Executive Summary

The Maryland Power Plant Research Program published the *Inventory of Renewable Energy Resources Eligible for the Maryland Renewable Energy Portfolio Standard* in 2006. The purpose of the report was to determine if there was sufficient renewable generation capacity within the PJM Interconnection, LLC (PJM) region to meet Maryland's renewable energy portfolio standard (RPS) targets established under the 2004 Maryland Renewable Energy Portfolio Standard and Credit Trading Act.

The Maryland Renewable Energy Portfolio Standard and Credit Trading Act has been amended on multiple occasions since its 2004 publication. These amendments modified the types of qualifying renewable energy sources eligible to receive credit under the RPS, added a solar-specific requirement (solar set-aside) under the Tier 1 requirements, changed the geographic eligibility of facilities to exclude RECs from the PJM region's adjacent states absent an accompanying delivery of electricity, and increased the percentage of electricity sales and changes to the Alternative Compliance Payments that must come from renewable energy sources for each year the RPS is in effect. Table ES.1 displays the current (October 2011) requirements of the Maryland RPS.

Table ES.1 – Current Percentage of Renewable Energy Required by Maryland RPS

Year	Solar Set-Aside (Percent)[1]	Tier 1 (Percent)[2]	Tier 2 (Percent)[3]	Total (Percent)
2006		1	2.5	3.5
2007		1	2.5	3.5
2008	0.005	2	2.5	4.505
2009	0.01	2	2.5	4.51
2010	0.025	3	2.5	5.525
2011	0.05	4.95	2.5	7.5
2012	0.1	6.4	2.5	9
2013	0.2	8	2.5	10.7
2014	0.3	10	2.5	12.8
2015	0.4	10.1	2.5	13
2016	0.5	12.2	2.5	15.2
2017	0.55	12.55	2.5	15.6
2018	0.9	14.9	2.5	18.3
2019	1.2	16.2	0	17.4
2020	1.5	16.5	0	18
2021	1.85	16.85	0	18.7
2022 (and beyond)	2	18	0	20

1 - Solar requirement started in compliance year 2008.
2 - Excludes the amount required under the solar set-aside.
3 - Tier 2 requirement sunsets at the end of 2018.

In addition to Maryland, seven PJM states (Delaware, Illinois, Michigan, New Jersey, North Carolina, Pennsylvania, and West Virginia) and the District of Columbia have mandatory RPS provisions. Virginia and Indiana have developed voluntary renewable energy goals. Steady changes in these policies and the growth of PJM as a whole through the incorporation of new transmission zones warrants a new assessment of renewable energy projects to gauge current and future resources needed to meet portfolio standards across the PJM market.

This report uses data contained in the PJM Generation Attributes Tracking System (GATS) to produce an inventory of available renewable energy resources that would qualify under the Maryland RPS. This inventory was incorporated into a database (i.e., the *2011 Inventory Report* database*)* with supplemental geophysical and capacity utilization data acquired from the U.S. Department of Energy's Energy Information Administration.

This study reflects all changes to the Maryland RPS that will be in effect in 2012, including the eligibility of solar water heating for Tier 1 solar set-aside compliance, and the planned addition of the Duke Energy transmission zone to the PJM Interconnection, including portions of Ohio and Kentucky.

The *2011 Inventory Report* database was analyzed to determine the current availability of renewable resources and the amount of growth that will be required to satisfy not only Maryland's RPS but also those of the other states in the PJM region. The Maryland Tier 1 solar set-aside requires that compliance be met through the use of in-state solar resources.[2] Only solar generation originating in Maryland qualifies for the Maryland solar set-aside. Maryland is on pace to meet its 2011 solar set-aside requirement, but substantial (approximately 41 percent per year) and sustained (every year from 2011 through 2022) growth of solar generation will be required to meet future Maryland solar targets. Table ES.2 shows the number of solar units of different size classifications necessary to meet the requirement if the size distribution of these units remains as it was in September 2011.[3]

Table ES.2 – 2011 Installed and Projected 2022 Solar Unit Requirements in Maryland

	Small-Scale (≤10 kW)	Mid-Scale (>10 to 100 kW)	Large-Scale (> 100 kW)
2011 Units (installed)	1,426	159	43
2022 Units (projected)*	62,000	6,900	1,870

* Assumes the size distribution of solar installations is consistent with the current distribution.

Maryland's Tier 1 non-solar RPS requirement allows Maryland electric suppliers to source Tier 1 Renewable Energy Credits (RECs) from anywhere within the PJM region. It appears likely that adequate supplies exist to meet Maryland and PJM state Tier 1 non-solar requirements in 2011. However, Tier 1 generation will need to grow at approximately 15 percent annually across PJM to meet future RPS requirements out to 2022.

The Maryland RPS Tier 2 eligibility requirements are different than the RPS requirements of some other PJM states. Some states, particularly Pennsylvania, allow additional resources such as pumped storage hydropower and waste coal to be counted towards Tier 2 eligibility. When considering these varying eligibility requirements, it is expected that available Tier 2 resources will exceed the total PJM Tier 2 requirements through 2018, the final year of the Maryland Tier 2 RPS requirement.

[2] In addition to the set-aside, solar resources might also be used for compliance with the basic Tier 1 requirements. For purposes of this report and analysis, we assume all in-state solar installations will be used to meet the Maryland solar-set aside. Solar facilities located outside of Maryland are expected to be used for compliance with other state solar set-aside or solar specific requirements. States without a solar set-aside might have solar installations that could contribute to compliance with Tier 1 requirements in Maryland or other PJM states; however, this is anticipated to be a *de minimis* amount. Therefore, the solar set-aside resources are accounted for separately from Maryland Tier 1 despite the fact that they could qualify under either category.

[3] The average size of solar installations in Maryland has increased over the past few years, a trend that is likely to continue as the cost of solar technologies decreases.

I. Introduction

A. Purpose of the Report

A renewable energy portfolio standard (RPS) requires that a portion of the electricity used to supply a load-serving entity's (LSE's) electricity demand comes from eligible renewable energy sources. The Maryland Power Plant Research Program published the first *Inventory of Renewable Energy Resources Eligible for the Maryland Renewable Energy Portfolio Standard* in 2006 (*2006 Inventory Report*).The purpose of the *2006 Inventory Report* was to determine the quantity of existing resources eligible for the Maryland RPS, and to assess how much, if any, additional renewable energy capacity would need to be constructed to meet those requirements.[4] This report, *2011 Inventory of Renewable Energy Generators Eligible for the Maryland Renewable Energy Portfolio Standard (2011 Inventory Report)*, revisits the RPS requirements of Maryland and other states within the PJM Interconnection in light of recent growth in renewable energy markets, significant changes to the Maryland RPS, changes in RPS policies in other PJM states, and increases to the geographic area served by PJM.

B. Maryland's Renewable Portfolio Standard

In 2004, the Maryland State Legislature passed Senate Bill 869, the Renewable Energy Portfolio Standard and Credit Trading Act. The law required that 3.5 percent of retail energy sales be derived from renewable sources in 2006, increasing to 9.5 percent by 2018, and then decreasing to 7.5 percent in 2019 and subsequent years. The law distinguished between energy derived from Tier 1 and Tier 2 facilities (see Table 1). Energy derived from Tier 1 resources was to comprise 1 percent of electricity sales in 2006 and increase to 7.5 percent by 2019. Tier 2 resources were to make up 2.5 percent each year and then sunset by 2019 (i.e., there is no Tier 2 requirement in 2019 and thereafter). Table 1 lists categories of facilities that are eligible under Tier 1 and Tier 2 according to Senate Bill 869 and as amended by subsequent legislation.

[4] Maryland Power Plant Research Project, *Inventory of Renewable Energy Resources Eligible for the Maryland Renewable Energy Portfolio Standard* (2006), 14, http://esm.versar.com/pprp/bibliography/PPES_06_01/PPES_06_01.pdf.

Table 1 – Maryland Tier 1 and Tier 2 Classifications
Tier 1 Qualifying Facilities
Solar – photovoltaic (PV) and solar thermal systems located within Maryland that produce electric power, and solar water heating systems constructed after June 1, 2011
Wind
Qualifying biomass*
Methane from the anaerobic decomposition of organic materials in a landfill or a wastewater treatment plant
Geothermal
Ocean energy
Fuel cells powered by methane or biomass
Hydroelectric plants under 30 MW licensed by FERC** or exempt from licensing
Poultry litter-to-energy facilities
Waste-to-energy facilities (including blast furnace gas and refuse derived fuels)
Tier 2 Qualifying Facilities
Hydroelectric plants other than pumped storage hydropower
Waste-to-energy facilities not connected to the Maryland distribution grid

*Qualifying biomass means a non-hazardous, organic material that is available on a renewable or recurring basis, is waste material that is segregated from inorganic waste material, and is derived from:

1. Except for old-growth timber, any of the following forest-related resources:
   a. mill residue, except sawdust and wood shavings
   b. pre-commercial soft wood thinning
   c. slash, brush, or yard waste
   d. pallets, crates, or dunnage
2. Agricultural and silvicultural sources, including tree crops, vineyard materials, grain, legumes, sugar, and other crop byproducts or residues
3. Gas produced from the anaerobic decomposition of animal waste or poultry waste
4. A plant that is cultivated exclusively for purposes of being used as a Tier 1 renewable source or a Tier 2 renewable source to produce electricity.

**FERC: Federal Energy Regulatory Commission.

In April 2007, the Maryland State Legislature passed Senate Bill 595, Electricity - Net Energy Metering - Renewable Energy Portfolio Standard - Solar Energy, which requires a solar set-aside, mandating that 2 percent of retail electricity sales be from eligible solar facilities by 2022, in addition to the 7.5 percent sales from Tier 1 facilities.[5] In April 2008, the legislature passed House Bill 375, Renewable Portfolio Standard Requirements - Acceleration, which increased the total Tier 1 requirement to 20 percent in 2022, with 2 percent as a solar set-aside and 18 percent as Tier 1. Note that out of state solar resources can qualify as a Tier 1 resource

[5]State of Maryland, *Electricity – Net Energy Metering – Renewable Energy Portfolio Standard – Solar Energy Act* (2007), http://mlis.state.md.us/2007RS/chapters_noln/Ch_119_sb0595E.pdf.

but are not eligible for use toward the solar set-aside. The Tier 2 requirements were not changed.[6] The legislature also passed Senate Bill 277 in May of 2010, which increased the solar set-side requirement between 2011 and 2016. Table 2 summarizes the requirements under the current RPS law.

Table 2 – Current Percentage of Renewable Energy Required by Maryland RPS

Year	Tier 1- Solar Set-Aside (Percent)[1]	Tier 1 (Percent)[2]	Tier 2 (Percent)[3]	Total (Percent)
2006	--	1.0	2.5	3.5
2007	--	1.0	2.5	3.5
2008	0.005	2.0	2.5	4.505
2009	0.01	2.0	2.5	4.51
2010	0.025	3.0	2.5	5.525
2011	0.05	4.95	2.5	7.50
2012	0.10	6.4	2.5	9.00
2013	0.20	8.0	2.5	10.7
2014	0.30	10.00	2.5	12.8
2015	0.40	10.10	2.5	13.0
2016	0.50	12.20	2.5	15.2
2017	0.55	12.55	2.5	15.6
2018	0.90	14.9	2.5	18.3
2019	1.2	16.2	--	17.4
2020	1.5	16.5	--	18.0
2021	1.85	16.85	--	18.7
2022 (and beyond)	2.0	18.0	--	20.0

1 - Solar requirement started in compliance year 2008.
2 - Excludes the Tier 1 solar set-aside.
3 - Tier 2 requirement sunsets at the end of 2018.

House Bill 375 also changed the geographic eligibility of facilities that qualify under Maryland's RPS. As provided in the original 2004 legislation (in effect through December 31, 2010), renewable energy generation could be located (1) in the PJM region, (2) in a state that is adjacent to the PJM region, or (3) in a control area (Regional Transmission Organization or Independent System Operator service area) that is adjacent to the ***PJM region if the electricity is delivered into the PJM region. Changes to the definition of eligibility enacted in the 2008 House Bill 375 came into effect beginning January 1, 2011, and require that renewable energy generation be located (1) in the PJM region or (2) in a control area that is adjacent to the PJM region if the electricity accompanying the renewable energy credits (RECs) is delivered into the PJM region. While Tier 1 and Tier 2 facilities in control areas adjacent to PJM regions could still be eligible under the modified RPS, the additional transmission and wheeling charges required to deliver this energy into PJM provides a competitive disadvantage for facilities located outside of PJM regions. Furthermore, smaller

[6]State of Maryland, *Renewable Portfolio Standard Requirements – Acceleration* (2008), H.B 375, Chapter 126, http://mlis.state.md.us/2008rs/chapters_noln/Ch_126_hb0375E.pdf.

facilities operating behind the meter or serving on-site loads are unable to deliver bundled energy and RECs into PJM regions from an adjacent control area.

Finally, Tier 1 eligibility was recently amended by Senate Bills 690 and 717. Senate Bill 690, signed into law in May 2011, allows Tier 1 eligibility for waste-to-energy and refuse derived fuel facilities located in Maryland. Waste incineration facilities must also meet certain requirements regarding the recycling rate of the jurisdictions where the municipal solid waste is collected. Prior to Senate Bill 690, waste-to-energy generation was only eligible for Tier 2 compliance. Waste-to-energy sited outside of Maryland remains ineligible for Tier 1 compliance but may still be used for Tier 2 compliance. Also enacted in May 2011, Senate Bill 717 allows RECs from solar water heating systems to qualify for the Tier 1 in-State solar set-aside. Previously, only electric generation from solar power facilities was eligible under the solar set-aside. The new solar water heating measure is applicable only to systems developed after June 1, 2011, and this provision will not take effect until the beginning of the 2012 RPS compliance year on January 1, 2012.

C. Alternative Compliance Payment

Maryland established an alternative compliance payment (ACP) in order to both enforce the RPS and cap the cost to customers. The ACP is essentially a fee paid by electricity suppliers to account for any shortfalls in their compliance with the RPS. To show compliance with the Maryland RPS, the electricity supplier must hold the appropriate number of RECs in a tracking account. A REC is a certificate demonstrating 1 megawatt-hour (MWh) of energy output from a certified renewable generator.[7] If the electricity supplier does not own the required number of RECs, it must pay an ACP for each REC that it is short in the given compliance period. Most states in the PJM region with mandatory renewable energy requirements have instituted ACPs. In the case of Maryland, funds generated from the ACP go to providing grants and loans for the construction of Tier 1 resources. The ACP amounts differ from state to state and influence the market price for RECs by driving competition for renewable energy sources in the region. Electricity suppliers in those states with a high ACP are willing to pay more - up to the ACP

[7] A renewable energy generator (such as a wind farm) is credited with one REC for every 1 MWh of electricity it produces. Each REC is given a unique identification number by a recognized certifying agency. The renewable electricity can then be fed into the electrical grid, while the accompanying REC can be sold separately.

amount - for RECs. Table 3 shows the ACPs for each state in the PJM region, as well as the geographic footprint of qualifying facilities according to each state's RPS. Please see Appendix A for more information on RPS requirements for other states.

Table 3 – Alternative Compliance Payments in the PJM Region

State	RPS Geographic Footprint	Alternative Compliance Payments
Delaware	A generation unit must (1) be in the PJM region or located outside the PJM region with the ability to import into the PJM region, and (2) be tracked through the PJM Market settlement system. Customer-sited generation must be in Delaware.	$25/MWh. The payment increases in subsequent years for suppliers who elect to pay it. After the first year that suppliers pay the ACP, the ACP increases to $50/MWh. After the second year, it increases to $80/MWh. For solar power, ACP begins at $400/MWh and increases $50/MWh for every year the ACP is elected up to a maximum of $500/MWh.
District of Columbia	Must be located (1) in the PJM region, or (2) in a state that is adjacent to the PJM region, or (3) outside the PJM region in a control area that is adjacent to the PJM region if the electricity from either is delivered into the PJM region.	For compliance years 2009 to 2018: Tier 1 – $50/MWh Tier 2 – $10/MWh Solar – Varies by year between $500/MWh from 2011 to 2016 and eventually dropping to $50/MWh in 2023
Illinois	For investor-owned utilities, resources must come from within the State through 2011 unless in-state resources are not cost-effective at which point IOUs may procure cost-effective RECs from outside Illinois. After 2011, resources can come from Illinois or other adjoining states so long as they pass established cost-effectiveness tests.	For compliance year June 2011 – May 2012, the estimated ACP for load serving entities in the Ameren territory is $0.0583/MWh and $0.0568/MWh for those in the ComEd territory. The ACP beyond 2012 has not yet been established.
Indiana	50 percent of RECs must be in-state. Other eligibility (e.g., trading) provisions have not yet been clarified but the rules of the program must be established by January 1, 2012.	Voluntary goals, no ACP.
Kentucky	No RPS.	No ACP.

Table 3 – Alternative Compliance Payments in the PJM Region		
State	**RPS Geographic Footprint**	**Alternative Compliance Payments**
Maryland	As of January 1, 2011, renewable energy generation must be located (1) in the PJM region only, or (2) in a control area that is adjacent to the PJM region if the electricity is delivered into the PJM region. Solar resources used to meet the solar set-aside must come from within the State.	Tier 1 – $40/MWh for non-solar shortfalls (raised from $20/MWh by H.B. 375). Tier 2 – $15/MWh Solar – $400/MWh in 2009 through 2014. Declines to $350/MWh for 2015 -2016, and then continues to decline bi-annually until it reaches $50/MWh in 2023 and beyond. $8/MWh for Tier 1 shortfalls for industrial process load in 2006 – 2008, $5/MWh in 2009/10, $4/MWh in 2011/12, $3/MWh in 2013/14, $2.5/MWh in 2015/16, and $2/MWh in 2017 and later; no fee for Tier 2 shortfalls for industrial process load.
Michigan	Electricity must be generated in Michigan or outside the state in the retail electric customer service territory of any provider that is not an alternative electric supplier.	No ACP.
New Jersey	Electricity must be generated within or delivered into the PJM region. For both Classes I and II facilities, renewable energy delivered into the PJM region must be generated at a facility that was constructed after January 1, 2003.	Non-Solar ACP is $50/MWh. Solar ACPs are as follows: 2009 – 2010: $693/MWh 2010 – 2011: $675/MWh 2011 – 2012 : $658/MWh 2012 – 2013: $641/MWh 2013 – 2014: $625/MWh 2014 – 2015: $609/MWh 2015 – 2016: $594/MWh Under recently passed legislation (A.B. 3520), the Board of Public Utilities is required to extend this up to 15 years (the previous requirement was 8 years).
North Carolina	Utilities may use unbundled RECs from out-of-state renewable energy facilities to meet up to 25 percent of the portfolio standard.	No ACP.
Ohio	At least 50 percent of the renewable energy requirement must be met by in-state facilities, and the remaining 50% with resources that can be shown to be deliverable into the state.	$45/MWh for non-solar. This will be adjusted annually by the Public Utilities Commission of Ohio but will never be less than $45/MWh. The Solar ACP is $450/MWh in 2009, decreasing biannually to a minimum of $50/MWh in 2024.

Table 3 – Alternative Compliance Payments in the PJM Region		
State	**RPS Geographic Footprint**	**Alternative Compliance Payments**
Pennsylvania	Eligible resources must originate within Pennsylvania or within the PJM region in order to be counted for compliance. Out of state resources located in the Midwest Independent System Operator (MISO) territory that serves parts of Pennsylvania are also eligible.	$45/MWh for non-solar. For solar PV, the ACP is valued at 200 percent of the average price of solar renewable energy credits sold during the reporting period.
Tennessee	No RPS.	No ACP.
Virginia	Electricity must be generated or purchased in Virginia or in the PJM region.	Voluntary goals, no ACP.
West Virginia	Alternative and renewable resources must be generated or purchased from a facility in West Virginia or in the PJM region.	No ACP.

The variations in ACP enforcement mechanisms can lead to widely differing values and prices for Tier 1 and Tier 2 RECs and competition for RECs within the region. For instance, Maryland law stipulates that only solar energy produced in Maryland is eligible to receive Maryland-certified solar RECs. Pennsylvania, for example, does not have this stipulation. Solar RECs from Maryland facilities are eligible for use in satisfying the Pennsylvania solar requirement. In addition, the ACP for solar in Maryland currently stands at $400 per REC in 2010, while the ACP in Pennsylvania is 200 percent of the average market value of solar RECs sold within the PJM region during the compliance period. In September 2011, the average price of solar RECs within the PJM region was $491; therefore, Pennsylvania suppliers would be faced with an ACP of $988 per solar REC for non-compliance.[8] However, the September 2011 Pennsylvania REC price remained at $135 per MWh, significantly lower than either the ACP or the PJM average market price.[9] While prices currently remain low, increasing demand from an increasing RPS requirement may force Pennsylvania electricity suppliers to compete for RECs from Maryland and other states, which would in turn drive up the price of Maryland solar RECs. This may make paying the Maryland solar ACP a less expensive option for Maryland LSEs than acquiring Maryland-eligible solar RECs. While the Maryland RPS requires that solar RECs come from Maryland, several other states within the PJM region would also accept Maryland-eligible solar RECs for their own solar RPS compliance. Therefore, some Maryland-eligible

[8] The September REC price is from PJM's Generation Attribute Tracking System (GATS) report on solar weighted average price.
[9] Ibid.

solar RECs may be sold out-of-state and therefore would be unavailable for compliance under the Maryland RPS.

Additionally, there is a provision in the Maryland statute stipulating that if the actual or projected cost for purchasing solar RECs in any one year is greater than or equal to 1 percent of the LSE's total annual electricity sales revenue in Maryland, the supplier may apply to the Maryland Public Service Commission (PSC) for a delay in complying with the RPS.
A hypothetical example based on the solar requirements for 2015 is as follows:

Utility X: Annual electricity sales are 15 million MWh
Average retail price of electricity supply is $50/MWh[10]
Annual revenue from electricity sales is $750 million
The 2015 Solar RPS Requirement is 0.40% or 60,000 solar RECs
With an ACP of $250, the cost of solar compliance is $15 million
$15 million in solar compliance costs/$750 million in revenues = 2.0%

If approved by the PSC, the delay would continue each year until the actual or anticipated cost is less than 1 percent of the LSE's annual retail electricity sales revenue in Maryland, at which time the LSE will be subject to the next scheduled percentage increase in RPS requirements. In effect, this will exempt an LSE from compliance with the solar REC requirement until such time as the cost of the solar RECs is less than 1 percent of the LSE's total annual Maryland electricity sales revenues. A similar provision exists for Tier 1 requirements in Maryland, except the threshold is the greater of 10 percent of an LSE's total annual retail electricity sales or the applicable Tier 1 percentage requirement for that year.[11,12] The regulations do not specify how the projected total annual retail electricity sales revenue is to be calculated. The PSC requires that an LSE seeking this delay provide the formula used to calculate the annual sales revenue. Therefore, the determination as to whether the LSE receives a delay is at the discretion of the PSC. This cost threshold could conceivably be reached for all LSEs as early as 2013 when the solar requirement increases to 0.20 percent of total annual retail electricity sales,

[10] The retail price of electricity used in this example is not intended to reflect or project actual prices but is only an example.
[11]State of Maryland, *An Act Concerning: Renewable Energy Portfolio Standard – Solar Energy* (2008), http://mlis.state.md.us/2010rs/chapters_noln/Ch_494_sb0277E.pdf.
[12]Database of State Incentives for Renewables & Efficiency, Maryland Incentives/Policies for Renewables & Efficiency: Renewable Energy Portfolio Standard, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MD05R&re=1&ee=1.

and assuming that average power supply costs do not increase significantly and solar REC prices remain close to the ACP.

II. Current Renewable Energy Facilities and Capacities within the PJM Region

The 2011 PJM Generator Attributes Tracking System (GATS) renewable inventory database contains 18,744 entries detailing electric generating units in the PJM control area that utilize renewable energy resources as of September 1, 2011. Of these entries, 211 are located outside the PJM control area and are therefore considered to be ineligible for the Maryland RPS, 23 were duplicates, and another 370 demonstrated no generation from Maryland-eligible resources. The remaining entries were aggregated by U.S. Energy Information Administration (EIA) facilities code (if this unique identifier was available) for a total of 18,048 unique generating facilities, 17,757 of which are solar, 261 are Tier 1 (non-solar), and 30 are eligible for Tier 2 compliance. For those facilities with more than one fuel source, the capacity associated with renewable resources was calculated based on historical generation by fuel source and the contribution of renewable fuels.[13] Some facilities utilize more than one renewable fuel and are listed under the qualifying fuel with the highest proportion of the facility's generation. The database does not identify any qualifying wastewater treatment biogas, geothermal, ocean, or poultry litter-to-energy electric resources. For detailed information on the data collection methodology employed in this analysis, refer to Appendix B.

Table 4 summarizes the number of renewable energy facilities by state and by Maryland RPS tier. Tables 5a and 6a show a compilation of the 2011 renewable electric generation capacity by PJM states as aligned to the Maryland Tier 1 and Tier 2 definitions, respectively.[14] However, not all of the facilities eligible for the Maryland RPS have been certified by the Maryland PSC and are subsequently unable to sell RECs to Maryland utilities until having done

[13]Generation data are typically not available for smaller methane-based plants, such as those utilizing internal combustion generators. It is expected that the renewable share of methane capacity may be overstated owing to the extensive cofiring or fuel switching between natural gas and diesel fuels.

[14] In most instances the capacity listed is the nameplate capacity. However, for multi-fuel plants, the capacity has been adjusted to reflect the ratio of renewable fuels to non-renewable fuels in an effort to avoid overstating the amount of Tier 1 capacity installed. Additionally, in some instances the GATS nameplate capacity is different than other documented nameplate capacity figures as published by EIA or state CPCN records. In these cases, generator owners were contacted to determine an appropriate renewable capacity value.

so. Tables 5b and 6b compile all facilities eligible for the RPS, including those not currently certified by the Maryland PSC.

Table 4 – Number of 2011 Renewable Energy Generating Facilities in the PJM Region

State	No. of Tier 1 Solar Facilities	No. of Tier 1 Non-Solar Facilities	No. of Tier 2 Facilities
Maryland	1,628	17	1
Delaware	891	13	-
District of Columbia	344	-	-
Illinois	36	40	-
Indiana	57	10	-
Kentucky	71	-	-
Michigan	9	5	-
New Jersey	9,227	45	5
North Carolina	91	-	2
Ohio	351	27	1
Pennsylvania	4,484	62	11
Virginia	509	34	6
West Virginia	59	8	4
TOTAL	**17,757**	**261**	**30**

Table 5a – 2011 Electric Generation Capacity (MW) and Number (No.) of Installed Units by State with Maryland Tier 1 Alignment

Tier 1 Facility Category		Maryland	Delaware	DC	Illinois	Indiana	Kentucky	Michigan	New Jersey	North Carolina	Ohio	Pennsylvania	Virginia	West Virginia	TOTAL
Solar[1]	MW	27.4	21.0	2.0	10.7	0.3	0.2	0.1	388.2	2.0	25.9	100.2	3.3	0.3	581.4
	No.	1,628	891	344	36	57	71	9	9,227	91	351	4,484	509	59	17,757
Wind	MW	120.0	0.1		2,437.9	1,099.4			7.7		109.3	790.7		528.1	5,093.2
	No.	4	10		16	6			17		12	21		4	90
Hydroelectric[2]	MW	20.0			3.2	8.2		13.9	3.5			77.8	34.4	48.3	209.4
	No.	1			1	2		4	2			8	8	4	30
Methane[3]	MW	25.9	30.1		146.2	8.0		8.0	102.0		52.2	212.6	126.9		712.0
	No.	8	3		23	2		1	26		13	28	17		121
Qualifying Biomass	MW										16.5	61.0	159.0		236.5
	No.										1	3	5		9
Waste-to-Energy[4]	MW	241.2													241.2
	No.	3													3
Black Liquor	MW	25.0									44.0	117.5	172.5		359.0
	No.	1									1	2	4		8
TOTALS	MW	**459.5**	**51.1**	**2.0**	**2,597.9**	**1,115.8**	**0.2**	**22.0**	**501.4**	**2.0**	**247.9**	**1359.8**	**496.2**	**576.7**	**7,432.7**
	No.	**1,645**	**904**	**344**	**76**	**67**	**71**	**14**	**9,272**	**91**	**378**	**4,546**	**543**	**67**	**18,018**

1 - Solar facilities are listed for all PJM states even though the Maryland RPS requires that solar RECs be sourced from within Maryland in order to qualify under the solar set-aside. Solar resources located outside of Maryland could be used to meet the non-solar Tier 1 requirement, however.
2 - Hydroelectric for Tier 1 (Tier 1 Hydro) includes power generating facilities less than 30 MW that were constructed at a dam that was in operation prior to 2004.
3 - Methane from the anaerobic decomposition of organic materials in a landfill or a wastewater treatment plant.
4 - As of May 2011, Maryland S.B. 609 designates waste-to-energy plants connected to the Maryland grid as Tier 1 resources.
Totals may not equal sum of components because of independent rounding.

Table 5b – 2011 Electric Generation Capacity (MW) and Number (No.) of Installed Units by State with Maryland Tier 1 Alignment and Maryland Renewable Certification

Tier 1 Facility Category		Maryland	Delaware	DC	Illinois	Indiana	Kentucky	Michigan	New Jersey	North Carolina	Ohio	Pennsylvania	Virginia	West Virginia	TOTAL
Solar	MW	26.0	1.1	0.6	10.2					0.0	0.3	6.0	1.0	0.0	45.3
	No.	1,607	93	83	5					5	14	379	125	4	2,315
Wind	MW	120.0			546.5	499.5						497.5		264.0	1,927.5
	No.	4			3	1						6		1	15
Hydroelectric[1]	MW	20.0										32.5	17.5	6.0	76.0
	No.	1										3	5	1	10
Methane[2]	MW	13.7	25.0		76.4				41.2			138.6	26.0		321.0
	No.	4	2		12				5			11	5		39
Qualifying Biomass	MW										16.5	18.0	80.0		114.5
	No.										1	1	1		3
Waste-to-Energy[3]	MW	241.2													241.2
	No.	3													3
Black Liquor	MW	25.0									44.0	57.5	95.0		221.5
	No.	1									1	1	3		6
TOTALS	MW	445.9	26.1	0.6	633.1	499.5			41.2	0.0	60.8	750.2	219.5	270.0	2,947.1
	No.	1,620	95	83	20	1			5	5	16	401	139	6	2,391

1 - Hydroelectric for Tier 1 (Tier 1 Hydro) includes power generating facilities less than 30 MW that were constructed at a dam that was in operation prior to 2004.

2 - Methane from the anaerobic decomposition of organic materials in a landfill or a wastewater treatment plant.

3 - As of May 2011, Maryland S.B. 609 designates waste-to-energy plants connected to the Maryland grid as Tier 1 resources.

Totals may not equal sum of components because of independent rounding.

Table 6a – Electric Generation Capacity (MW) and Number (No.) of Installed Units by State with Maryland Tier 2 Alignment									
Tier 2 Facility Category		**Maryland**	**New Jersey**	**North Carolina**	**Ohio**	**Pennsylvania**	**Virginia**	**West Virginia**	**TOTAL**
Waste-to-Energy	MW	0	162	0	0	317	123	0	602
	No.	0	5	0	0	7	2	0	14
Hydroelectric*	MW	474	0	325	47	601	326	211	1,984
	No.	1	0	2	1	4	4	4	16
TOTALS	**MW**	**474**	**162**	**325**	**47**	**918**	**449**	**211**	**2,587**
	No.	**1**	**5**	**2**	**1**	**11**	**6**	**4**	**30**

*Hydroelectric for Tier 2 includes all hydroelectric facilities other than those less than 30 MW and that were constructed at a dam that was in operation prior to 2004 (i.e., Tier 1 Hydro)
Note: States with no Tier 2 qualifying facilities: Delaware, Illinois, Indiana, Kentucky, Michigan, Tennessee, and the District of Columbia.

Totals may not equal sum of components because of independent rounding.

Table 6b – Electric Generation Capacity (MW) and Number (No.) of Installed Units by State with Maryland Tier 2 Alignment and Maryland Renewable Certification									
Tier 2 Facility Category		**Maryland**	**New Jersey**	**North Carolina**	**Ohio**	**Pennsylvania**	**Virginia**	**West Virginia**	**TOTAL**
Waste-to-Energy	MW	0	59	0	0	85	60	0	204
	No.	0	2	0	0	2	1	0	5
Hydroelectric*	MW	474	0	0	0	450	0	169	1,092
	No.	1	0	0	0	2	0	3	6
TOTALS	**MW**	**474**	**59**	**0**	**0**	**534**	**60**	**169**	**1,296**
	No.	**1**	**2**	**0**	**0**	**4**	**1**	**3**	**11**

*Hydroelectric for Tier 2 includes all hydroelectric facilities other than those less than 30 MW and that were constructed at a dam that was in operation prior to 2004 (i.e., Tier 1 Hydro)
Note: States with no Tier 2 qualifying facilities: Delaware, Illinois, Indiana, Kentucky, Michigan, Tennessee, and the District of Columbia.

Totals may not equal sum of components because of independent rounding.

III. Renewable Energy RPS Requirements within the PJM Region

The renewable electricity generation required to meet a state's renewable energy requirement as established by an RPS is typically based on a percentage of the sales of electricity within each particular state. (Solar requirements in New Jersey are an exception in that the New Jersey RPS requirement states a specific MWh quantity which is not tied to electricity sales.) The total electric sales in 2011 for each state are those used in the Power Plant Research Program's recent *Long-Term Electricity Report* (LTER). [15]

To estimate the future RPS requirement for renewable energy, it is necessary to project the sales of electricity within the PJM region out to 2022. The *2011 Inventory Report* uses the electricity sales projections established in the Reference Case of the LTER. These projections reflect expected growth; short-term recessionary impacts; current expectations of demand-side management reductions, including demand response and energy efficiency programs; and plug-in electric vehicle (PEV) impacts on energy demand.[16]

There are several states in which only a portion of the state is located within the PJM control area. The portions of the state located outside of PJM might be served by a utility system operator (for example, the Tennessee Valley Authority) or an independent system operator such as the Midwest Independent System Operator. Table 7 presents the estimated amount of electric consumption that is within the PJM region for states with more than one system operator.[17] This study assumes that the RPS requirement for states with only a portion of the state in PJM is directly proportional to the amount of service supplied through PJM. For example, in Michigan, the PJM system is estimated to provide approximately 7 percent of the total electrical demand. Accordingly, this analysis assumes that 7 percent of Michigan's RPS requirements will be

[15] Exeter Associates, Inc., *Long-Term Electricity Report for Maryland* (December 1, 2011), Prepared for the Maryland Department of Natural Resources Power Plant Research Program Pursuant to Executive Order 01.01.2010.16, http://esm.versar.com/pprp/pprac/Longterm_Electricity_Report.htm.
[16] Ibid.
[17] The portion of electric supply estimated as sourced from the PJM region is based on the ratio of population in the counties served by PJM to the state's total population.

satisfied from PJM resources, and 93 percent of the Michigan renewable energy requirement would be met with renewable generation outside of the PJM region.

Table 7 – State Energy Consumption in PJM and Proportion Supplied by the PJM Region

State	2011 Consumption	Proportion Supplied by PJM	
	GWh	Percent	GWh
Maryland	68,246	100	68,246
Delaware	11,593	100	11,593
District of Columbia	10,996	100	10,996
Illinois	144,345	78	112,589
Indiana	90,434	39	35,269
Kentucky	76,486	13	9,943
Michigan	104,032	7	7,282
New Jersey	85,268	100	85,268
North Carolina	124,503	10	12,450
Ohio	159,959	100	159,959
Pennsylvania	157,237	100	157,237
Tennessee	111,398	5	5,570
Virginia	110,831	100	110,831
West Virginia	37,764	100	37,764
Total	**1,293,093**	**64**	**824,998**

The states within the PJM region and the District of Columbia have differing RPS standards. These varying standards, for the most part, align very well with Maryland's RPS tier structure. For the three states with RPSs that did not neatly align with Maryland's structure, the following tier assignments were made:

- The Michigan RPS sets an overall renewable target. It does not specify the percent requirement of any particular renewable resource. For purposes of this analysis, the Michigan RPS is assumed to align with Maryland Tier 1 values (i.e., no breakout was made specifically for the Tier 1 solar set-aside or Tier 2 resources). This may overstate competition for Tier 1 resources among Michigan LSEs.
- New Jersey sets a Tier 2 qualifying hydroelectric size limit of 30 MW. Maryland does not set an upper limit and all hydroelectric plants qualify as either Tier 1 or Tier 2.
- West Virginia, similar to Michigan, sets an overall RPS target.
- West Virginia, Pennsylvania, and Ohio allow certain non-renewable resources to qualify for RPS compliance.[18] West Virginia's RPS is the most permissive, allowing alternative energy resources such as advanced coal technology, coal bed methane, natural gas, fuel produced by a coal gasification or liquefaction facility, synthetic gas, integrated gasification combined cycle technologies, waste coal, tire-derived fuel, pumped storage

[18] The term "non-renewable resources" refers to fossil fuels or alternative fuels excluding wind, solar, traditional hydroelectric, and biomass.

hydroelectric projects, and recycled energy.[19] The blanket RPS targets for these states were assumed to align in total with Maryland tiers. These assumptions may overstate competition for Tier 1 and Tier 2 resources.

Table 8 shows the percent of the electricity supply in each PJM state and the District of Columbia that is to be met by its RPS requirements. The individual percentages have been aligned to track with Maryland tier criteria where possible. The RPS standards from those states without Tier 2 requirements are typically included as Tier 1.

The renewable energy RPS requirement in GWh within the PJM region can be calculated by multiplying the RPS percentage requirement for each state and the District of Columbia by its total MWh consumption.[20] Table 9 provides the projected renewable energy consumption in GWh within the PJM region. Maryland's 2022 solar RPS requirement equals about 17 percent of the total solar requirements within the PJM region and Maryland's Tier 1 requirements amount to 14 percent of the PJM region Tier 1 requirements. The tables list the RPS requirements for West Virginia, although it is not anticipated that West Virginia suppliers will be willing to compete for Tier 1 RECs due to the large number of cheaper alternatives, such as coal and natural gas-based technologies, permitted under the West Virginia RPS regulations. West Virginia currently accounts for approximately 4.4 percent of total energy consumption within the PJM region and, therefore, would only have a minimal impact on overall REC requirements within the PJM geographical area.

[19]West Virginia House Bill 103, §24-2F-3. Definitions – "(1) 'Advanced coal technology' means technology that is used in a new or existing energy generating facility to reduce airborne carbon emissions associated with the combustion or use of coal and includes, but is not limited to, carbon dioxide capture and sequestration technology, supercritical technology, ultra supercritical technology and pressurized fluidized bed technology."

[20] Estimates do not consider exemptions from RPS compliance that are available in some states, such as Maryland. The electricity sales that are exempt from state RPS requirements are expected to be less than 5 percent of total sales.

Table 8 - RPS Requirements for States and the District of Columbia in the PJM Region Aligned to Maryland Tiers

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Maryland												
Tier 1 Solar	0.05%	0.10%	0.20%	0.30%	0.40%	0.50%	0.55%	0.90%	1.20%	1.50%	1.85%	2.00%
Tier 1	4.95%	6.40%	8.00%	10.00%	10.10%	12.20%	12.55%	14.90%	16.20%	16.50%	16.85%	18.00%
Tier 2	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%				
Delaware												
Tier 1 Solar	0.20%	0.40%	0.60%	0.80%	1.00%	1.25%	1.50%	1.75%	2.00%	2.25%	2.50%	2.75%
Tier 1	5.80%	6.60%	7.40%	8.20%	9.00%	10.25%	11.50%	12.75%	14.00%	15.25%	16.50%	17.75%
Tier 2												
District of Columbia												
Tier 1 Solar	0.40%	0.50%	0.50%	0.60%	0.70%	0.83%	0.98%	1.15%	1.35%	1.58%	1.85%	2.18%
Tier 1	3.60%	4.50%	6.00%	7.40%	8.80%	10.68%	12.52%	14.35%	16.15%	18.42%	18.15%	17.83%
Tier 2	2.5%	2.5%	2.5%	2.5%	2.5%	2.0%	1.5%	1.0%	0.5%	0.0%	0.0%	0.0%
Illinois												
Tier 1 Solar		0.04%	0.12%	0.27%	0.60%	0.69%	0.78%	0.87%	0.96%	1.05%	1.14%	1.23%
Tier 1	6.00%	6.97%	7.88%	8.73%	9.40%	10.81%	12.22%	13.63%	15.04%	16.45%	17.86%	19.27%
Tier 2												
Indiana												
Tier 1 Solar												
Tier 1			4.000%	4.000%	4.000%	4.000%	4.000%	4.000%	7.000%	7.000%	7.000%	7.000%
Tier 2												
Michigan												
Tier 1 Solar												
Tier 1	2.0%	3.3%	5.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Tier 2												
New Jersey												
Tier 1 Solar	0.52%	0.67%	0.86%	1.05%	1.24%	1.44%	1.67%	1.93%	2.23%	2.58%	2.97%	3.46%
Tier 1	6.32%	7.14%	7.98%	8.81%	9.65%	10.49%	12.33%	14.18%	16.03%	17.88%	17.88%	17.88%
Tier 2	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
North Carolina												
Tier 1 Solar	0.02%	0.07%	0.07%	0.07%	0.14%	0.14%	0.14%	0.20%	0.20%	0.20%	0.20%	0.20%
Tier 1	0.00%	2.93%	2.93%	2.93%	5.86%	5.86%	5.86%	9.80%	9.80%	9.80%	12.30%	12.30%
Tier 2												
Ohio												
Tier 1 Solar	0.03%	0.06%	0.09%	0.12%	0.15%	0.18%	0.22%	0.26%	0.30%	0.34%	0.38%	0.42%
Tier 1	0.97%	1.44%	1.91%	2.38%	3.35%	4.32%	5.28%	6.24%	7.20%	8.16%	9.12%	10.08%
Tier 2												
Pennsylvania												
Tier 1 Solar	0.03%	0.05%	0.08%	0.14%	0.25%	0.29%	0.34%	0.39%	0.44%	0.50%	0.50%	0.50%
Tier 1	3.47%	3.95%	4.42%	4.86%	5.25%	5.71%	6.16%	6.61%	7.06%	7.50%	7.50%	7.50%
Tier 2	6%	6%	6%	6%	8%	8%	8%	8%	8%	10%	10%	10%
Virginia												
Tier 1 Solar												
Tier 1	4%	4%	4%	4%	4%	7%	7%	7%	7%	7%	7%	12%
Tier 2												
West Virginia												
Tier 1 Solar												
Tier 1					10%	10%	10%	10%	10%	15%	15%	15%
Tier 2												

Table 9 - Projected RPS GWh Requirements for States and the District of Columbia in the PJM Region Aligned to Maryland Tiers

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Maryland												
Tier 1 Solar	34	70	141	214	289	367	408	676	911	1,150	1,432	1,563
Tier 1	3,378	4,454	5,628	7,135	7,304	8,965	9,310	11,184	12,298	12,649	13,043	14,070
Tier 2	1,706	1,740	1,759	1,784	1,808	1,837	1,855	1,877				
Delaware												
Tier 1 Solar	23	47	71	96	121	154	186	219	252	286	320	355
Tier 1	672	777	879	986	1,093	1,262	1,425	1,595	1,766	1,939	2,113	2,291
Tier 2												
District of Columbia												
Tier 1 Solar	44	56	57	69	81	97	116	137	163	192	227	269
Tier 1	396	505	681	850	1,021	1,254	1,482	1,715	1,948	2,240	2,224	2,202
Tier 2	275	281	284	287	290	235	178	120	60			
Illinois												
Tier 1 Solar		41	144	330	746	872	996	1,125	1,255	1,387	1,521	1,658
Tier 1	6,755	8,165	9,468	10,676	11,686	13,664	15,611	17,618	19,668	21,731	23,835	25,979
Tier 2												
Indiana												
Tier 1 Solar												
Tier 1												
Tier 2												
Michigan												
Tier 1 Solar												
Tier 1	146	242	370	744	750	755	760	766	771	775	779	784
Tier 2												
New Jersey												
Tier 1 Solar	442	596	772	965	1,150	1,357	1,591	1,858	2,164	2,518	2,928	3,433
Tier 1	5,389	6,310	7,188	8,068	8,960	9,883	11,714	13,612	15,525	17,465	17,613	17,763
Tier 2	2,132	2,208	2,253	2,290	2,321	2,357	2,376	2,401	2,421	2,442	2,463	2,484
North Carolina												
Tier 1 Solar	2	9	9	9	19	19	19	28	28	29	29	30
Tier 1		371	379	386	782	795	808	1,372	1,396	1,414	1,798	1,821
Tier 2												
Ohio												
Tier 1 Solar	48	99	151	203	257	311	382	454	525	598	672	746
Tier 1	1,552	2,375	3,197	4,032	5,731	7,468	9,163	10,890	12,612	14,361	16,127	17,909
Tier 2												
Pennsylvania												
Tier 1 Solar	51	83	139	243	427	508	593	688	788	896	903	910
Tier 1	5,452	6,422	7,319	8,183	8,966	9,886	10,752	11,652	12,539	13,433	13,541	13,649
Tier 2	9,749	10,082	10,275	10,448	14,004	14,206	14,313	14,455	14,570	17,911	18,054	18,199
Virginia												
Tier 1 Solar												
Tier 1												
Tier 2												
West Virginia												
Tier 1 Solar												
Tier 1					4,019	4,065	4,083	4,112	4,135	6,239	6,275	6,311
Tier 2												
PJM Area Total												
Tier 1 Solar	645	1,001	1,484	2,129	3,090	3,686	4,292	5,184	6,087	7,056	8,032	8,964
Tier 1	23,740	29,620	35,108	41,060	50,313	57,998	65,108	74,517	82,658	92,245	97,348	102,778
Tier 2	13,861	14,311	14,571	14,809	18,423	18,635	18,721	18,852	17,052	20,353	20,517	20,682

IV. Projected Renewable Energy Requirements within the PJM Region

A. Electricity Generation Capacity Factors

The capacity factor of an electric generating unit is measured as the ratio of the actual power output (MWh) over a period of time compared to output at full nameplate capacity over that same period.[21] For example, a 100-MW wind farm that produces 262,800 MWh of energy in a year has a capacity factor of 30 percent.[22] Generating units generally do not run at full capacity for many reasons, including breakdowns, shutdowns for routine maintenance, insufficient demand, or economic factors (i.e., idled when electric demand is low or market price is too low to make generation economical). In addition to these factors, renewable generators lose capacity when their driving forces (wind, sunlight, or water) or fuel sources (biomass, municipal waste) are reduced or not available.

Table 10 – Electric Generating Capacity Factors

Generator Type	PJM Capacity Factor (%)
Biomass	83
Geothermal	n/a[1]
Hydroelectric	33[2]
Solar PV	15
Solar Thermal	15
Wind – Land-based	30
Wind – Offshore	40
Black Liquor	83
Methane (mixed fuel)	48
Waste-to-Energy	41

1 - PJM currently has no geothermal plants.
2 - Tier 1 Hydroelectric (i.e., < 30 MW).

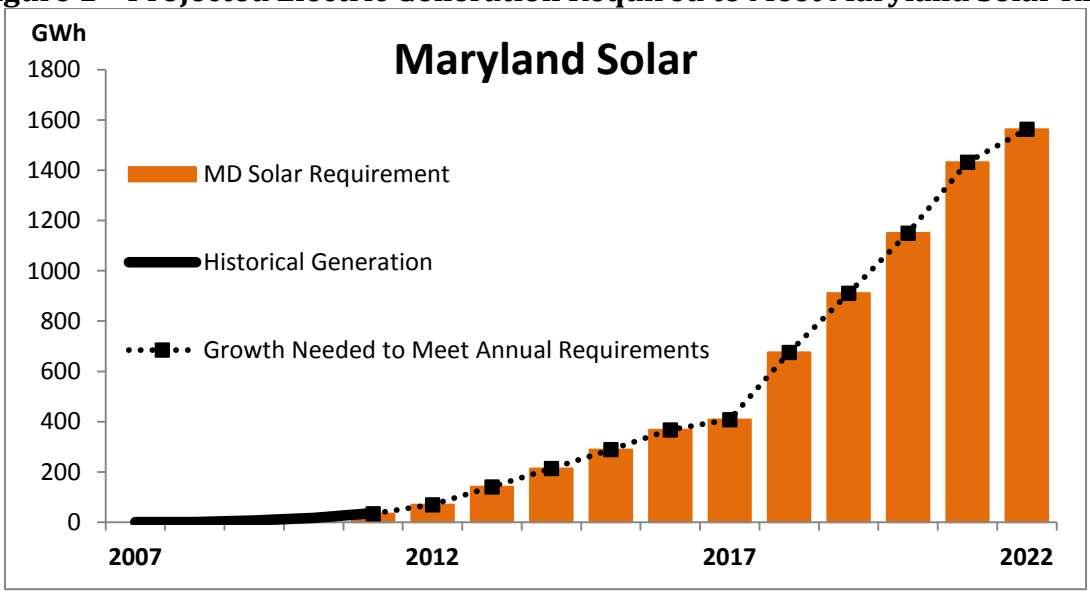
Nationally, the PJM region is not in the most favorable location for wind and solar electric generation and thus the PJM capacity factors are anticipated to be lower than generally accepted national factors. The renewable PJM capacity factors that were used in this analysis are shown in Table 10. The PJM capacity factors are approximate and based on a combination of the national values as reported by the National Energy Modeling System, current literature, and capacity factors derived from EIA data for PJM units when reasonable sample sizes are available. The derivation of the capacity factors relied upon is described in Appendix B.

[21] "Capacity factor" is not to be confused with "capacity credit," which is an assessment by PJM of a facility's generation output at the time of the PJM peak demand. Currently, PJM grants wind facilities a capacity credit of 13 percent of nameplate capacity for reliability purposes and capacity market participation. Wind facilities can apply for a higher capacity credit if they can provide production data to justify a higher value.
[22] Using 8,760 hours in a year, then 262,800 MWh/(100 MW * 8,760 hours) = 30 percent capacity factor.

B. Projected Tier 1 Solar Set-Aside RPS Requirements in Maryland and the PJM Region

In 2007, Maryland enacted a set-aside for solar energy within Tier 1, which the Maryland Legislature further amended in 2010. Figure 1 shows the projected Tier 1 solar generation output needed to meet RPS requirements in Maryland. The *2011 Inventory Report* database includes 1,628 solar systems installed in Maryland for 27.4 MW of electric generating capacity. Given a 15 percent capacity factor, these Maryland solar units will generate an estimated 36,000 MWh in 2011, approximately 0.053 percent of Maryland's 2011 electric consumption, slightly exceeding Maryland's 2011 solar RPS requirement (0.05 percent).[23] Maryland consumes 8.3 percent of the electricity generated in the PJM region and currently produces 4.7 percent of the PJM region's solar electric power.

Figure 1 – Projected Electric Generation Required to Meet Maryland Solar RPS



The Maryland RPS requirement for solar-generated power in 2022 is estimated to be 1,563 GWh (Table 9), which must be met with in-State solar resources. Maryland's in-State solar

[23] Solar facilities installed mid-year will not generate 12-months of electricity. However due to the lag in reporting data in GATS and acknowledging that additional installations will occur through the end of 2011, the estimated 36,000 MWh of solar generation remains a fair estimate for Maryland solar generation in 2011 as it will under represent actual installations on-line in September 2011 but will overestimate the output from solar projects installed mid-year.

generation must grow by approximately 41 percent annually between 2011 and 2022 in order to meet the 2022 Maryland Tier 1 solar RPS requirement (2 percent). The PJM queue of future Maryland units shows only 123 MW of potential solar capacity coming on line by 2017. Recent historical experience suggests that 19 MW of new solar capacity should come on-line from that currently listed in the queue.[24] Note that the PJM queue lists only those projects selling power into the wholesale market, which thus far has been only a small fraction of the total number of solar projects. Most solar projects are net-metered, meaning they are not selling electricity into the wholesale market but are using most of the electricity "behind the meter," with any excess being stored or going to the utility and providing a bill credit to the owner. Year-over-year growth in solar system installations in Maryland is presently exceeding 100 percent. This unusually high rate of growth is likely the result of "early adopters" and current policy incentives that include financial incentives in the form of solar REC prices, tax credits, and grants. As a point of comparison, the U.S. Energy Information Administration reports that the use of solar energy has grown at an average rate of 27 percent per year since 1990.[25]

Solar installations can be segregated into a variety of categories based on unit size (e.g., nameplate capacity) and/or type of installation. This report examines the following size/type of markets:

- Small-scale (≤10 kW) – typically representing single residential and small commercial rooftop installations. This scale, referred to as Level 1, does not require a revenue-quality meter for determining the associated solar RECs. A 10 kW photovoltaic (PV) system requires approximately 1,000 square feet of installation area.
- Mid-scale (>10 kW and ≤100 kW) – representing community, larger commercial, and utility installations.
- Large-scale (>100 kW) – representing large commercial and utility installations; utility scale installations are generally larger.

[24] See section V for more information.

25 U.S. Energy Information Administration, Total Energy: Annual Energy Review, Table 10.8: 1990-2009 data, http://www.eia.gov/totalenergy/data/annual/showtext.cfm?t=ptb1008.

A significant consideration in solar RPS policy and allocation of incentives is the size distribution of the units. Small-scale unit incentives need to be higher on a per-kW basis to achieve the same power supply as would be developed from financial incentives geared towards larger installations since the smaller units have a higher per-watt installation cost than do the mid-scale and large-scale generation facilities. Table 11 shows the distribution of generating units and power supply by unit scale. About 72 percent of the PJM control area solar power comes from 5 percent of the solar units (the 810 units with capacity of greater than 100 kW). Likewise, in Maryland, 63 percent of the power comes from the 3 percent of the units classified as large-scale.

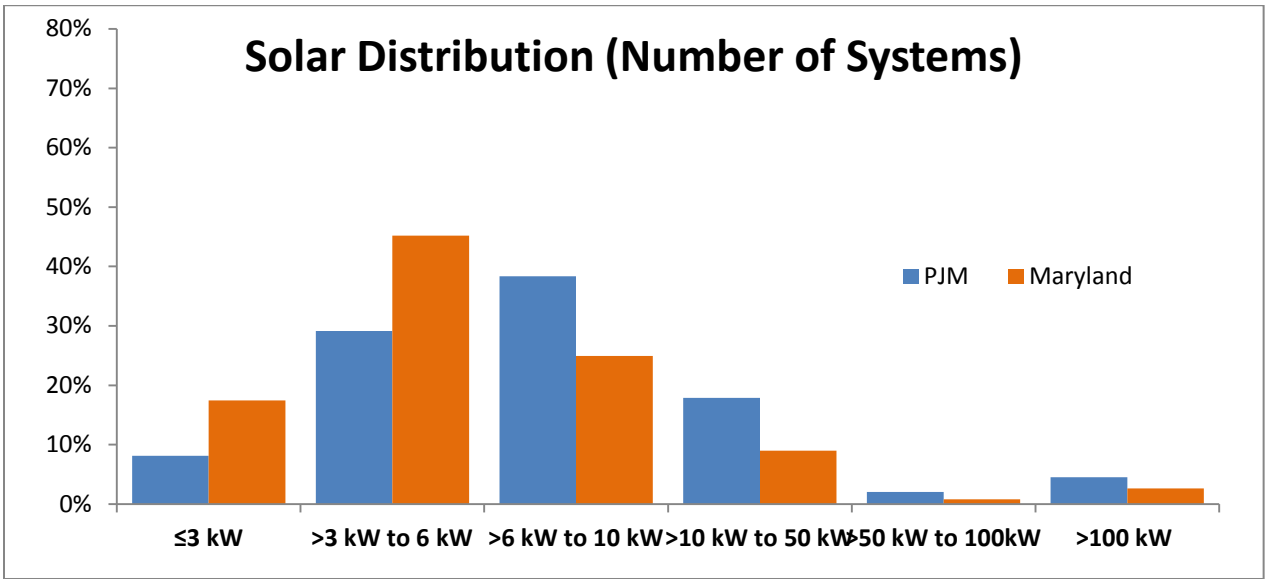
Table 11 – Solar Unit Distribution by Number of Units, Total Power Capacity, and Average Unit Capacity in the Unit Size Category

	Small-Scale (Level-1)			Mid-Scale		Large-Scale	Total
	≤3 kW	>3 to 6 kW	>6 to 10 kW	>10 kW to 50 kW	>50 kW to 100 kW	>100 kW	
PJM							
Number of Units	1,458	5,216	6,864	3,197	361	810	17,906
Percent of Units	8%	29%	38%	18%	2%	5%	100%
Power (total MW)	3.3	24.1	56.4	56.9	25.0	417.6	583.3
Average Unit kW	2.2	4.6	8.2	17.8	69.4	515.5	32.6
Percent of Power	1%	4%	10%	10%	4%	72%	100%
Maryland							
Number of Units	284	736	406	146	13	43	1,628
Percent of Units	17%	45%	25%	9%	1%	3%	100%
Power (total MW)	0.6	3.3	3.1	2.2	0.9	17.2	27.3
Average Unit kW	2.2	4.4	7.6	15.1	72.2	400.6	16.8
Percent of Power	2%	12%	11%	8%	3%	63%	100%

Percent totals may not equal 100% because of independent rounding.

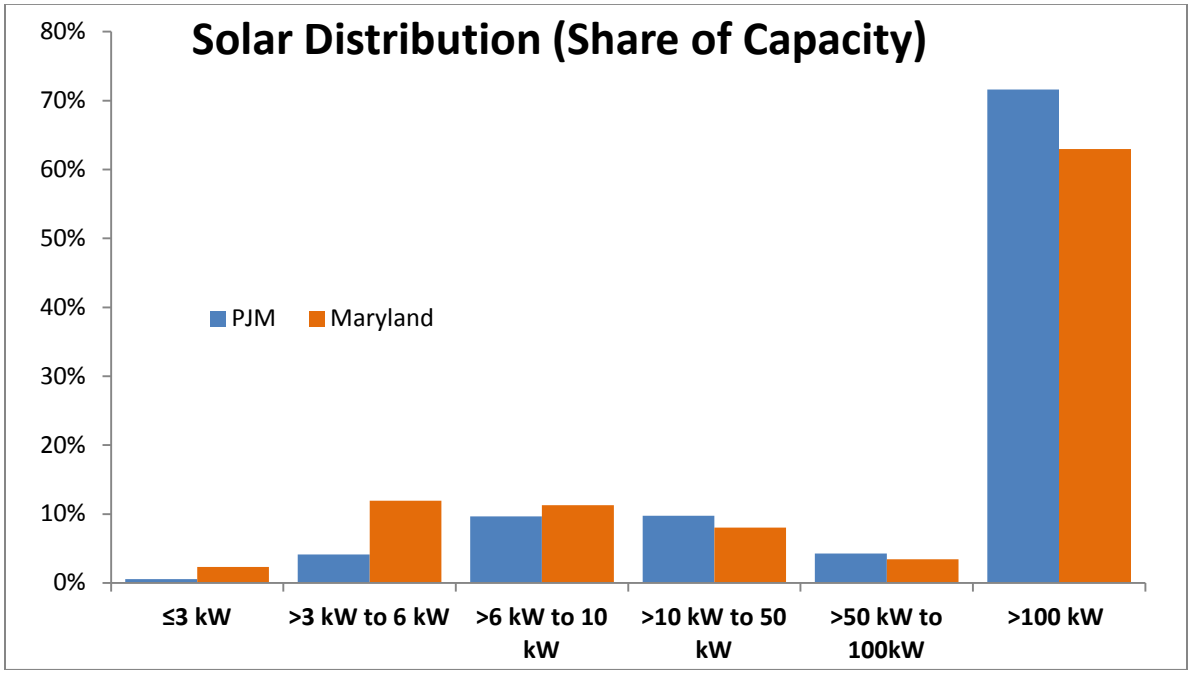
Figure 2 shows the size distribution of the solar units in both PJM and those sited in Maryland by electric nameplate capacity categories.

Figure 2 – PJM and Maryland Generating Unit Distribution for Tier 1 Solar



Most of the solar units (both within Maryland and within PJM) are relatively small and are presumably rooftop residential and commercial PV resources (see Figure 2). However, Figure 3 demonstrates a radically different distribution of solar resources when the distribution is based on the capacity of the units rather than simply on the number of units.

Figure 3 – Maryland and PJM Solar Capacity Distribution



It is clear that the bulk of solar compliance will be realized from large, utility-scale facilities. Rooftop PV still plays an essential role in meeting RPS requirements throughout the PJM and in Maryland, representing 28 and 37 percent of installed capacity in the respective geographical regions, but policies aimed at ensuring compliance with solar carve-out provisions must necessarily target larger, utility-scale solar installations to be most cost effective.

This fact is highlighted by a detailed examination of the distribution of solar units in Maryland listed in the *2011 Inventory Report* database. While small-scale units are currently more dominant in Maryland than within the PJM region as a whole, units in Maryland are steadily increasing in size as the market responds to the incentives laid out by the RPS and ACP. Table 12 shows the number of units that will need to be installed in Maryland to meet the projected 2022 requirement, assuming that the average unit size in each distribution remains unchanged from the 2011 size distributions.

Table 12 – Installed and Projected 2022 Solar Unit Requirements in Maryland

	Small-Scale			Mid-Scale		Large-Scale
Unit Size Category	≤3 kW	>3 to 6 kW	>6 to 10 kW	>10 kW to 50 kW	>50 kW to 100 kW	>100 kW
Average Capacity (kW)	2.2	4.4	7.6	15.1	72.2	401
Maryland Solar Units						
2011Units (installed)	284	736	406	146	13	43
2022 Units (projected)	12,350	32,006	17,656	6,349	565	1,870
Note: the number of units is based on the average unit nameplate capacity for each size category.						

For context, Maryland currently has approximately 1,740,000 single family households.[26] If solar installations continue at the 2011 size distribution, and assuming single family homes make up the majority of these small units, then approximately 3.5 percent of all Maryland single family households will need to install rooftop solar units, approximately 62,000 homes. This suggests that meeting the 2022 compliance goals will require a larger portion of mid-scale and large-scale units than what is found in the current distribution. As shown in Table 13, evidence from 2010 and 2011 solar installations in Maryland shows an upward trend in the average system

[26] Estimate of Maryland's single residential households from U.S. Census data: U.S. Census Bureau, State and County Quick Facts: Maryland, http://quickfacts.census.gov/qfd/states/24000.html.

size (driven, in part, by a few very large projects). Additionally, the evidence also indicates an increase in the average site of small systems.

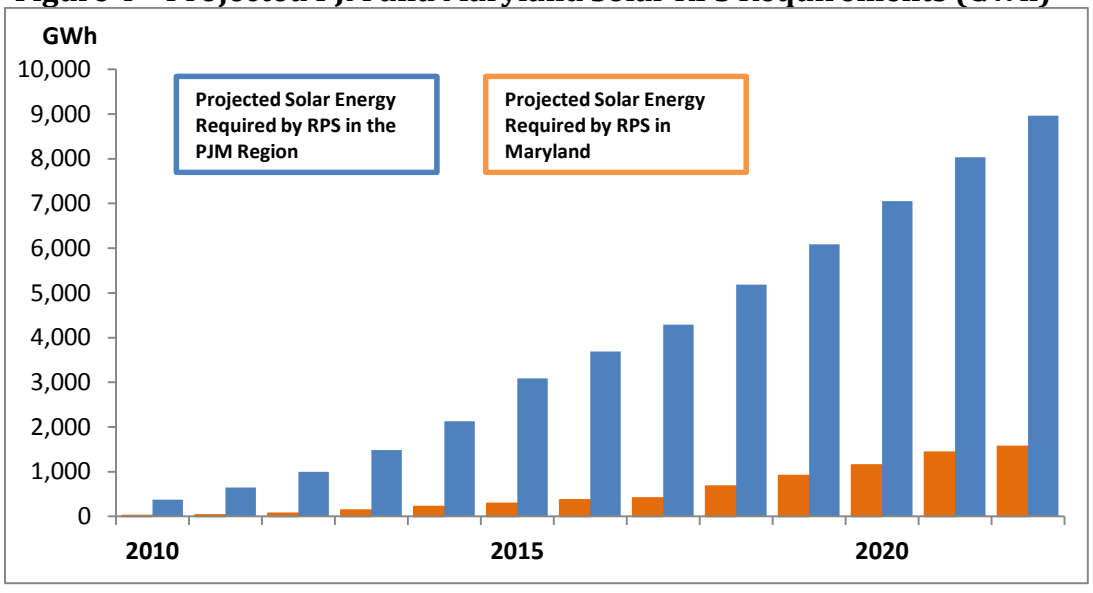
Table 13 - Maryland Solar Installations by Year

	No. of Systems	Capacity Installed (MW)	Average Size (MW)	Median Size (MW)	Largest Size
2011*	311	10.14	0.0327	0.0063	2.22
2010	667	10.13	0.0152	0.0055	1.84
2009	485	5.16	0.0106	0.0044	0.30
2008	92	1.64	0.0177	0.0035	0.50
2007	41	0.20	0.0048	0.0030	0.04
2006	15	0.05	0.0033	0.0030	0.01
2005	17	0.04	0.0025	0.0027	0.01
TOTAL/ AVERAGE	1,628	27.36	0.0168	0.0050	2.22

* Partial year only with data collected in September 2011.

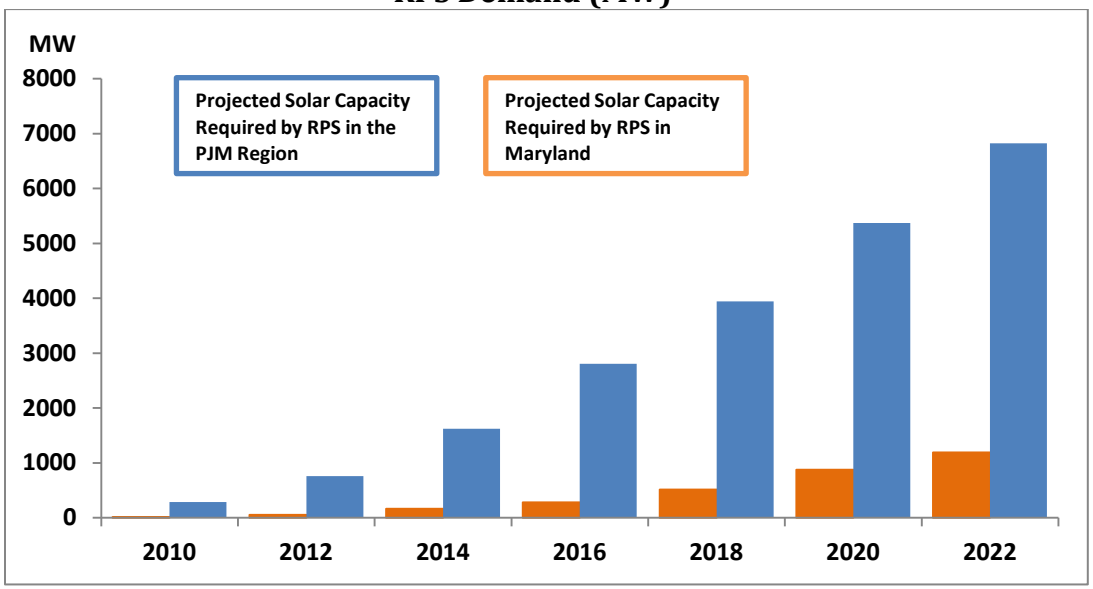
The *2011 Inventory Report* database lists 581 MW of nameplate solar capacity from 17,757 units in the PJM control area. Given a 15 percent capacity factor, these solar units will generate an estimated 764 GWh of energy in 2011.

Figure 4 – Projected PJM and Maryland Solar RPS Requirements (GWh)



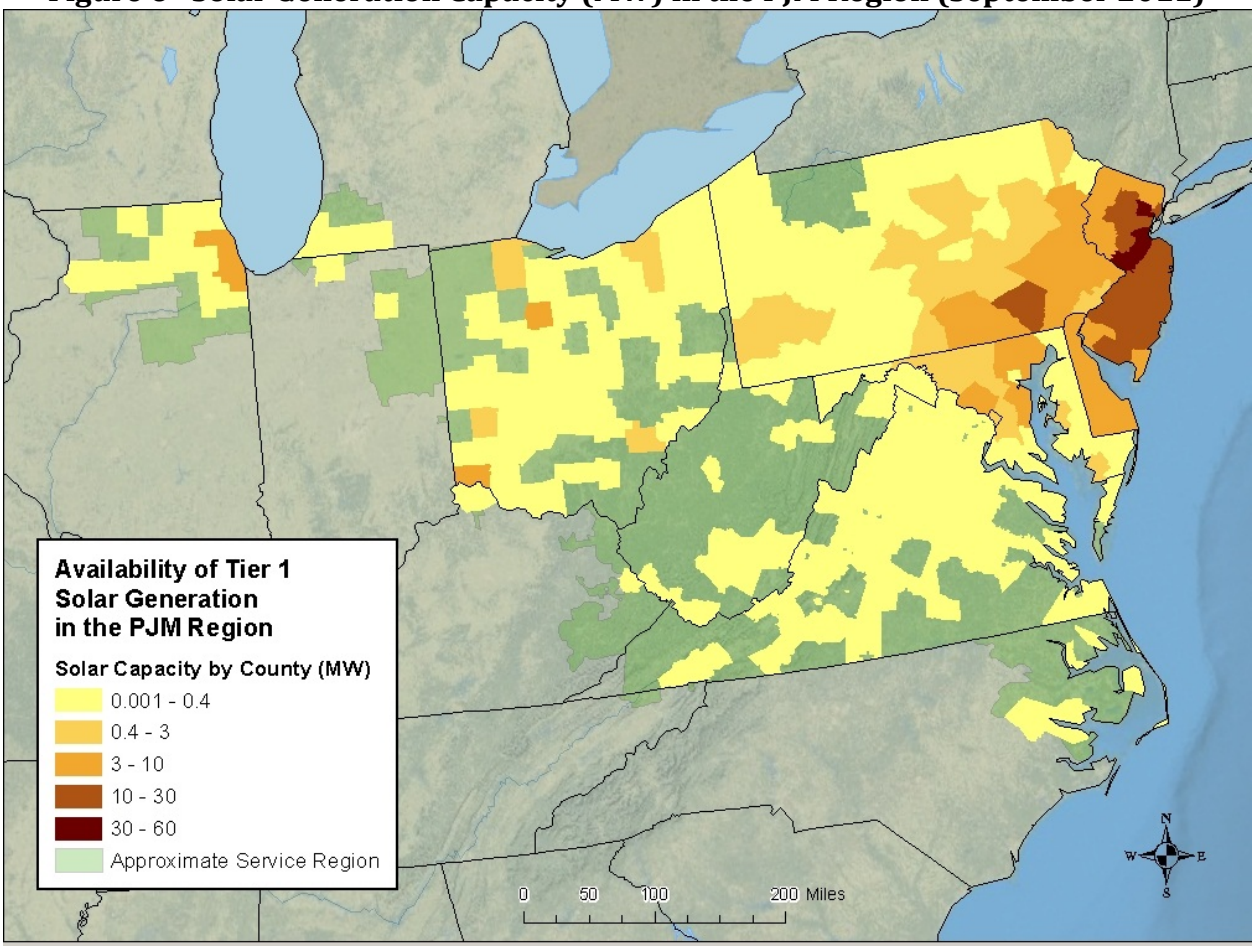
Using the solar capacity factor from Table 10 (i.e., 15 percent), Figure 5 shows the estimated total solar nameplate capacity that would need to be available each year to meet the projected RPS energy requirements. The annual MW capacity increases shown for PJM in Figure 5 translate into an annual average growth rate in installed solar capacity in PJM of about 25 percent between 2010 and 2011. Maryland requires (approximately) an additional 1,300 MW of solar generation capacity to meet its RPS requirement in 2022, which corresponds to an average annual growth rate of about 41 percent.

Figure 5 – PJM and Maryland Installed Solar Nameplate Capacity Required to Meet RPS Demand (MW)



New Jersey dominates the solar energy market in the PJM region and currently accounts for 67 percent of PJM's solar generation. Despite this favorable position, the rapid 25 percent annual growth in solar energy production needed to reach all PJM 2022 solar RPS goals will require the development of nearly 7,000 MW of solar resources. The map below (Figure 6) shows the geographic distribution of solar generation units currently installed in the PJM control area. The data in Figure 6 indicate that the highest concentrations of solar generation are within New Jersey, Delaware, Maryland, and Pennsylvania, and the District of Columbia, with New Jersey displaying the highest concentrations of solar systems.

Figure 6– Solar Generation Capacity (MW) in the PJM Region (September 2011)

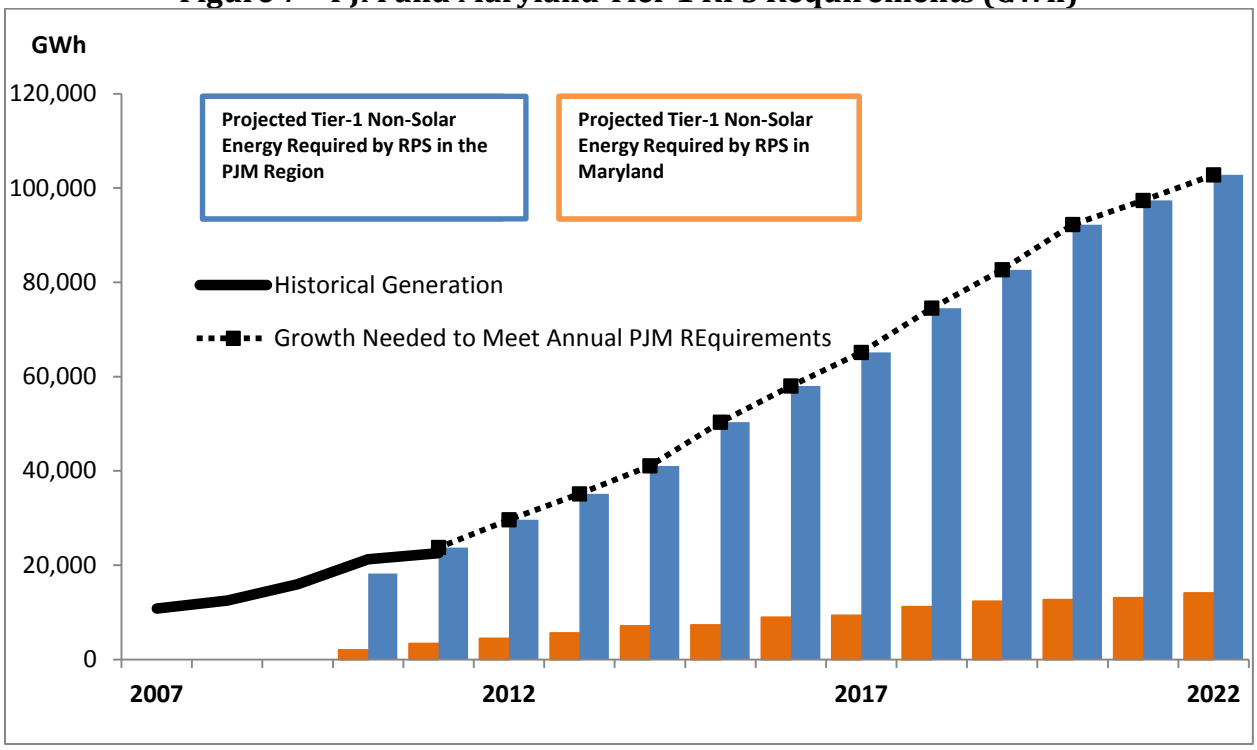


Created September, 2011

C. Projected Tier 1 RPS Requirements in Maryland and the PJM Region

The *2011 Inventory Report* database contains 6,851 MW of nameplate Tier 1 capacity from 261 individual plants. This excludes solar resources, although solar is eligible for meeting Maryland's Tier 1 requirements. However, it is anticipated that the vast majority of Maryland solar installations will be used to meet the solar set-aside, and thus will be unavailable for meeting the remaining Tier 1 requirement. Similarly, it is expected that other states' solar set-aside programs will soak up most of the available solar RECs and therefore are not available to meet non-solar Tier 1 requirements. Tier 1 resources in the PJM control area produced nearly 22,180 GWh of energy in 2011 based on the assumed capacity factors listed in Table 10. Generation of Tier 1 RECs in Maryland is estimated at 1,530 GWh for 2011. Figure 7 provides a projection for Tier 1 RPS requirements for Maryland and the PJM region.

Figure 7 – PJM and Maryland Tier 1 RPS Requirements (GWh)



The Maryland RPS requirement for Tier 1 in 2022 is estimated to be 14,070 GWh. If this were to be met by Maryland-located generators, it would require 22 percent year-over-year growth in eligible resources. However, Tier 1 compliance is not limited to generation in

Maryland. The total PJM Tier 1 RPS requirements in 2022 are estimated at nearly 102,800 GWh. To meet these requirements, eligible generating units within the PJM region will need to increase by approximately 15 percent annually.

This analysis assumes that West Virginia's RPS is aligned with Maryland's Tier 1 requirements. However, it is possible that West Virginia could meet its RPS targets completely through the use of their "alternative fuels" option (i.e., the use of coal wastes and coal-based fuels). West Virginia's Tier 1 requirement is only 6 percent of the total PJM Tier 1 requirement. Therefore, even if West Virginia did fulfill its RPS requirements completely with alternative fuels, the reduction in total PJM Tier 1 requirements (6 percent by 2022) would not have a significant impact on the annual growth needed to meet state RPS policies.

As shown in Figure 8, nearly 60 percent of the 2011 Tier 1 generation in PJM comes from wind, which has an assumed capacity factor of 30 percent. The other 40 percent of Tier 1 generation typically provides more electricity per unit of installed capacity bringing the generation-weighted overall Tier 1 resource capacity factor to 38 percent. Figure 9 shows the total nameplate capacity that would need to be available to meet the RPS Tier 1 requirements assuming that the 38 percent capacity factor remains constant over the period. Over 30,000 GW of Tier 1 resources will be required to meet the RPS requirements of all PJM member states. This is in addition to any Tier 1 solar set-aside requirements.

The 38 percent capacity factor estimate may remain representative of Tier 1 resources as PJM moves towards full RPS compliance. Proposed development in Maryland and Delaware, and a new carve-out in New Jersey, suggest that a significant portion of the needed capacity may be met by offshore wind, which has an assumed capacity factor of 40 percent.

Figure 8 –PJM Renewable Generation Aligned to Maryland Tier 1 (Solar and Non-Solar)

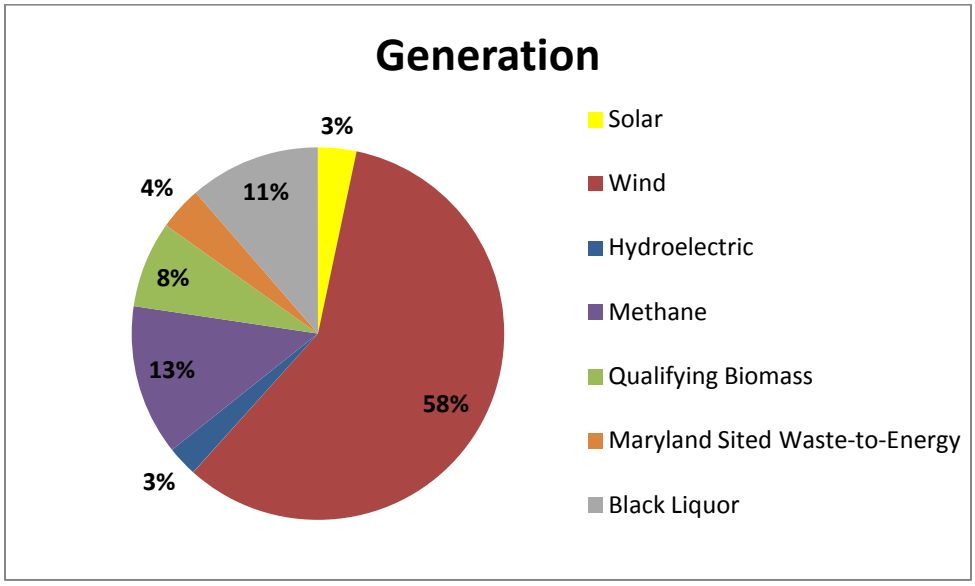
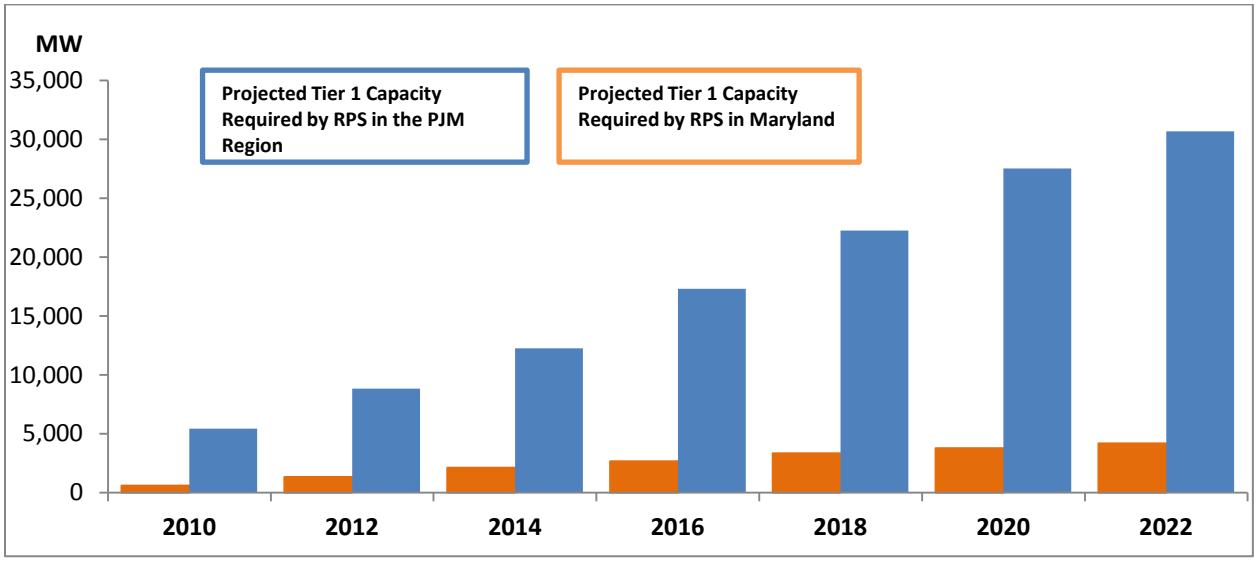


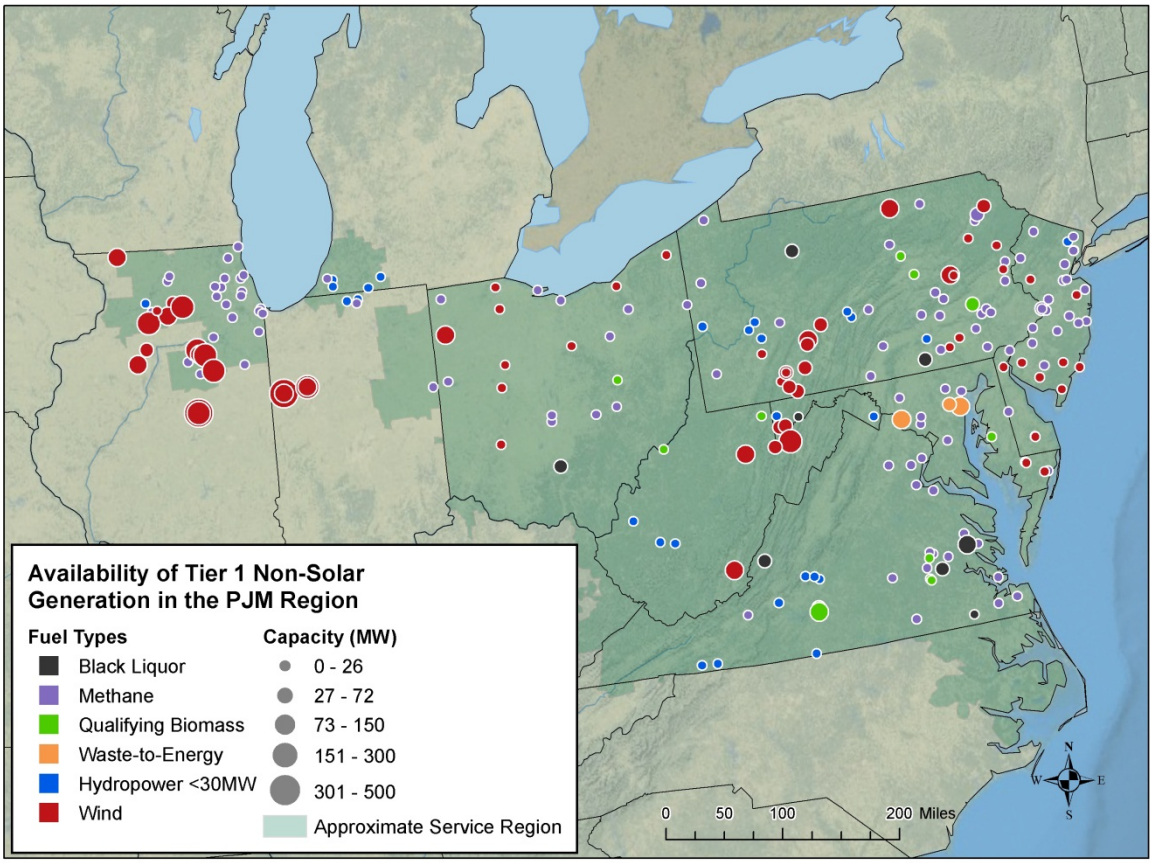
Figure 9 – PJM and Maryland Tier 1 Resources Required to Meet RPS Requirements[27]



[27] Excludes the solar set-aside.

Figure 10 shows the distribution of Tier 1 generation within the PJM control area. As the map demonstrates, there are high concentrations of wind projects in Illinois and Eastern Pennsylvania. New Jersey and Pennsylvania have a high concentration of landfill gas generation capacity.

Figure 10 – PJM Tier 1 Generation Capacity (September 2011)



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D. Projected Tier 2 RPS Requirements in Maryland and the PJM Region

Figure 11 provides an outlook for Tier 2 generation and RPS requirements. The *2011 Inventory Report* database contains 2,587 MW of Tier 2 nameplate capacity from 30 units. Using the capacity factors shown in Table 10 and the MWh estimates from Table 9, Tier 2 resources

will produce approximately 7,900 GWh of energy in 2011. Maryland will produce 1,370 GWh of that energy from one large Tier 2 qualifying hydroelectric facility -- Conowingo (474 MW).[28]

The Tier 2 component of Maryland's RPS requires that 2.5 percent of energy consumption be supplied by Tier 2 resources every year through 2018, after which the requirement expires. The 2.5 percent requirement is approximately 1,877 GWh in 2018, or 10 percent of total PJM control area Tier 2 requirements. Based only on Maryland-qualifying Tier 2 resources, it appears as though the PJM Interconnection faces a Tier 2 deficit of 6,000 GWh in 2011. However, this deficit does not reflect the discrepancies between the Maryland definition of Tier 2 resources and the definition of Tier 2 as defined by law and regulation for other state RPS policies. Pennsylvania's Tier 2 definition, described in greater detail below, allows for a wider variety of resources than the Maryland definition of Tier 2. Therefore, there is a larger pool of resources than what is defined by Maryland's RPS Statute and states do not always compete for the same Tier 2 resources. After considering the difference in State RPS policies it is evident that there will be sufficient Maryland-eligible Tier 2 RECs to meet the Maryland RPS.

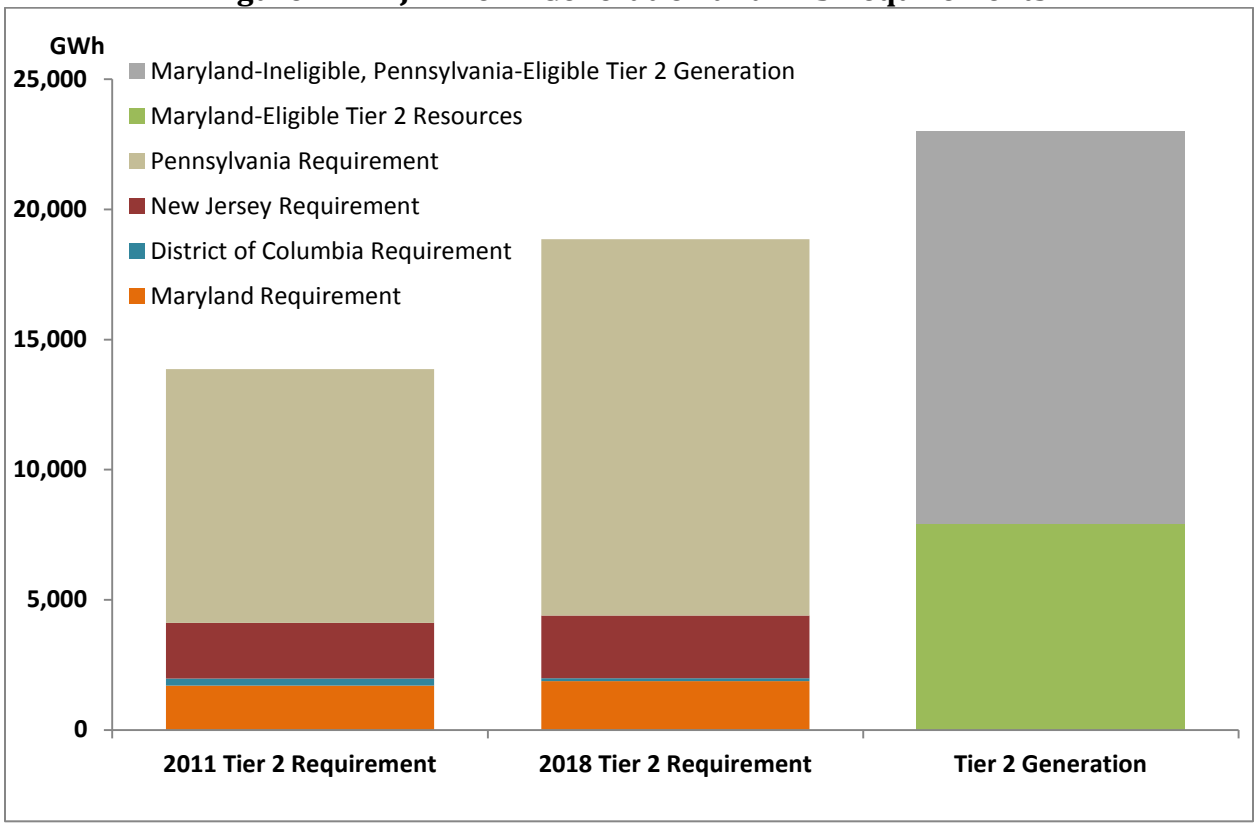
Similar to the manner in which alternative fuel eligibility in the West Virginia RPS potentially overstates PJM demand for Tier 1 resources, the Pennsylvania RPS allows for waste coal and pumped storage hydropower to qualify for Tier 2 compliance. Energy efficiency reductions also qualify. The difference between these two scenarios is that the Pennsylvania Tier 2 requirement constitutes the vast majority of all Tier 2 needs in the PJM region. The Pennsylvania RPS currently requires an estimated 9,749 GWh of Tier 2 production in 2011, or 70 percent of the PJM total. This figure rises to 88 percent of the PJM total in 2022 following Tier 2 sunset provisions in Maryland and other states.

The Pennsylvania facilities ineligible for the Maryland Tier 2 RPS compliance are only certified in GATS as eligible for RPS compliance in Pennsylvania. These 29 facilities total nearly 5,600 MW of capacity, the majority of which is from pumped storage hydropower. The pumped storage facilities listed in the *2011 Inventory Report* database are Bath County (2,400

[28] The listed capacity of the Conowingo Hydropower Plant varies between data sources. See Appendix B for more information.

MW), Muddy Run (800 MW), Seneca (220 MW), and Yards Creek (151 MW). The remaining Pennsylvania Tier 2 eligible capacity is primarily waste coal and energy efficiency. Assuming the pumped storage facilities operate in a generating cycle 20 percent of the time (a 20 percent capacity factor for generation), and waste coal and energy efficiency have 50 percent capacity factors, in 2011 Pennsylvania eligible Tier 2 generation exceeds the needs of all Pennsylvania's RPS requirements. The remaining renewable Tier 2 generation for 2011, eligible as defined by the Maryland RPS, exceeds the needs of all other PJM RPS requirements including Maryland, New Jersey, and the District of Columbia. Figure 11 illustrates this relationship. Therefore, despite the appearance of a shortage of Tier 2 resources, there will be sufficient Tier 2 generation available to meet all PJM Tier 2 requirements, including Maryland's. This is due to the state-to-state variation in how Tier 2 is defined.

Figure 11 – PJM Tier 2 Generation and RPS Requirements



V. Projects in the PJM Queue

The PJM GATS tracks projects that have requested interconnection to the PJM system. Table 13 displays the sum of nameplate capacity of renewable generation projects that were listed in the PJM queue as being under construction or active (meaning requisite studies are being performed for each project) in the years 2011 through 2017. [29] The total capacity of all renewable projects listed in the PJM queue is 6,305 MW (wind power accounts for 80 percent, approximately 5,013 MW of this planned capacity). It is important to note that behind-the-meter projects, such as residential solar panels, are not reflected in the queue. Additionally, not all projects in the queue will come on-line, and not all projects that will ultimately be constructed in the 2011-2017 timeframe are currently listed.

Of those projects listed in the PJM queue, it is expected that only 24 percent will be put into operation.[30] Note that each project listed in the PJM queue has its own probability of being placed in service based on that project's status in the interconnection process. The column labeled "Estimated In-Service" in Table 14 reflects the estimated MW that will go on-line, and reveals that a total of 1,491 MW of additional renewable capacity will be in service by 2017. Applying the capacity factors from Table 10, it is estimated that 3,642 GWh of renewable energy from new projects will be available by 2017. However, PJM will need an additional 45,000 GWh of annual renewable production to meet all Tier 1 requirements by 2022, meaning that many resources not yet in the queue will be needed to reach compliance.

[29] PJM, Generation Queues: Active, http://www.pjm.com/planning/generation-interconnection/generation-queue-active.aspx (accessed September 31, 2011).

[30] This is an aggregate percentage based on historical experience with the PJM Queue. PJM explains: "Commercial probability is based on each project's status in the interconnection queue. Based on experience with the queue since 1999, the commercial probabilities increase throughout the study period and are assigned as below: Feasibility Study 12%, System Impact Study 35%, Facility Study 59%, Interconnection Service Agreement 73%." The 24 percent is a weighted average that reflects the current status of projects in the queue as of September 2011; PJM, Forecasted Reserve Margin, slides, 3, http://www.pjminterconnection.com/planning/resource-adequacy-planning/~/media/planning/res-adeq/res-reports/20110121-forecasted-reserve-margin.ashx.

Table 14 – Nameplate Capacity (MW) of Active Renewable Energy Projects in the PJM Queue

Energy Source	State	2011	2012	2013	2014	2015	2016	2017	Total In Queue	Est. In Service*
Utility Scale Solar	MD	4	59	20				40	123	19
	DE		15	20					35	4
	IL		6	30					36	4
	NJ	107	354	186					647	156
	NC	20							20	7
	OH		51	10					61	12
	PA	4	85		100				189	23
Total		**135**	**570**	**266**	**100**			**40**	**1,111**	**225**
Wind	MD				210				210	25
	DE									0
	IL		189						189	23
	IN			612		1,500			2,112	739
	NJ		52				720		772	97
	NC									0
	OH		150	660		150			960	230
	PA			330	200				530	64
	VA		50						50	6
	WV		150	40					190	32
Total			**591**	**1,642**	**410**	**1,650**	**720**		**5,013**	**1,216**
Tier 1 Hydropower	WV			30					30	4
Total				**30**					**30**	**4**
Methane	MD		2						2	0
	IL		19						19	2
	MI		3						3	0
	OH			6					6	1
	PA		10						10	1
Total			**34**	**6**					**40**	**5**
Biomass	VA			90					90	39
	KY		21						21	3
Total			**21**	**90**					**111**	**42**
Grand Total		**135**	**1,216**	**2,034**	**510**	**1,650**	**720**	**40**	**6,305**	**1,491**

* Note that in-service probability will vary by state and technology depending on the individual projects' status in the interconnection process.

VI. Conclusions

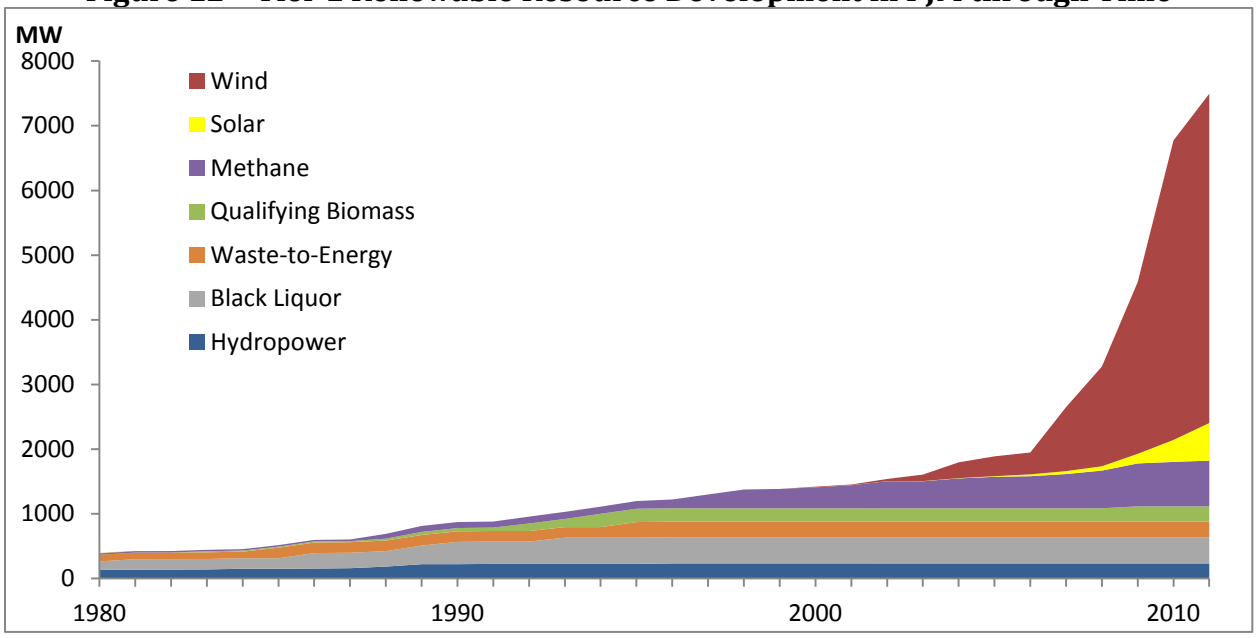
Each of Maryland's RPS categories (i.e., solar set-aside, Tier 1, and Tier 2) has distinct goals and alternative compliance payment schedules when goals are not achieved. Table 15 summarizes Maryland's and the PJM control area's RPS 2011 and 2022 power generation and renewable electric power requirements and provides an estimate of the required average annual growth rates to achieve 2022 RPS goals. As previously discussed, owing to the eligibility of alternative resources in Pennsylvania, there are sufficient resources available within PJM to achieve the Tier 2 renewable targets without significant additional development. Table 15 also lists the growth rate necessary if all Tier 2 resources through PJM were restricted to Maryland eligibility requirements, despite the fact that some stats allow for other resources to qualify as Tier 2, specifically, Pennsylvania, which allows for waste coal and pumped storage hydroelectric, among others.

Table 15 – Summary of RPS Requirements and Generation			
Maryland		**2011 GWh**	**2022 GWh (Projection)**
Energy/RPS Requirements	Total Electric	68,246	78,165
	Solar Set-Aside	34	1,563
	Tier 1	3,378	14,070
	Tier 2	1,706	(sunsets in 2018)
Estimated Generation			**Annual Growth Rate Required To Meet 2022 RPS with In-State Resources**
	Solar Set-Aside	35.9	41%
	Tier 1-Other	1,530	22%
	Tier 2	1,370	4.6%
PJM Region		**2011GWh**	**2022 GWh (Projection)**
Energy/RPS Requirements	Total Electric	824,998	953,917
	Tier 1-Solar	377	8,964
	Tier 1-Other	23,740	102,778
	Tier 2	13,861	20,682
Estimated Generation			**Annual Growth Rate Required To Meet 2022 RPS under Maryland Eligibility**
	Tier 1-Solar	764	25%
	Tier 1-Other	22,180	15%
	Tier 2	7,899	9.1%

Maryland electricity suppliers are able to draw on resources located throughout the PJM region to meet the Tier 1 and Tier 2 renewable requirements.[31] Therefore, renewable energy facilities located throughout the PJM region were accounted for in this inventory and analysis. The solar set-aside energy requirements must be met from solar energy resources located within Maryland.

The RPS requirements in Maryland and the PJM states have begun to have a transformative effect on the electricity mix in PJM. Figure 12 shows the growth of Tier 1 resources from 1980 to 2011. Since the early 2000's, growth has been most rapid in wind and solar resources, though it should be recognized that in the early part of the decade, both wind and solar resources were negligible.

Figure 12 – Tier 1 Renewable Resource Development in PJM through Time



[31] As noted earlier, resources from outside of the PJM footprint are also eligible, but only when the electricity is delivered into the PJM region. Due to the transmission charges that result from wheeling power into the PJM service area, it is unlikely that many renewable resources will come from outside of PJM.

A. Availability of Solar Set-Aside Resources

Maryland's recent solar growth has been substantial, with 1,628 solar systems totaling 27.4 MW of capacity currently installed in the state as reported in GATS as of September 2011. Given a 15 percent capacity factor, these Maryland solar units will generate nearly 36 GWh of renewable energy in 2011. [32] Assuming that the solar RECs generated in Maryland are all made available to Maryland electricity suppliers, Maryland suppliers will meet their 2011 RPS solar set-aside requirement. However, Maryland's solar RPS requirement increases rapidly over time, and in order to meet the 2022 requirement of over 1,500 GWh of solar generation (nearly 71,000 solar installations, assuming the current size distribution of solar projects is maintained) would need to be installed. Regardless of the size of installations, a significant investment is required to meet the Maryland solar RPS targets. In the early years, a high level of growth is likely to occur (as exhibited by recent annual growth rates of over 100 percent) as new projects enter the Maryland market. Maintaining this high level of growth, however, will depend on many factors, including availability of state and federal incentives, the cost of conventional energy, and the cost of solar systems. The recent growth rates in solar installations may be unsustainable, however, without additional incentives.

Maryland faces two challenges to maintaining the level of growth required to meet the solar RPS requirement. First, as discussed above, the current median size of installed projects is relatively small: 16 kW. As noted, it will take a larger quantity of smaller projects to achieve the RPS solar requirement, or, alternatively, a smaller number of larger-sized solar installations. Table 16 summarizes the number of installations that would be required to meet the RPS targets given the current size distribution of solar installations in Maryland. Installing several larger facilities (greater than 500 kW -- the current average for large projects in PJM) would greatly accelerate the rate of growth of installed solar capacity and the associated solar RECs required for RPS compliance. The companies installing large solar installations, however, face financial challenges and the financing of projects typically requires commitments on the part of a credit-worthy third party to purchase the RECs at a favorable price. The difficulties in arranging for

[32] This estimate does not take into consideration that facilities built in 2011 will not generate a full year of solar RECs. Furthermore this estimate does not account for solar installations that may have occurred toward the end of 2011.

financing on the part of project developers could negatively affect the rate at which solar resources can be installed. Given the programmed decline in the solar ACP in Maryland through 2022, developers of utility-scale solar energy projects may be more likely to direct their resources to higher-value markets, for example, New Jersey. Some evidence of this trend may exist in the relative average size of projects between PJM (33 kW) and Maryland (16 kW).

Table 16 – Installed and Projected 2022 Solar Unit Requirements in Maryland			
	Small-Scale	**Mid-Scale**	**Large-Scale**
Maryland			
2010 Units (installed)	1,426	159	43
2022 Units (projected with current power size distribution)	62,013	6,914	1,870

In an effort to support the development of larger solar installations, Maryland has established the Generating Clean Horizons Initiative to provide developers with longer-term electricity sales agreements that will help the financing of larger solar projects. On December 8, 2009, the Governor of Maryland announced that, in partnership with the University System of Maryland, the State was planning to purchase renewable energy from four projects being awarded contracts through the Initiative. The awards, in the form of 20-year power purchase agreements, included a 17.1 MW solar project that Constellation Energy Group built on the Mount St. Mary's University campus near Emmitsburg, Maryland. This facility adds 17.1 MW of in-State solar capacity and will generate approximately 22,300 MWh of electricity annually.[33]

Another program that has helped spur the larger-scale installation is Project Sunburst. The Maryland Energy Administration allocated over $9 million of federal stimulus funding to help offset the cost of systems installed at State and local government facilities. There were 17 projects selected and when the program is completed in early 2012, over 9 MW of new solar will have been installed in the State.

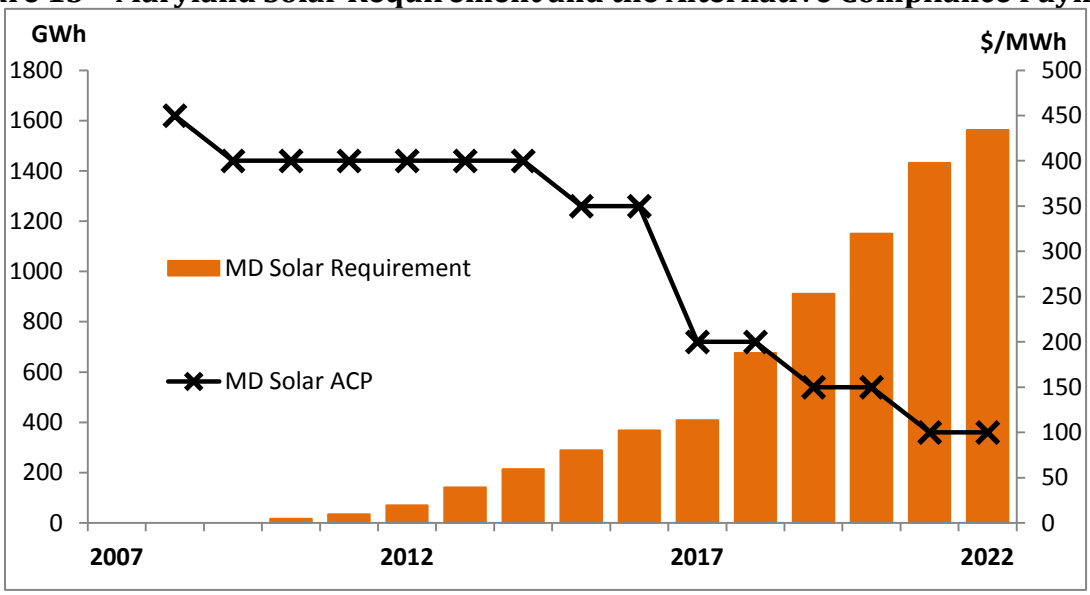
As indicated above, the second challenge facing Maryland suppliers and policy makers as they strive to achieve the solar RPS target is Maryland's declining solar ACP which may increase

[33] The estimated output from Constellation's solar facility is based on the Company estimate and is higher than the 15 percent capacity factor used in this analysis for projecting output from solar facilities. This higher capacity factor is related to the efficiencies associated with a larger project.

economic risks to project developers. Solar installations are likely to move ahead, however, as awareness of renewable energy increases and small-scale developers become more competitive in the Maryland market, offering lower prices and better services. The recent introduction of solar leasing for residential properties in Maryland provides an alternative for customers who might otherwise not be able to afford the upfront costs of a solar system. Notwithstanding these factors, there will be significant challenges to developing solar energy facilities of the number and size required to meet the RPS.

Structurally, the Maryland RPS lowers the ACP while increasing the solar set-aside requirement. Between 2016 and 2020, the ACP drops from $350 to $150 per solar REC while the projected solar energy requirement triples from approximately 360 to over 1,100 GWh per year. To date, Maryland has developed annual solar generation capability of 36 GWh per year under a $400 ACP— any reduction in federal incentives (production or investment tax credits) or a lack of major sustained reductions in solar facility costs may leave future Maryland solar ACP's too low to stimulate the development of solar resources to meet the RPS solar requirements. Figure 13 demonstrates the decline in solar ACP and the increases in the solar set-aside requirements.

Figure 13 – Maryland Solar Requirement and the Alternative Compliance Payment



B. Availability of Tier 1 Resources

Table 17 summarizes the availability of, and requirements for, Tier 1 renewable resources within Maryland and the PJM region. Based on available data, there appears to be sufficient installed renewable energy to meet the 2011 RPS requirements for the PJM region; however, Maryland's contribution to the availability of Tier 1 renewable resources within the region falls well below its RPS requirement and is still slightly lower than its share of the PJM market.

Table 17 – 2011 Availability and Requirements of Tier 1 Renewable Resources

	Maryland		PJM	
	GWh	PJM Market Share (%)	GWh	PJM Market Share (%)
Estimated Electricity Generation (2011)	68,246	8.27%	824,998	100%
Estimated Tier 1 Generation (2011)	1,530	6.90%	22,180	100%
Estimated Tier 1 Requirement (2011)	3,378	14.23%	23,740	100%

According to market reports, the price for Maryland Tier 1 RECs has historically been inexpensive, generally varying between $0.75 and $1.50, well below the ACP of $40. This substantial difference is due to the abundance of RECs eligible to meet the Maryland requirement.

Increased Tier 1 RPS requirements will place upward pressure on the market value of Maryland Tier 1 RECs in 2011 and subsequent years. Additionally, the new Ohio in-State RPS restriction may reduce the availability of Ohio resources for purchase by Maryland utilities for compliance. However, there are also a number of downward market pressures including the addition of waste-to-energy eligibility which added substantial new in-State Tier 1 resources and the development of new PJM renewable energy projects. With the sustained Tier 1 growth seen in the past five years, Maryland electricity suppliers will continue to find sufficient resources to meet the Tier 1 RPS requirements.

C. Availability of Tier 2 Resources

The *2011 Inventory Report* database identifies 30 Tier 2 facilities with 2,587 MW of nameplate capacity. These will produce approximately 7,900 GWh of energy in 2011. Additionally, 5,600 GW of Tier 2 resources that are ineligible in Maryland will produce an estimated 15,100 GWh that can be used to meet the Pennsylvania RPS that constitutes 70 percent of the Tier 2 requirement for 2011. Maryland's 2018 (the final year prior to the sunset) Tier 2 RPS requirement is about 1,877 GWh, only 10 percent of the PJM total requirement of approximately 18,850 GWh. In light of alternative resource eligibility in Pennsylvania, no new Tier 2 development is necessary.

Appendix A – Overview of State Renewable Portfolio Standards

To add context to the Maryland and PJM state RPS policies, Table A-1 displays all of the states with such standards, the dates by which their requirements must be met, and the dates the standards were enacted (or updated). It is important to note that each state with an RPS defines qualifying renewable energy differently, usually by a class or a tier system. For more information on a particular state's RPS, visit the Database of State Incentives for Renewables & Efficiency at www.DSIREUSA.org.

Table A-1 – Summary of State RPS Policies

State	Renewable Energy Requirements	Year by Which Requirements Shall be Met	Date Enacted (or Updated)
Arizona	15% overall	2025	2001 (2005, 2006)
California	20% by 2013 25% by 2016 33% by 2020	2013, 2016, 2020	2002 (2003, 2006, 2009, 2010, 2011)
Colorado	10% from electric cooperatives and municipal utilities serving over 40,000 customers 30% from investor-owned utilities	2020	2004 (2006, 2010)
Connecticut	Class I: 20% by 2020 Class I or Class II: 3% by 2010 Class III: 4% by 2010	2020	1998 (2007, 2011)
Delaware	25% overall 3.5% solar PV minimum	2025-2026	2005 (2007, 2011)
District of Columbia	20% overall 2.5% solar	2020 2023	2005 (2008, 2011)
Hawaii	40% overall	2030	2004 (2009)
Illinois	25% overall 18.75% wind minimum (utilities) 15% wind minimum (alternative suppliers) 1.5% solar PV minimum	2025-2026	2007 (2009, 2010, 2011)
Indiana*	10% of participating utility sales	2025	
Iowa	105 MW		1983 (1991,2003)
Kansas	20% peak demand	2020	2009 (2010)
Maine	40% overall 10% from Class I (new resources)	2017	1999 (2006, 2007, 2009, 2011)
Maryland	20% overall Solar-electric 2%	2022	2004 (2007,2008, 2010, 2011)
Massachusetts	Class I: 15%, with 1% each following year Class II: 7.1% in 2009	2020	1997 (2009, 2011)
Michigan	10% overall	2015	2008
Minnesota	25% overall	2025	2007 (2009)

State	Renewable Energy Requirements	Year by Which Requirements Shall be Met	Date Enacted (or Updated)
Missouri	15% overall Solar-electric 0.3%	2021	2008 (2010)
Montana	15% overall	2015	2005
New Hampshire	23.8% overall 0.3% solar by 2014	2025	2007 (2008)
New Jersey	22.5% overall 5,316 GWh solar-electric by 2026 1,100 MW of offshore wind	2020-2021	1999 (2005, 2010, 2011)
New Mexico	Investor-owned utilities: 20% overall by 2020 4% solar minimum Rural electric cooperatives: 10% overall by 2020	2020	2002 (2007)
New York	29% overall .4788% minimum customer-sited facilities	2015	2004 (2005, 2010)
Nevada	25% overall 1.5% solar by 2016	2025	1997 (2001, 2009)
North Carolina	12.5% overall investor-owned utilities Solar: 0.2% by 2018 Cooperatives, municipals: 10% by 2018	2021	2007 (2008, 2009, 2010, 2011)
North Dakota*	10% overall	2015	2007
Ohio	25% alternative energy 12.5% renewable by 2024 0.05% solar by 2024	2025	2008 (2009, 2010)
Oklahoma*	15% overall	2015	2010
Oregon	Large utilities (more than 3% of the State's load): 25% overall; solar: 20 MW sized 500 kW to 5MW by 2020 Small utilities (between 1.5% and 3.0% of the State's load): 10% overall Smallest utilities (less than 1.5% of the State's load): 5% overall	2025	2007 (2008, 2010)
Pennsylvania	18% overall 0.5% solar	2020-2021	2004 (2007, 2009)
Rhode Island	16% overall 90 MW by 2014, of which 3 MW must be solar	2019	2004 (2009)
South Dakota*	10% overall	2015	2008 (2009)
Texas	5,880 MW by 2015 10,000 MW by 2025 goal	2015; 2025	1999 (2005)
Utah*	20% overall	2025	2008 (2010)
Vermont*	20% overall 25% consumed by 2025	2017	2006 (2008, 2010)
Virginia*	15% of base year (2007) sales	2025	2007 (2010)
Washington	15% overall	2020	2006
West Virginia*	25% alternative and renewable energy	2025	2009
Wisconsin	10% overall	2015	2001 (2006, 2010, 2011)

* Denotes states with voluntary renewable portfolio goals.
** State's class or tier system may differ from other state tiers.

A. Renewable Portfolio Standards in the PJM Region

PJM is the regional transmission organization (RTO) that serves Maryland, Delaware, Illinois, Indiana, Kentucky, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia.[1] FigureA-1 illustrates the PJM service region.

Figure A-1 –PJM Service Region (Effective January 1, 2012)

Created October, 2011

Twelve of the fourteen states served wholly or in part by the PJM interconnection have RPS requirements or goals. New Jersey has one of the most aggressive standards requiring 22.5 percent of the State's electricity sales to come from qualifying renewable energy sources for the 2020–2021 compliance year (June 2020–May 2021). In January 2010, New Jersey further

[1]PJM, Territory Served, http://www.pjm.com/about-pjm/how-we-operate/territory-served.aspx.

amended its standard by setting specific GWh solar energy carve-outs. Beginning in 2011, providers and suppliers must procure 306 GWh of RECs from in-State solar electric generators, going up to 5,316 GWh by 2026.[2] New Jersey also has a carve-out provision (in percentage terms) suitable to develop 1,100 MW of offshore wind capacity.

Illinois set another aggressive goal by requiring that 25 percent of the State's electricity sales come from renewable sources by 2025. The Illinois RPS also includes a provision that solar PV must make up 1.5 percent and wind 75 percent of the 2025 requirement and requires utilities serving over 100,000 customers to comply with its renewable energy requirements. The two utilities that meet this threshold are Commonwealth Edison and Ameren Corporation. In addition, alternative energy retail electric providers in Illinois that sell outside of their service territories must comply with the law. Municipal and cooperative utilities are currently exempt from the Illinois RPS.[3]

North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard requires that by 2021 investor-owned utilities must supply 12.5 percent of 2020 retail electricity sales from qualifying energy sources, including sub-requirements of 900 GWh from poultry waste by 2014, as well as 0.2 percent from solar and 0.2 percent from swine waste by 2018. Electric cooperatives and municipal utilities must meet only a 10 percent overall requirement by 2018.[4]

Michigan's RPS, passed in 2008, requires that investor-owned utilities, electric cooperatives, municipal utilities, and alternative retail suppliers generate 10 percent of their retail electricity from renewable energy sources by 2015.[5] The compliance period for this requirement begins in 2012 with the utility needing to meet 20 percent of the ultimate goal that year. The

[2]Database of State Incentives for Renewables & Efficiency, New Jersey Incentives/Policies for Renewable Energy: Renewables Portfolio Standard, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ05R&re=1&ee=0.
[3]Database of State Incentives for Renewables & Efficiency, Illinois Incentives/Policies for Renewable Energy: Renewables Portfolio Standard, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=IL04R&re=1&ee=0.
[4] Database of State Incentives for Renewables & Efficiency, North Carolina Incentives/Policies for Renewable Energy: Renewable Energy and Energy Efficiency Portfolio Standard, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC09R&re=1&ee=0.
[5] Database of State Incentives for Renewables & Efficiency, Michigan Incentives/Policies for Renewable Energy: Renewables Portfolio Standard, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MI16R&re=1&ee=0.

requirement increases to 33 percent, 50 percent, and 100 percent in the following three years. Detroit Edison and Consumers Energy have specific thresholds: 300 MW by 2013 and 600 MW by 2015, and 200 MW by 2013 and 500 MW by 2015, respectively.

Ohio's RPS requires that all utilities except for cooperatives and municipal utilities must supply 25 percent of their retail electricity from alternative energy sources by 2025. Starting in 2009, there are sub-requirements for both the overall renewable energy and solar energy categories. For 2024 and onward, the sub-requirements are 12.5 percent for all renewable energy and 0.5 percent for solar.[6]

West Virginia's alternative energy standard is similar to Ohio's; however, the list of acceptable resources is not limited to only renewable resources as the standard allows for "clean" fossil fuel-based generation as well. The standard requires that utilities serving over 30,000 retail customers supply 10 percent of their sales from alternative sources by 2015, with further requirements of 15 percent by 2020 and the full 25 percent by 2025. The standard does not set specific benchmarks pertaining to the amount of renewable energy that must compose the 10-, 15-, or 25-percent requirements. Thus, it is possible that a utility can meet the requirements by generating electricity from alternative sources (e.g., coal bed methane, synthetic gas), but not necessarily renewable sources. Table A-2 lists all of the renewable and alternative sources that qualify under West Virginia's standard.[7]

Virginia's renewable energy portfolio goal sets voluntary targets that can be met by the State's electric utilities. The voluntary target asks that 4 percent of 2007's electric sales be met by renewable energy sources by 2010. The percentage increases to 7 percent in 2016, 12 percent in 2022, and 15 percent in 2025. Land-based wind and solar receive double credit under the goal, whereas offshore wind receives triple credit.[8] As of September 2011, both major Virginia

[6] Database of State Incentives for Renewables & Efficiency, Ohio Incentives/Policies for Renewable Energy: Alternative Energy Resource Standard, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=OH14R&re=1&ee=0.
[7] Database of State Incentives for Renewables & Efficiency, West Virginia Incentives/Policies for Renewable Energy: Alternative and Renewable Energy Portfolio Standard, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=WV05R&re=1&ee=0.
[8] Database of State Incentives for Renewables & Efficiency, Virginia Incentives/Policies for Renewable Energy: Voluntary Renewable Energy Portfolio Goal,

utilities, Dominion Virginia Power and Appalachian Power have claimed to meet their 2010 voluntary goals.[9]

Finally, similar to Virginia, Indiana established a voluntary renewables goal in 2011. This "Clean Energy Portfolio Standard" sets a target of 10 percent alternative energy production by 2025. In addition to renewable electric energy and solar heating, coal bed methane and new nuclear generation also are eligible for voluntary compliance.

http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=VA10R&re=1&ee=0.

[9] Commonwealth of Virginia State Corporation Commission, "Status Report: Implementation of the Electric Utility Regulation Act (September 1, 2011)", http://www.scc.virginia.gov/comm/reports/2011_veur.pdf.

Table A-2 – Overview of RPS Requirements of States & Territories in the PJM Interconnection Region

State	Qualifying Facilities	Requirements	Geographic Footprint	ACPs
Delaware	Solar electric, heating, and cooling that offsets electricity; wind; ocean tidal; ocean thermal; fuel cells powered by renewable fuels; hydroelectric facilities with a maximum capacity of 30 megawatts (MW); sustainable biomass; anaerobic digestion; and landfill gas.	25% overall by June. 2026; solar PV – 3.5% by 2026.	A generation unit must (1) be in the PJM region or located outside the PJM region with the ability to import into the PJM region, and (2) be tracked through the PJM market settlement system.	$25/MWh shortfall. The payment increases in subsequent years for suppliers who elect to pay it. After the first year that suppliers pay the ACP, the payment increases to $50/MWh. After the second year, it increases to $80/MWh. For solar power, the shortfall begins at $400/MWh and increases $50/MWh for every year the ACP is elected up to a maximum of $500/MWh.
District of Columbia	Tier 1 – Solar water heat, space heat, space cooling,, thermal electric, thermal process heat, or PV; landfill gas; wind; biomass; geothermal electric; fuel cells; cofiring; tidal energy; wave energy; and ocean thermal. Tier 2 – Hydroelectric (other than pumped storage) and, municipal solid waste.	20% overall by 2020. 2.5% solar by 2023. Tier 1 – Starting at 1.5% in 2007, increasing to 20% by 2020 (solar – 0.4% by 2020). Tier 2 – Starting at 2.5% in 2007 and sunsets at 0% in 2020.	Must be located (1) in the PJM region, or (2) in a state that is adjacent to the PJM region, or (3) outside the PJM region in a control area that is adjacent to the PJM region if the electricity from either is delivered into the PJM region.	For compliance years 2009 to 2018: Tier 1 – $50/MWh Tier 2 – $10/MWh Solar – Varies by year between $500/MWh from 2011 to 2016 and eventually drops to $50/MWh in 2023.
Illinois	Solar thermal (heat or electricity), PV; landfill gas; wind; biomass; hydroelectric; biodiesel; waste heat, anaerobic digestion.	2% by June 1, 2008, increasing to 25% by June 1, 2025 (1.5% solar PV and 75% wind).	For investor-owned utilities, resources must come from within state through 2011. After that, resources can come from Illinois or adjoining states.	For compliance year June 2011 – May 2012, the estimated ACP for load serving entities in the Ameren territory is $0.0583/MWh and $0.0568/MWh for those in the ComEd territory. ACP beyond 2012 has not yet been established.

State	Qualifying Facilities	Requirements	Geographic Footprint	ACPs
Indiana	Solar electric and heating, wind, qualifying biomass, hydroelectric, geothermal electric, heating, and direct uses, fuel cells, hydrogen, nuclear, coal bed methane	2013-2018: 4%. 2019-2024: 7%. 2025: 10%.	Half of qualifying clean energy generation must be produced in-state.	No ACP. The program is voluntary.
Kentucky	**No RPS**			
Maryland (effective January 1, 2012)	Tier 1 – Solar electric and solar water heating, wind, qualifying biomass[43] (excluding sawdust), methane from the anaerobic decomposition of organic materials in a landfill or a wastewater treatment plant, geothermal, ocean (including energy from waves, tides, currents, and thermal differences), fuel cells powered by methane or biomass, small hydroelectric plants (systems less than 30 megawatts in capacity and on dams constructed before January 1, 2004), and waste-to-energy facilities connected to the Maryland distribution grid. Tier 2 - Hydroelectric power other than pump-storage generation, and waste-to-energy facilities.	Tier 1 – Starting at 1% in 2006, increasing to 20% in 2022 (of which solar portion is 2.0% by 2022). Tier 2 – Starting at 2.5% in 2006 and sunsets to 0% at the end of 2018.	Renewable energy generation must be located (1) in the PJM region only, or (2) in a control area that is adjacent to the PJM region if the electricity is delivered into the PJM region. Tier 1 waste-to-energy must be connected to the distribution grid. Solar energy must be connected to the distribution grid.	Tier 1 – $40/MWh for non-solar shortfalls (raised from $20/MWh by H.B. 375). Tier 2 – $15/MWh. Solar – $400/MWh in 2009 through 2014. Declines to $350/MWh for 2015-2016, and then continues to decline bi-annually until it reaches $50/MWh in 2023 and beyond. $8/MWh for Tier 1 shortfalls for industrial process load in 2006-2008, $5/MWh in 2009/10, $4/MWh in 2011/12, $3/MWh in 2013/14, $2.5/MWh in 2015/16, and $2/MWh in 2017 and later; no fee for Tier 2 shortfalls for industrial process load.

[43] Qualifying biomass means a non-hazardous, organic material that is available on a renewable or recurring basis, is waste material that is segregated from inorganic waste material, and is derived from:

1. Except for old-growth timber, any of the following forest-related resources: (a) mill residue, except sawdust and wood shavings; (b) pre-commercial soft wood thinning; (c) slash, brush, or yard waste ; and (d) pallets, crates, or dunnage
2. Agricultural and silvicultural sources, including tree crops, vineyard materials, grain, legumes, sugar, and other crop byproducts or residues
3. Gas produced from the anaerobic decomposition of animal waste or poultry waste
4. A plant that is cultivated exclusively for purposes of being used as a Tier 1 renewable source or a Tier 2 renewable source to produce electricity.

State	Qualifying Facilities	Requirements	Geographic Footprint	ACPs
Michigan	Solar thermal electric or PV, landfill gas, wind, biomass, hydroelectric, geothermal electric, municipal solid waste, CHP/cogeneration, coal-fired with carbon capture and sequestration, gasification, anaerobic digestion, tidal energy, and wave energy.	2% by 2012. 10% by 2015.	Electricity must be generated in Michigan or outside the state in the retail electric customer service territory of any provider that is not an alternative electric supplier.	No ACP.
New Jersey	Class I – Solar energy, wind energy, wave or tidal action, geothermal energy, landfill gas, anaerobic digestion, fuel cells using renewable fuels, and certain other forms of sustainable biomass (requires Department of Environmental Protection Authorization). Class II – Hydropower facilities no greater than 30MW and resource-recovery facilities located in New Jersey and approved by the Department of Environmental Protection.	Class I – Starting at 0.74% in 2004, increasing to 17.88% in 2020. Class II – 2.5% through 2020. Solar-specific carve-out: 306 GWh beginning in 2011, increasing to 5,316 by 2026. Offshore wind specific carve-out: percentage necessary to ensure the development of 1,100 MW.	Electricity must be generated within or delivered into the PJM region. For both Class I and II facilities, renewable energy delivered into the PJM region must be generated at a facility that was constructed after January 1, 2003.	$50/MWh for non-solar. Solar Alternative Compliance Payment increases annually as follows: 2008-2009: $711 per MWh 2009-2010: $693 per MWh 2010-2011: $675 per MWh 2011-2012 :$658 per MWh 2012-2013: $641 per MWh 2013-2014: $625 per MWh 2014-2015: $609 per MWh 2015-2016: $594 per MWh Under recently passed legislation (A.B. 3520), the Board of Public Utilities is required to extend this up to 15 years (the previous requirement was 8 years).

State	Qualifying Facilities	Requirements	Geographic Footprint	ACPs
North Carolina	Solar electric or thermal, wind, hydropower up to 10 megawatts (MW), ocean current or wave energy, biomass (agricultural waste, animal waste, wood waste, spent pulping liquors, combustible residues, combustible liquids, combustible gases, energy crops, landfill methane, waste heat derived from a renewable energy resource) that uses Best Available Control Technology (BACT) for air emissions, landfill gas, combined heat and power (CHP) using waste heat from renewables, hydrogen derived from renewables, demand-side management.	For investor-owned utilities starting in 2010, 0.02% from solar, increasing to 3% overall in 2012 and to 12.5% in 2021 (with 0.2% from solar, 0.2% from swine waste, and 900,000 MWh from poultry waste). Municipal utilities and electric cooperatives only have to meet an overall goal of 10% by 2018.	Utilities may use unbundled RECs from out-of-state renewable energy facilities to meet up to 25% of the portfolio standard.	No ACP.
Ohio	Solar thermal electric or PV, landfill gas, wind, biomass, hydroelectric, geothermal electric, fuel cells, municipal solid waste, waste heat, energy storage, clean coal, advanced nuclear, anaerobic digestion, and microturbines.	25% alternative energy by 2025 (renewable energy starting at 0.25% in 2009 to 12.5% and 0.5% solar electric by 2024).	At least 50% of the renewable energy requirement must be met by in-state facilities, and the remaining 50% with resources that can be shown to be deliverable into the state.	$45/MWh for non-solar. This will be adjusted annually by the Public Utilities Commission of Ohio, but can never be below $45/MWh. Solar Alternative Compliance Payment is $450/MWh in 2009, decreasing bi-annually to a minimum of $50/MWh in 2024.

State	Qualifying Facilities	Requirements	Geographic Footprint	ACPs
Pennsylvania	Tier 1 – Solar thermal or PV, wind, low-impact hydroelectric, geothermal, biomass, biologically-derived methane gas, coalmine methane, and fuel cells. Tier 2 – Waste coal, distributed generation systems, demand-side management, large-scale hydroelectric, municipal solid waste, wood pulping and manufacturing byproducts, and integrated gasification combined cycle coal technology.	Tier 1 - For compliance year 2006-2007, 1.5% (0.0013% from solar PV), increasing to 8% (0.5% from solar PV) for compliance year 2020-2021. Tier 2 – For compliance year 2006-2007, 4.2%, increasing to 10% for compliance year 2020-2021.	Eligible resources must originate within Pennsylvania or within the PJM region in order to be counted for compliance. Out of state resources located in the Midwest Independent System Operator (MISO) territory that serves parts of Pennsylvania are also eligible.	$45/MWh for non-solar. For solar PV, the ACP is valued at 200 percent of the average price of solar renewable energy credits sold during the reporting period.
Tennessee	**No RPS**			
Virginia	Solar thermal electric or PV, landfill gas, wind, biomass, hydroelectric, geothermal electric, energy from waste, anaerobic digestion, tidal energy, and wave energy.	From 4% of base year sales in 2010 to 15% of base year sales in 2025.	Electricity must be generated or purchased in Virginia or in the PJM region.	Voluntary goals, no ACP.
West Virginia	Solar thermal electric or PV, landfill gas, wind, biomass, hydroelectric, geothermal electric, fuel cells, municipal solid waste, other non-renewable alternative energy resources (coal technology, coal bed methane, natural gas, fuel produced by a coal gasification or liquefaction facility, synthetic gas, integrated gasification combined cycle technologies, waste coal, tire-derived fuel, pumped storage. hydroelectric projects, and recycled energy), anaerobic digestion, small hydroelectric, biodiesel.	From 10% in 2015 to 25% by January 1, 2025.	Alternative and renewable resources must be generated or purchased from a facility in West Virginia or in the PJM region.	No ACP.

Appendix B – Methodology

A. Data Collection and Sources

The primary source of data for this report was the PJM Generator Attribute Tracking System (GATS) database, made available through PJM Environmental Information Services. PJM-EIS developed GATS in response to the needs of state regulatory commissions, other state agencies, and market participants for a single, regional, integrated system to implement state-imposed fuel mix and emissions disclosure requirements and RPS.[1] GATS is structured as: (1) a master database of all of the generators located within, or registered to sell electricity into, the PJM region; and (2) a subset database of renewable generators located within, or registered to sell electricity into, the PJM region. The data collected for this updated *2011 Inventory Report* were sourced from the renewable generators database, accessed on September 1, 2011. The information listed in Table B-1 was obtained from the PJM GATS system for each generator.

Table B-1 – Data Gathered from PJM GATS Database

Data Field	Description
Plant Name	Facility name
Unit Name	Name of generator unit
ORISPL (Plant Code)	EIA plant code (if available)
GATS Unit ID	GATS System ID code
State	State location
County	County location
Location	PJM Control Area
Nameplate	Nameplate capacity (MW)
Date Online	Date unit began production
Primary through eighth fuel type	Fuel/energy source
RPS Eligible	Energy certificate numbers by state and fuel type

PJM GATS, however, does not contain all of the data elements needed for this updated inventory. Therefore, GATS data were supplemented, as needed, with data collected by the United States Energy Information Administration (EIA). Specifically, parameters provided in the plant and generator-level databases from EIA Form 860 were used to augment the information obtained from the PJM GATS database. The EIA-860 is a generator-level data file that includes specific information about generators and electric power plants owned and operated by electric utilities and non-utilities (including independent power producers, combined heat and power producers, and other industrials). The file contains generator-specific information such as initial date of commercial operation, prime movers, generating capacity,

[1]PJM, EIS, http://www.pjm-eis.com/gats/about-gats.html.

energy sources, status of existing and proposed generators, proposed changes to existing generators, county and state location (including power plant address), ownership, and Federal Energy Regulatory Commission (FERC) Qualifying Facility status.[2] The data available in EIA-860 were through 2009. Table B-2 details the information that was taken from the EIA-860 database to supplement the PJM GATS data.

Finally, to complete the updated inventory data set, information detailing net electric generation from facilities with an EIA code was obtained from the EIA 920 and 923 databases, which include monthly and annual data on generation and fuel consumption at power plants. The 920 and 923 forms provided data for 2006 and 2007, 2008, 2009, and preliminary data for 2010.

Table B-2 – Data Obtained from EIA 860 Database

Data Field	Description
EIA Plant Code	Unique identification number
Street Address	Street address of facility
Mail City	City address of facility
Zip Code	5-digit zip code of facility
EIA operating Status	Status according to EIA (Operating, Retired, Stand by)

B. Data Collection and Compilation

Renewable facilities in the PJM region were identified using the fuel type provided in the PJM GATS database. Multifuel plants were classified by the first listed qualifying fuel. The information in Table B-1 and Table B-2 was integrated into the overall *2011 Inventory Report* database. The data in the inventory were cross checked against the EIA 860, 920, and 923 data using the EIA plant code if provided by the PJM GATS database.

C. Data Challenges and Resolution

The September 1, 2011, PJM GATS renewable database provides information on 18,744 generators. Some of these listings represent multiple generation units located at a single plant, others are duplicate entries. Of these entries, 211 are outside the PJM Control Area (and, for purposes of this report, are considered ineligible for the Maryland RPS), 23 were duplicates, and another 370 demonstrated no generation from Maryland-eligible resources. The remaining

[2] Energy Information Administration, Electricity: Form EIA-860 Data Files, http://www.eia.doe.gov/cneaf/electricity/page/eia860.html.

entries were aggregated by EIA facilities code (when available), reducing the total number of unique facilities to 18,018. There are 17,757 solar facilities (including one solar water heating system),[3] 261 Tier 1 Non-Solar, and 30 Tier 2 facilities. The vast majority are listed as being smaller than 1 MW of capacity, and thus do not have associated EIA codes because they are smaller than EIA's 1 MW reporting cutoff. Despite the lack of information on these facilities from EIA, the PJM GATS database still provides information on the nameplate capacity and county location of these facilities.

For facilities larger than 1 MW without a listed EIA number, manual searches through the EIA databases were conducted based on common data in both the EIA and PJM databases, such as county and state. Facility names in the PJM and EIA databases differ for some of the facilities, which presented a challenge in determining if a facility has an EIA code. This was resolved by comparing data such as location and start-up dates to determine if a facility was in both the EIA and PJM databases.

The September 1, 2011, PJM GATS renewable database "Fuel Type" field provides the basis for determining the number of plants and total capacity available to satisfy the RPS requirements within the PJM region. Maryland's RPS requirement differs slightly from other states. This report aligns the PJM renewable plants to meet Maryland's requirements. The alignment criteria have the following conditions:

1. Plants must be in the PJM Control Area.
2. Solar thermal heating units must be commissioned after June 1, 2011.
3. Waste-to-energy facilities sited in Maryland are assumed to be connected to the distribution grid, and are therefore eligible for Tier 1 compliance.
4. Other biomass gas fuels were listed with LFG plants. .
5. Other biomass liquid and solids were listed as qualifying biomass in addition to wood solids.
6. Natural gas and residual fuel oil (includes No. 5 and No. 6 fuel oils and bunker C fuel oil) plants were excluded.
7. Two fuel cells utilizing renewable energy were categorized as LFG. These fuel cells represent less than 100 kW of capacity.

[3] The Maryland solar set-aside requirements limit eligibility to only those solar hot water systems located in Maryland and installed after June 1, 2011. There is only one system thus far that meets this requirement. There are many other solar water heating systems throughout PJM that may be eligible for other state RPS policies and solar set-asides.

8. To match the Maryland requirement that qualifying hydropower be associated with a dam constructed prior to 2004, hydropower dam age was approximated by the age of the hydropower plant itself. One small hydropower facility was excluded under this criterion.
9. Energy efficiency improvements were excluded since energy efficiency is not included in the Maryland RPS.
10. Other gas (butane, coal processes, coke-oven refinery, and other processes) plants were excluded as they do not qualify under the Maryland RPS.
11. Waste coal plants were excluded as they do not qualify under the Maryland RPS.
12. Pumped hydropower storage generators were excluded as they do not qualify under the Maryland RPS. Some large hydropower plants include both conventional and pump turbines—for these facilities, the capacity of the pumped storage hydro units was subtracted from total plant capacity.

There are 43 plants that utilize multiple fuels (either fuel switching or co-firing). Out of the 43, 13 show no electricity production from Maryland qualifying fuels despite having renewable fuels listed as a non-primary resource. These plants were excluded from Maryland eligibility. There were 9 more of these facilities which were derated—i.e., their Maryland-qualifying capacity was reduced—based on the share of proportional generation from RPS qualifying fuels. The affected plants were typically large generating stations primarily burning coal and natural gas mixed with a limited amount of renewable fuel, such as blast furnace gas, black liquor, or landfill methane.

D. Maryland Data Resolution

Owing to deratings and discrepancies in the reporting of capacity in GATS, the capacity of some Maryland facilities will be different than that reported in other publications:

- The Conowingo Hydropower Station is reported in GATS to be 474 MW. EIA estimates from the Form 860 database list Conowingo as having 507 MW nameplate, and 572 MW of summer capability. Maryland's Power Plant Research Program (PPRP) lists Conowingo at 549.5 MW.[4]
- Sparrows Point is listed in GATS at 129 MW. EIA reporting sizes this facility at 120 MW nameplate and 152.3 MW summer capability. PPRP lists Sparrows Point at 120

[4]Maryland Power Plant Research Program, *Maryland Power Plants and the Environment: A review of the impacts of power plants and transmission lines on Maryland's natural resources (CEIR-15)* (January 19, 2010).

MW. The plant is derated based on renewable generation percentage (blast furnace gas) from the GATS listing of 129 MW to a renewable capacity of 103 MW.

- The Wicomico Newland Park landfill was derated from 6 MW in GATS to 1 MW of renewable capacity based on actual landfill gas usage.
- The Easton generating facility is not included in the report as it exhibited zero renewable generation based on historical data. However, the internal combustion and gas turbine generators at the site are capable of using renewable fuels such as landfill gas. Easton has recently been certified as a renewable generator in Maryland. Updated generation data from 2010 or 2011 may show renewable generation and this plant will likely be included in future *Inventory* updates.

E. Mapping Methodology

Tier 1 electrical generation facilities and solar PV installations were mapped using data collected according to the methods described above. These data varied in their level of reported spatial resolution. All maps and analyses were completed using ArcGIS 9.3 software to create cartographic-quality maps (e.g., to scale, consistent coordinate systems) using the WGS1984 projection. Depending on the level of detail reported in the various source databases, facilities were mapped at three levels of spatial specificity:

- When street addresses were available, the U.S. Postal address geolocator was used.
- When street addresses were not reported, facilities were mapped at the center of their reported zip code using the U.S. Zip Code geolocator. Both geolocators are part of the Street Maps package supplied with ArcGIS 9.3.
- When neither addresses nor zip codes were available, facilities were mapped at the center of their reported county. County centroids were calculated in ArcGIS using a data layer of U.S. counties used for the 2000 U.S. Census.

Street addresses were obtained by referencing the EIA 860 plant-level database. As these addresses are derived from self-response forms (Form 860) from major generators, some exhibited data entry errors. Manual inspection of plants listed within the "PJM Control Area" in

GATS but lying outside of the control area (based on unaltered EIA addresses) reveal that some facilities were listed in incorrect zip codes. These errors were corrected. A handful of large wind facilities in Illinois and Indiana sited physically outside of the PJM service territories are connected via transmission lines into the PJM market and subsequently qualify under the Maryland RPS.

Tier 1 facilities included the following generation fuel types: methane gas, qualifying biomass, Maryland-sited waste-to-energy, hydroelectric less than 30MW, and wind. These facilities were mapped according to the nameplate capacity and fuel type. A map showing all facilities relevant to the PJM region overall was produced, as were individual maps for each state in the PJM region.

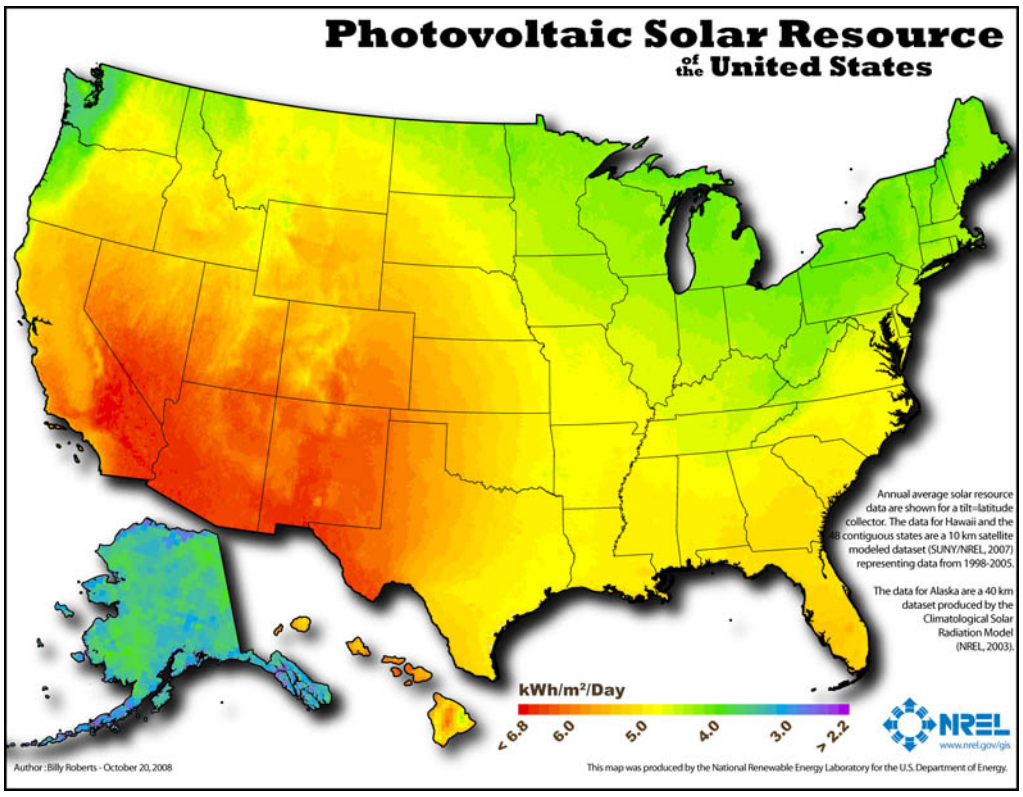
Solar PV capacity was mapped by county. The solar PV data in the *2011 Inventory Report* database were summed by county to obtain the nameplate installation capacity in megawatts in a given county. These data were mapped using the U.S. Census map of U.S. counties supplied in ArcGIS 9.3. A PJM region map with the capacity of all the counties relevant to the PJM region was created, as were maps of each state in the PJM region. In addition to the solar capacity in megawatts, the individual state maps also included the number installations in each county.

F. Capacity Factors for Renewable Projects in the PJM Region

Solar –Solar energy is variable by nature due to the rotation and tilt of the planet, cloud cover, weather (season), and geographic location. The U.S. Department of Energy's National Energy Modeling System uses a nationwide capacity factor of 21.7 percent for solar PV. The PJM regions, as shown in Figure B-1, receive substantially less solar radiation than the national average. Neither the PJM GATS nor the EIA databases provide sufficient data to estimate an average capacity factor for existing units within the PJM region. This analysis conservatively assumed 15 percent for a solar PV capacity factor. This is the same value that was used for solar PV in the *2006 Inventory Report* and the *Long-Term Electricity Report*

The distribution of solar unit sizes also impacts the capacity of the installed base. A smaller-than 10kW rooftop installation typically does not track the sun (i.e., it is not at the optimal angle for power, other than at noon on one day a year, and frequently it is placed on a roof with a slope that is not at the optimal latitude angle), whereas a large-scale system has more economies of scale to allow it to be sited properly with tracking mechanisms.

Figure B-1 – PJM Control Area is in the Lower Resource Level Area (green)



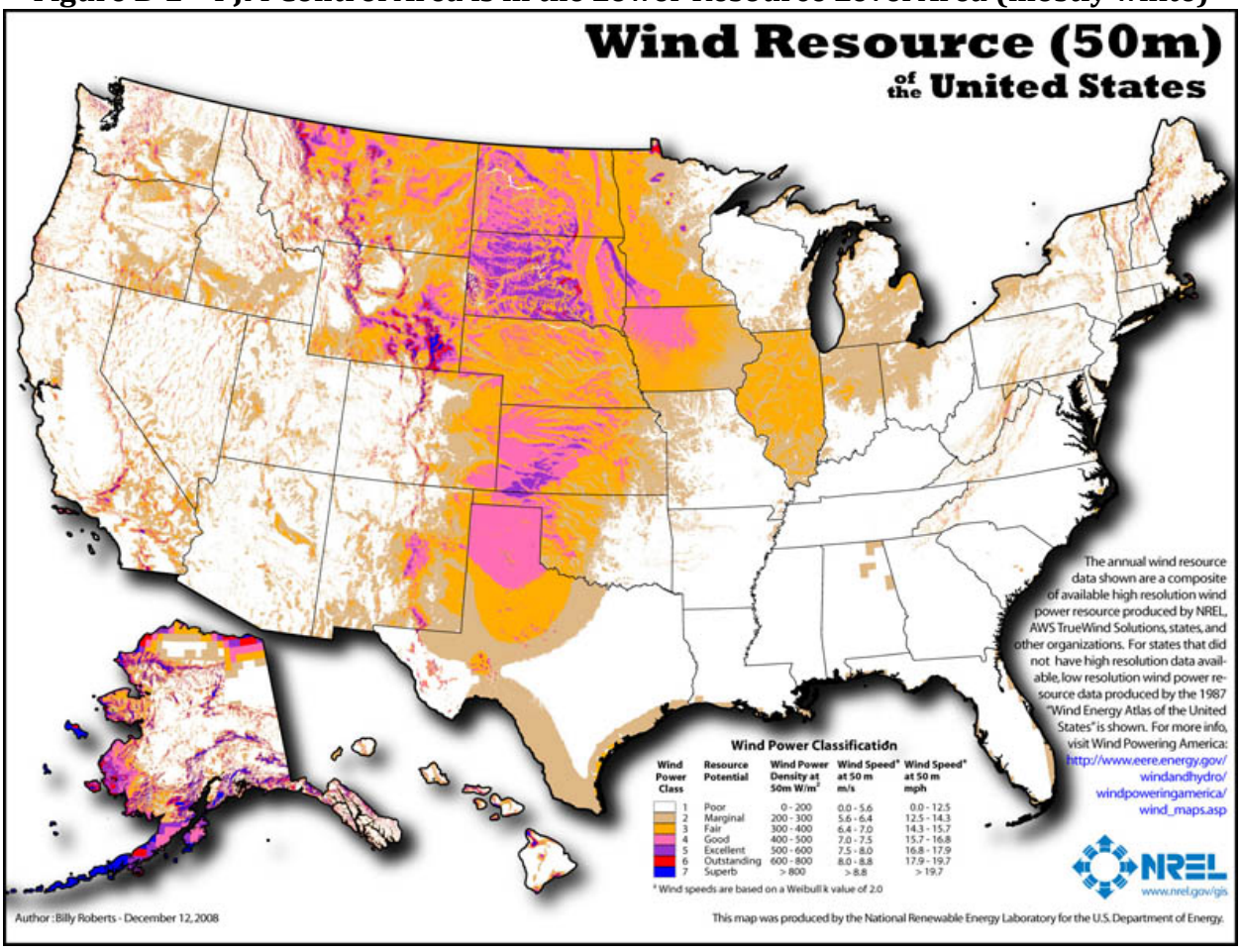
Wind **–**Wind speeds are naturally variable. Wind-generating units have performance curves bounded by upper and lower wind speed operating limits. Wind units produce no electricity below the lower limit (i.e., there is not enough wind velocity to bring the turbine up to a productive level) and above the upper mechanical stress limit (i.e., the windmill is locked down to protect the blades and structure). Once above the lower wind speed limit (maybe 5 mph), the turbine begins to produce electric power. As wind speed increases, electric generation increases until full capacity output is reached (at approximately 30 mph). Above this limit, the blades are

adjusted to maintain maximum capacity. Additional wind speed does not produce more power. The *Annual Report on U.S. Wind Power Installation, Cost, and Performance Trends: 2007 (*Ryan Wiser Lawrence, Mark Bolinger, Lawrence Berkeley National Laboratory) states that capacity factors ranging from 18 percent to 48 percent were achieved among projects built in 2006. A portion of this range is attributable to regional variations in wind resources. Table B-4 shows wind capacity factors by region, and Figure B-2 shows wind resources for the United States. Most of the PJM region (East) is considered "poor" to "marginal" for wind capacity—except for Illinois (Heartland), which is considered "fair." The majority of wind resources eligible under Maryland's RPS will come from the East region. Given recent trends in the upward scaling of wind turbines resulting in increased capacity factors, this study assumes a 30 percent capacity factor for the PJM region consistent with the *Long-Term Electricity Report*.

Table B-3 – Capacity: Weighted-Average 2007 Wind Capacity Factors by Region

Capacity Factor	Heartland	Texas	California	Northwest	Mountain	East	Great Lakes	Hawaii	New England
Pre-1998	28.9%	11.9%	22.3%						19.8%
1998-99	30.2%	28.2%	29.8%	32.1%	34.4%		23.4%		
2000-01	33.4%	29.6%	34.5%	38.7%	29.3%	22.5%	23.5%		27%
2002-03	34.4%	33.5%	32.6%	30.5%	30.3%	28.5%	21.2%		
2004-05	36.8%	34.5%	37.5%	34.0%	28.9%	26.7%	31.0%		
2006	40.8%	30.4%	36.9%	31.3%	34.7%	29.4%		45%	22.1%

Figure B-2 – PJM Control Area is in the Lower Resource Level Area (mostly white)



Hydroelectric–A hydroelectric unit's production is variable because of seasonal factors and environmental and/or recreational requirements to maintain water levels upstream and downstream. The *Feasibility Assessment of the Water Energy Resources of the United States for New Low Power and Small Hydroelectric Classes of Hydroelectric Plants* report (Douglas G. Hall, January 2006, Prepared for the U.S. Department of Energy's Idaho Operations Office, page 23) states that the average capacity factor for the U.S. hydroelectric plant population is 50 percent. The *2011 Inventory Report* includes data that allow the calculation of capacity factor for 24 hydroelectric units under 30 MW. These units on average have a capacity factor of approximately 33 percent. The large (474 MW) Conowingo facility had a capacity factor of 45 percent in 2006 and 2007.

Methane– Generation data from 79 units in the PJM control area were available from the EIA Form 906/920/923 database. Annual plant utilization ranged from less than 1 percent to over 93 percent. These compute to an average capacity factor of approximately 48 percent, which was assumed to apply to LFG facilities in the PJM control area.

Biomass –EIA reports biomass facilities to have an 83-percent capacity factor. This same factor was used for the primary fuel wood waste facilities in the PJM control area.

Black Liquor (BLQ) –EIA reports biomass facilities to have an 83-percent capacity factor, and that is assumed to relate also to BLQ firing. Economic paper mill production is fully dependent on the ability to recover chemicals and energy from black liquor.

Waste-to-Energy – Municipal solid waste-to-energy (MSW) generating units are subject to variation in the quantity and quality of their waste supply (i.e., their fuel). These variations are seasonal, peak with holidays, and are weather-related (for example, rain soaks wastes). Data for 15 units in the PJM control area were available. Additionally, data were available for two plants utilizing blast-furnace gas (BFG), qualifying as Waste-to-Energy under the Maryland RPS. Between 2001 and 2009, annual plant utilization ranged from less than 8 percent to 70 percent, computing to an average capacity factor of approximately 41 percent in the PJM control area.

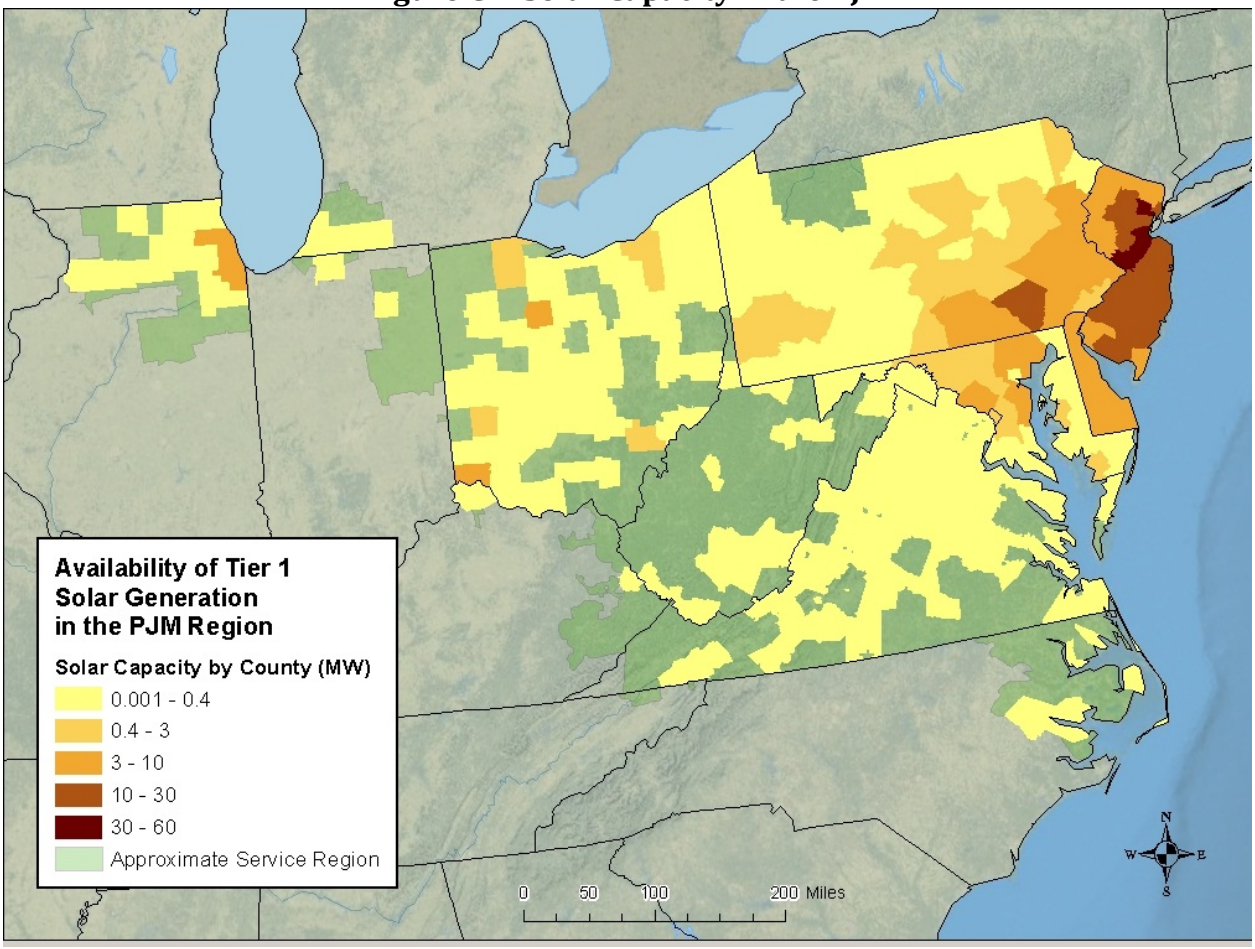
Appendix C – RPS Resource Maps

The following maps show the availability of renewable generation facilities that are registered to sell electricity into the PJM region. The maps were generated using geospatial data (state, county, city, street address) obtained from the PJM GATS Renewable Database (accessed September 1, 2011) and EIA Forms 860 for the year 2009.

Solar resources are mapped by county, showing the total number of MW of capacity available in a particular county. Figure C-1 shows the total available solar capacity in the PJM region. The solar availability maps for each individual state (Figures C-2 through C-14) detail the amount of MW of capacity using the color code provided in the map legend. In addition, the number in each county identifies the number of registered units in that county. Figures C-15 through C-25 show Tier 1-Other (i.e., non-solar) generation for the PJM region as a whole (Figure C-15) and for individual states within the PJM region (Figures C-16 through C-25). Figure C-26 displays the distribution of Tier 2 renewable generating resources across the PJM territory.

A. Available Solar Capacity in the PJM Region

Figure C-1 Solar Capacity in the PJM



Created September, 2011

Figure C-2 Solar Capacity in Maryland

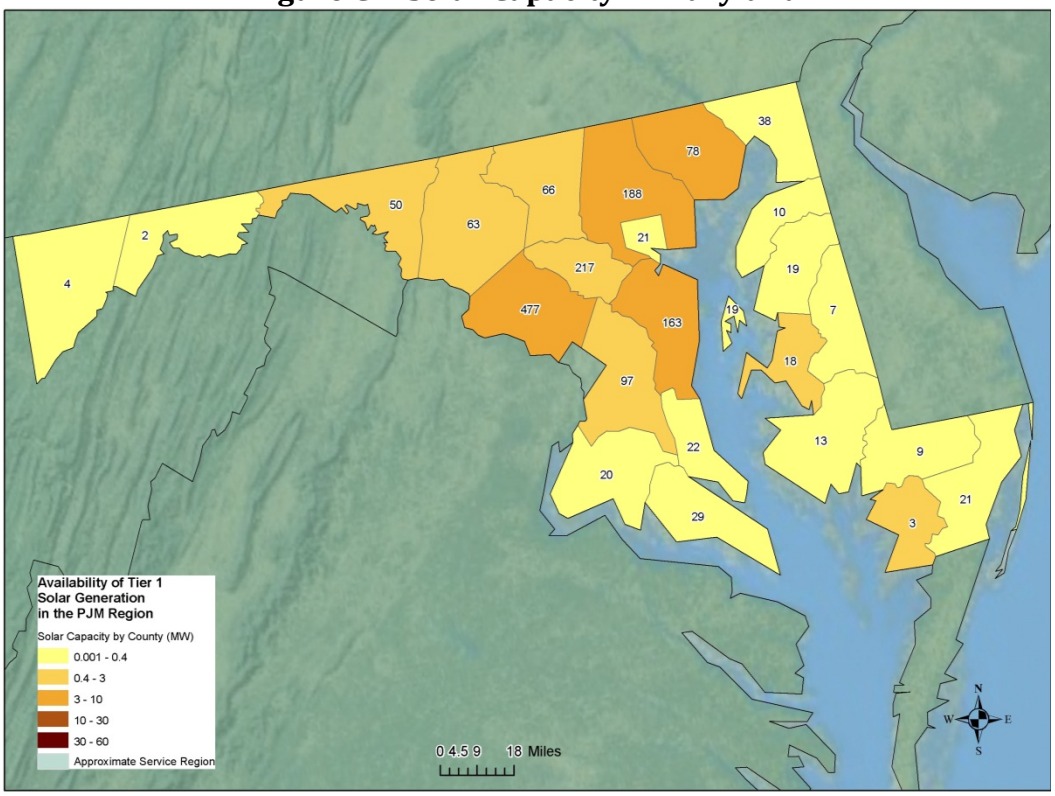


Figure C-3 Solar Capacity in Delaware

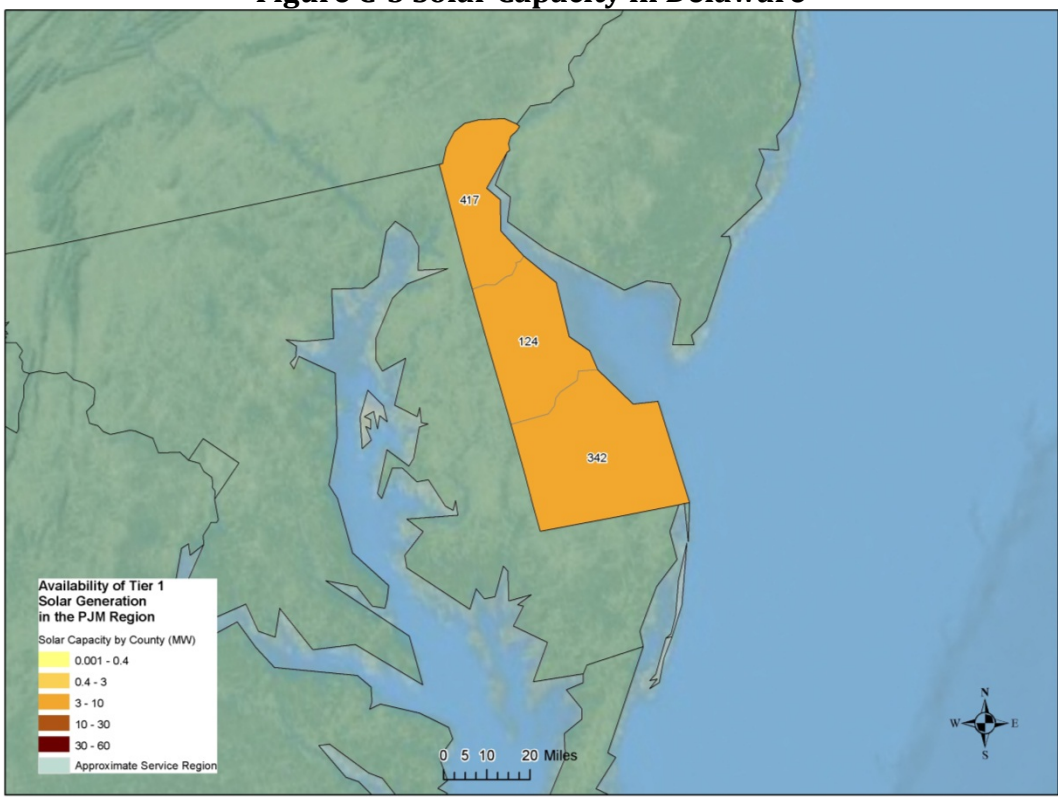


Figure C-4 Solar Capacity in the District of Columbia

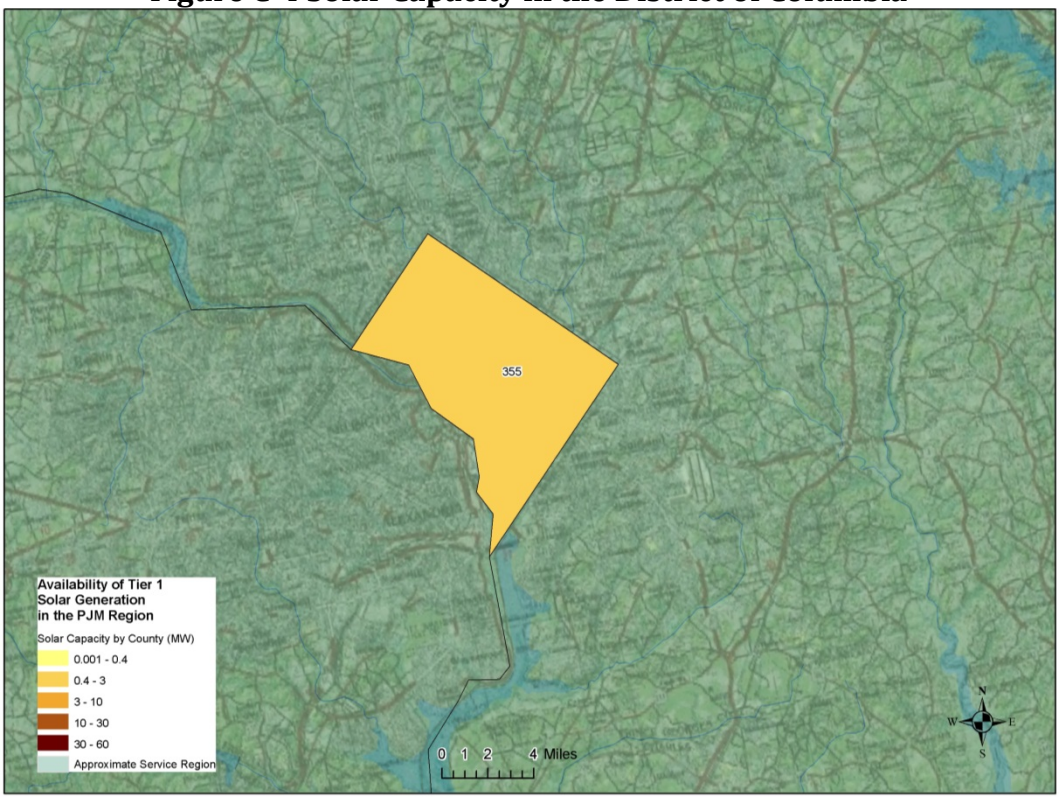


Figure C-5 Solar Capacity in Illinois

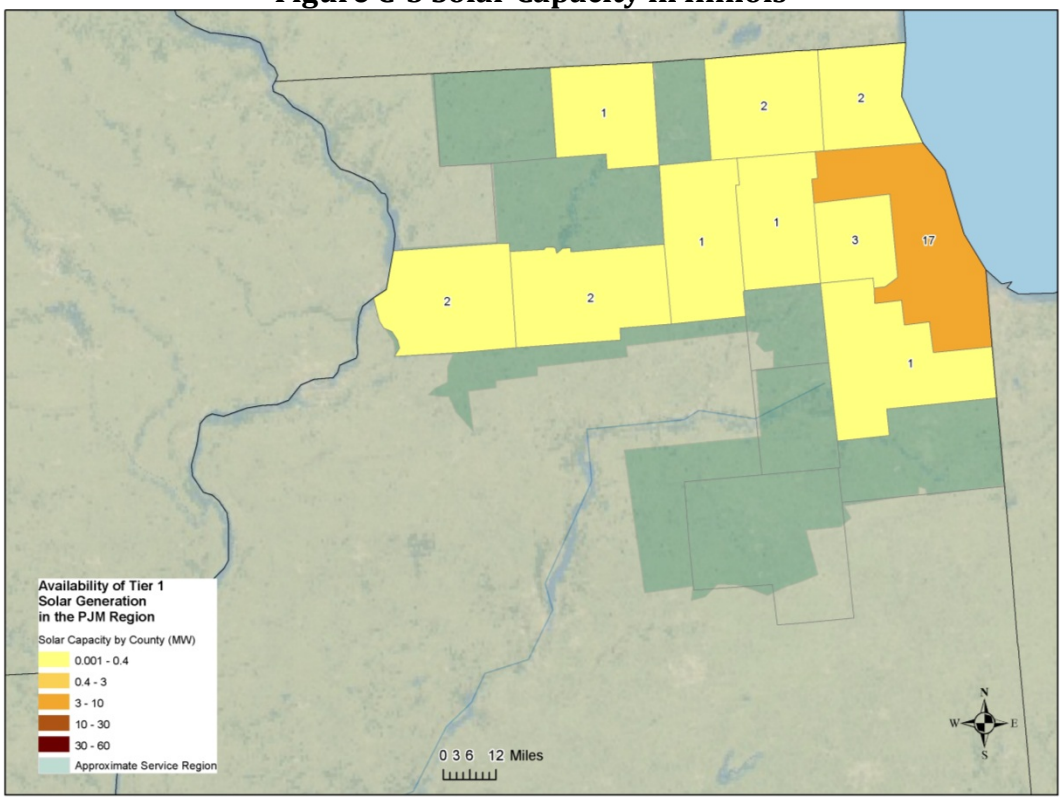


Figure C-6 Solar Capacity in Indiana

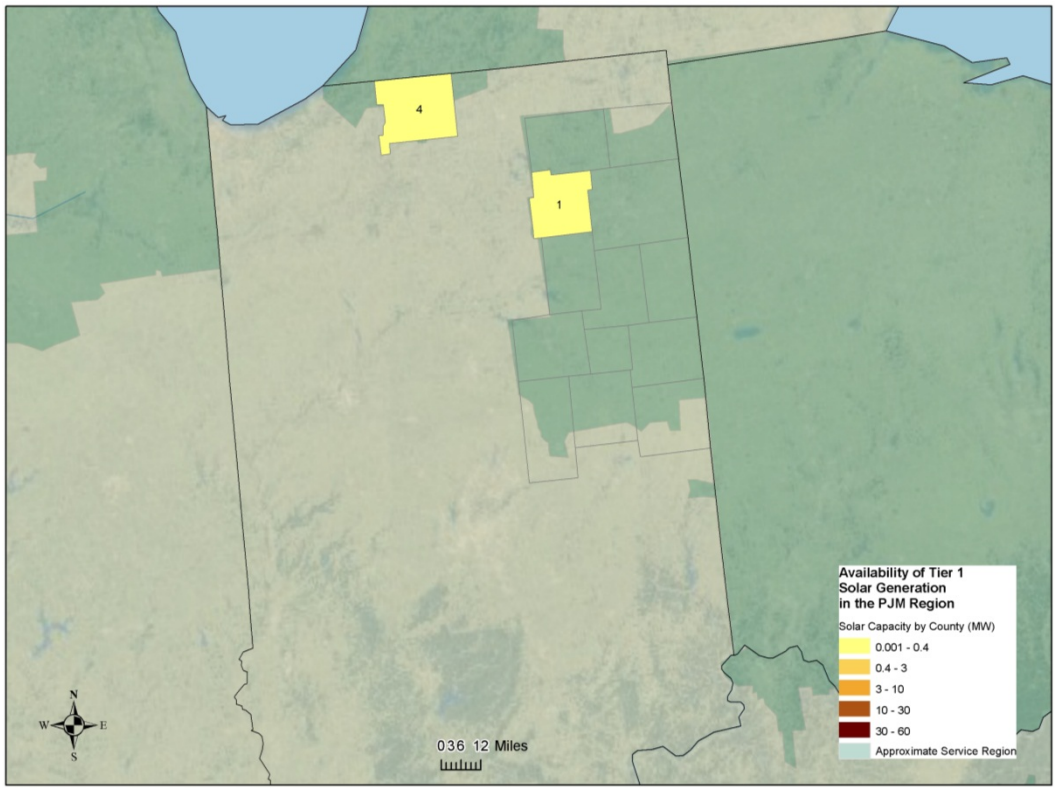


Figure C-7 Solar Capacity in Kentucky

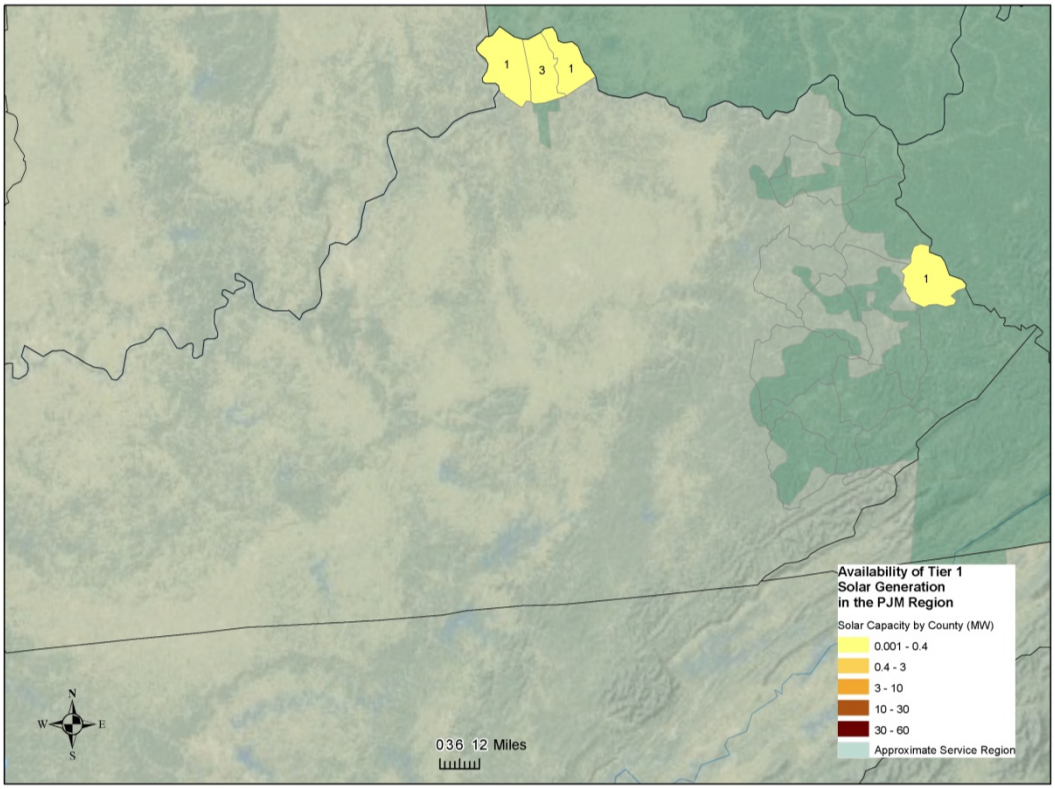


Figure C-8 Solar Capacity in Michigan

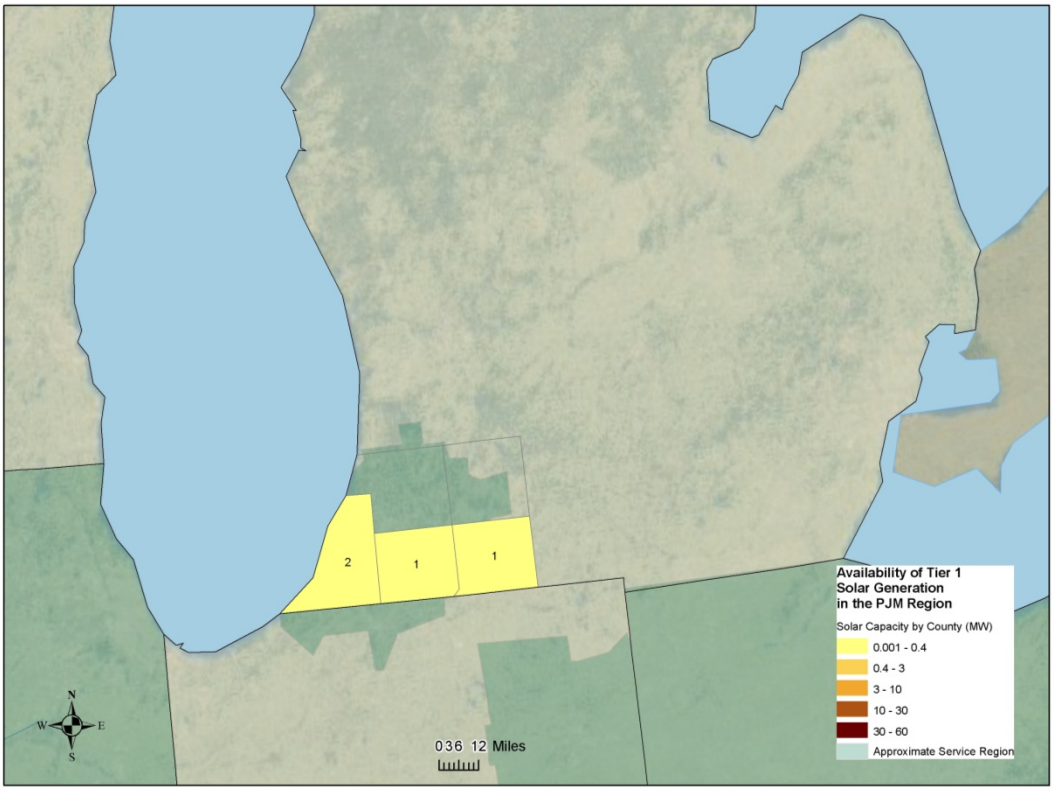


Figure C-9 Solar Capacity in New Jersey

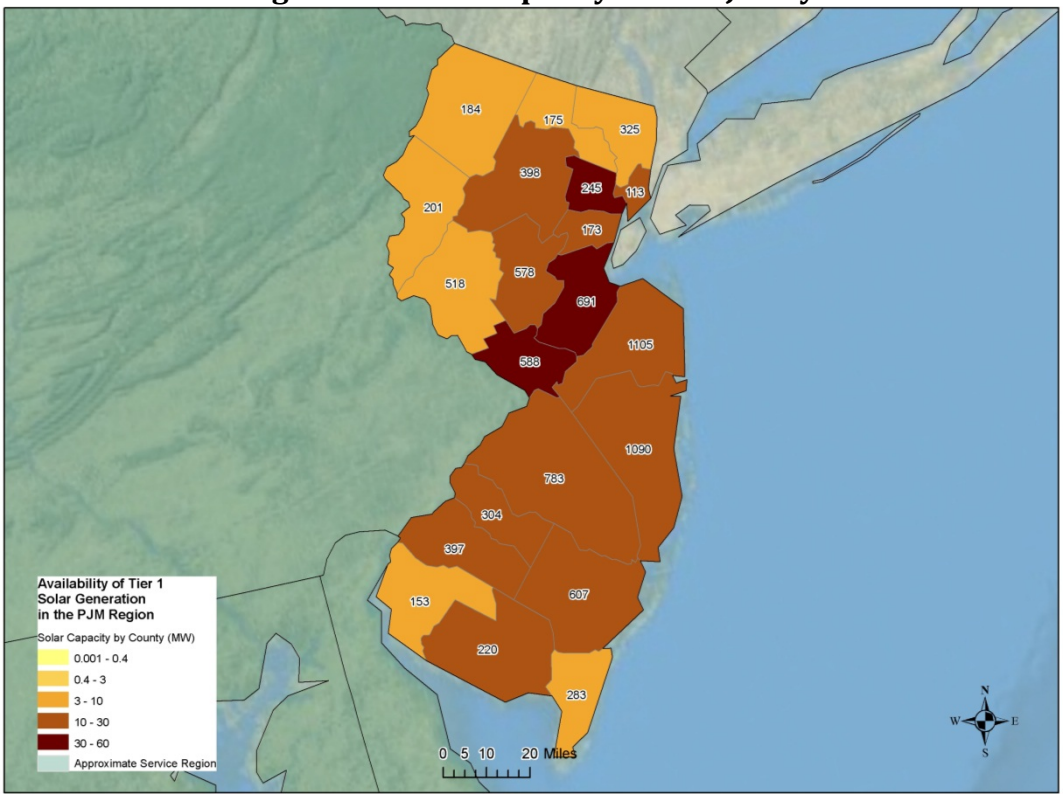


Figure C-10 Solar Capacity in North Carolina

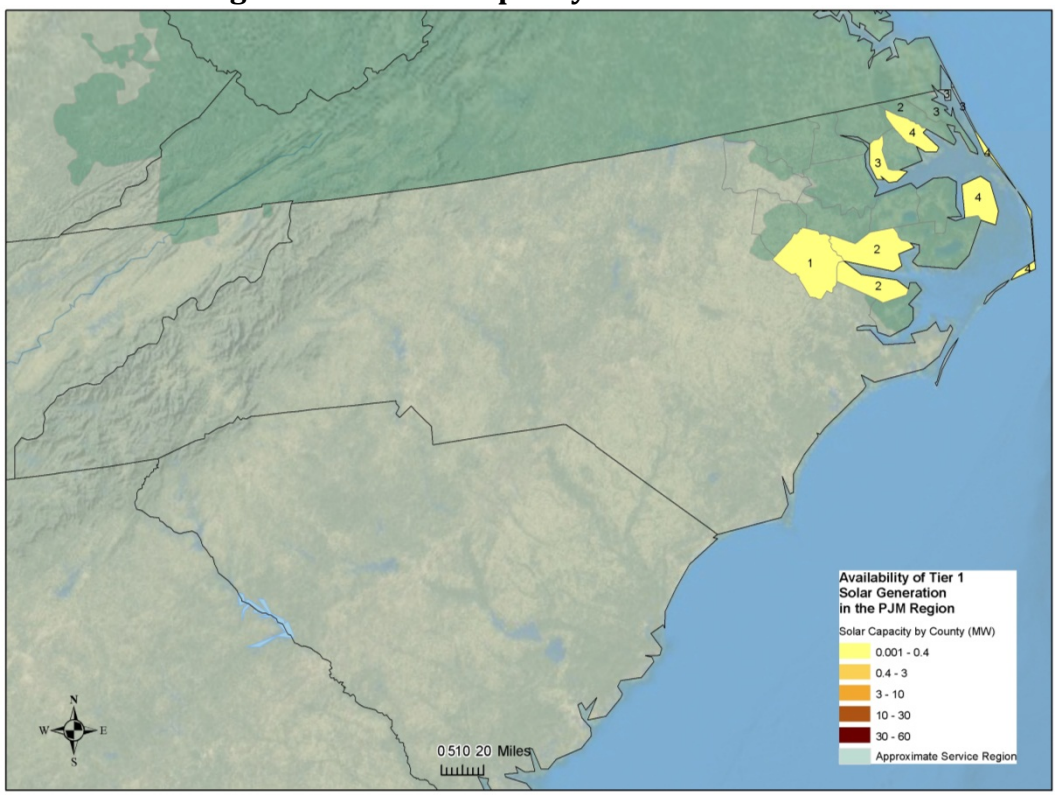


Figure C-11 Solar Capacity in Ohio

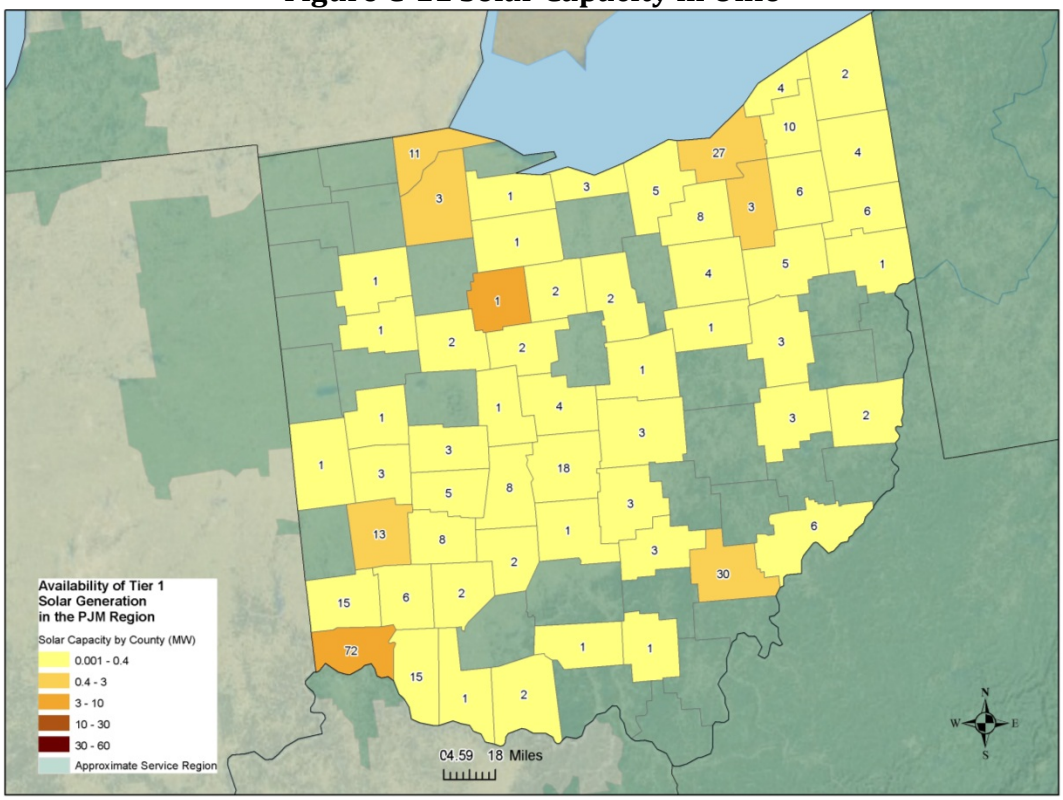


Figure C-12 Solar Capacity in Pennsylvania

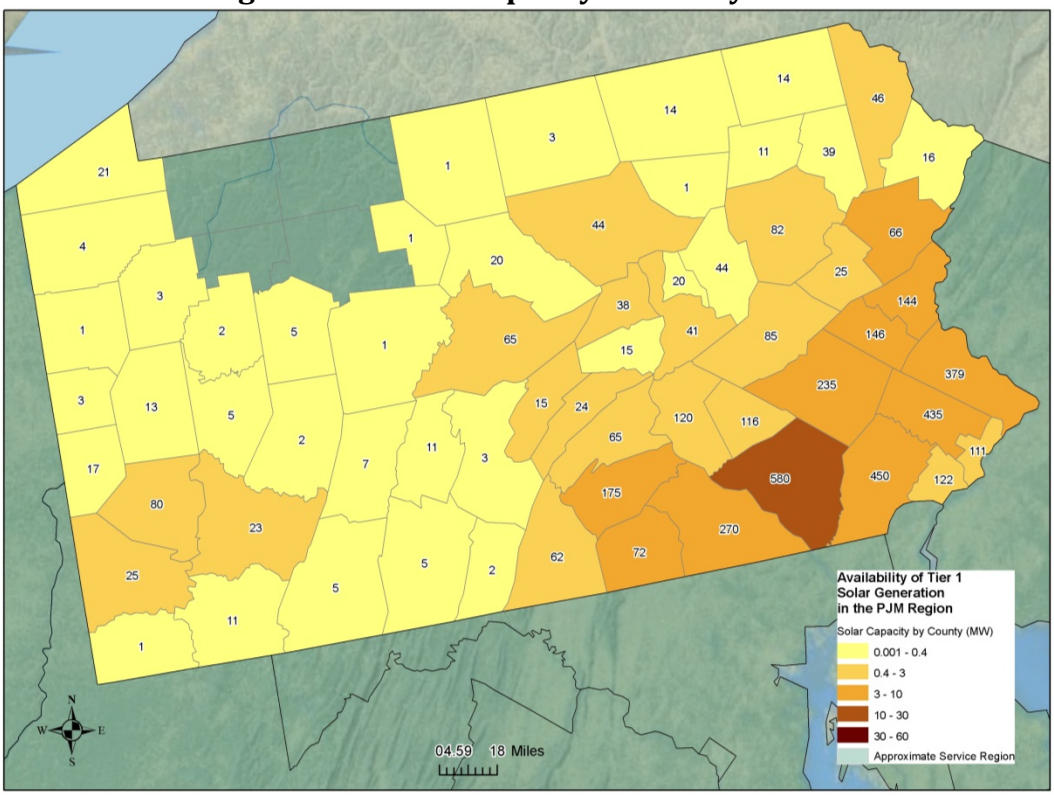


Figure C-13 Solar Capacity in Virginia

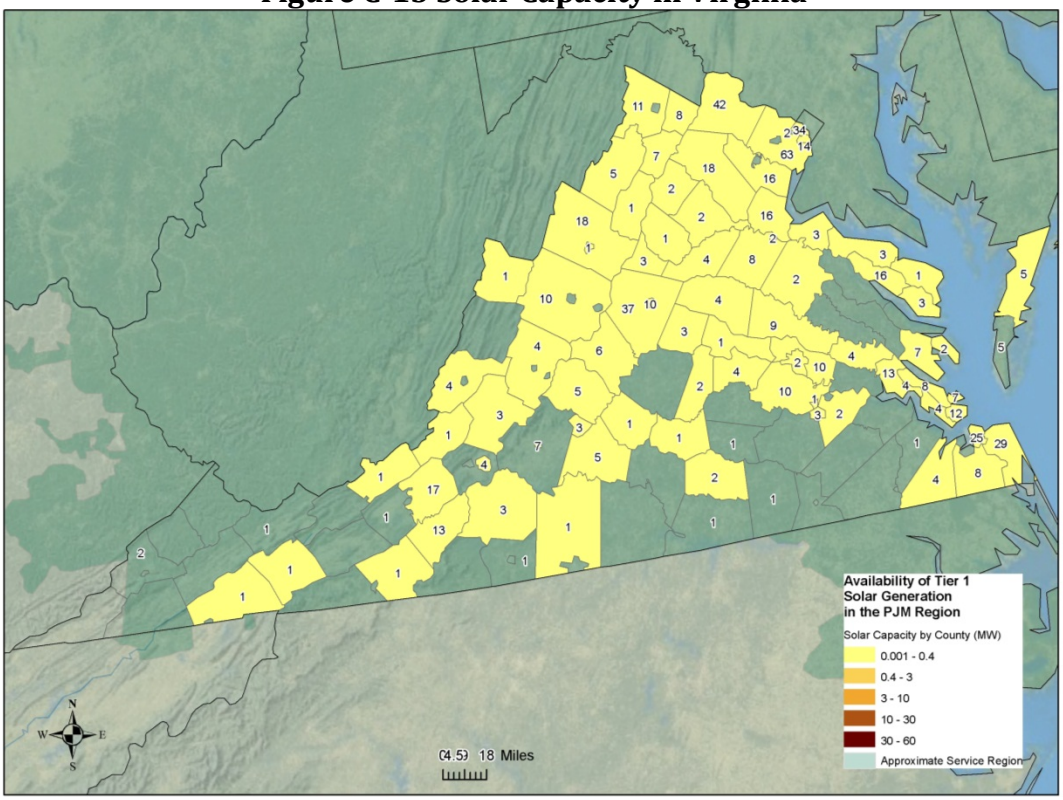
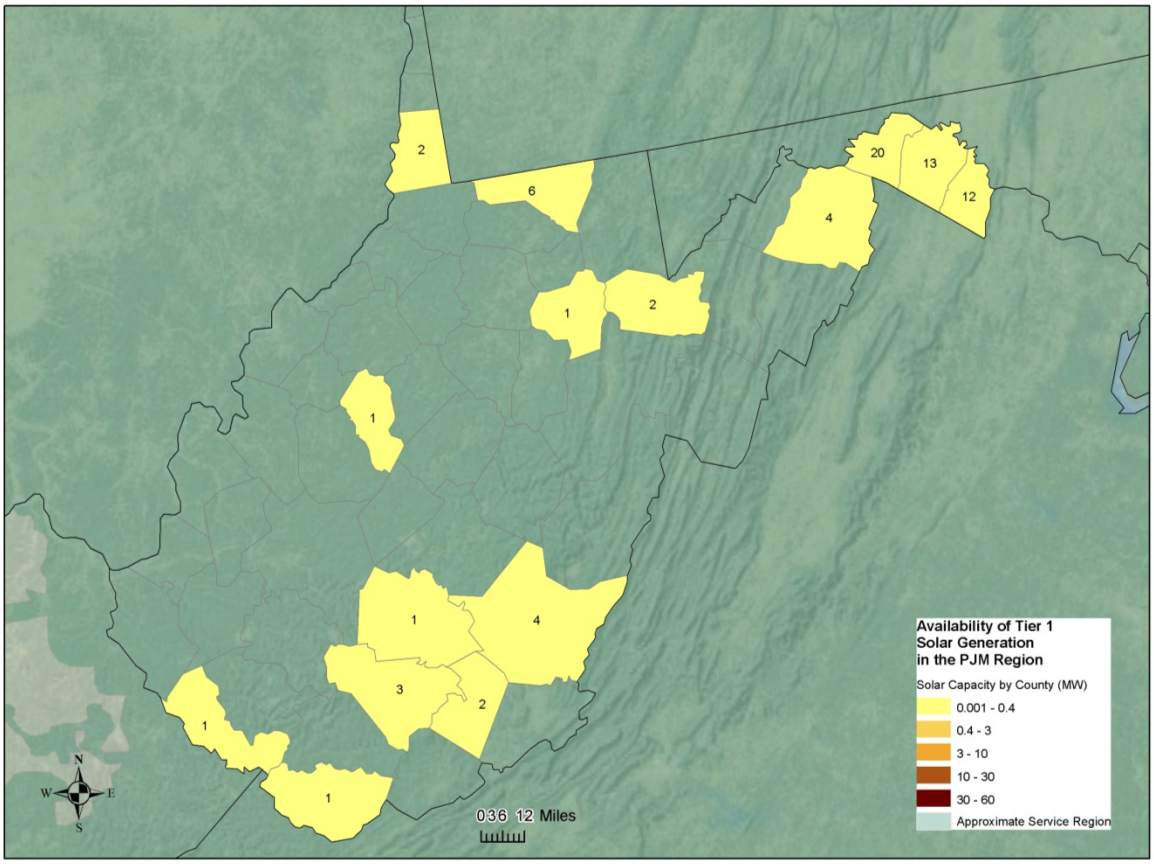
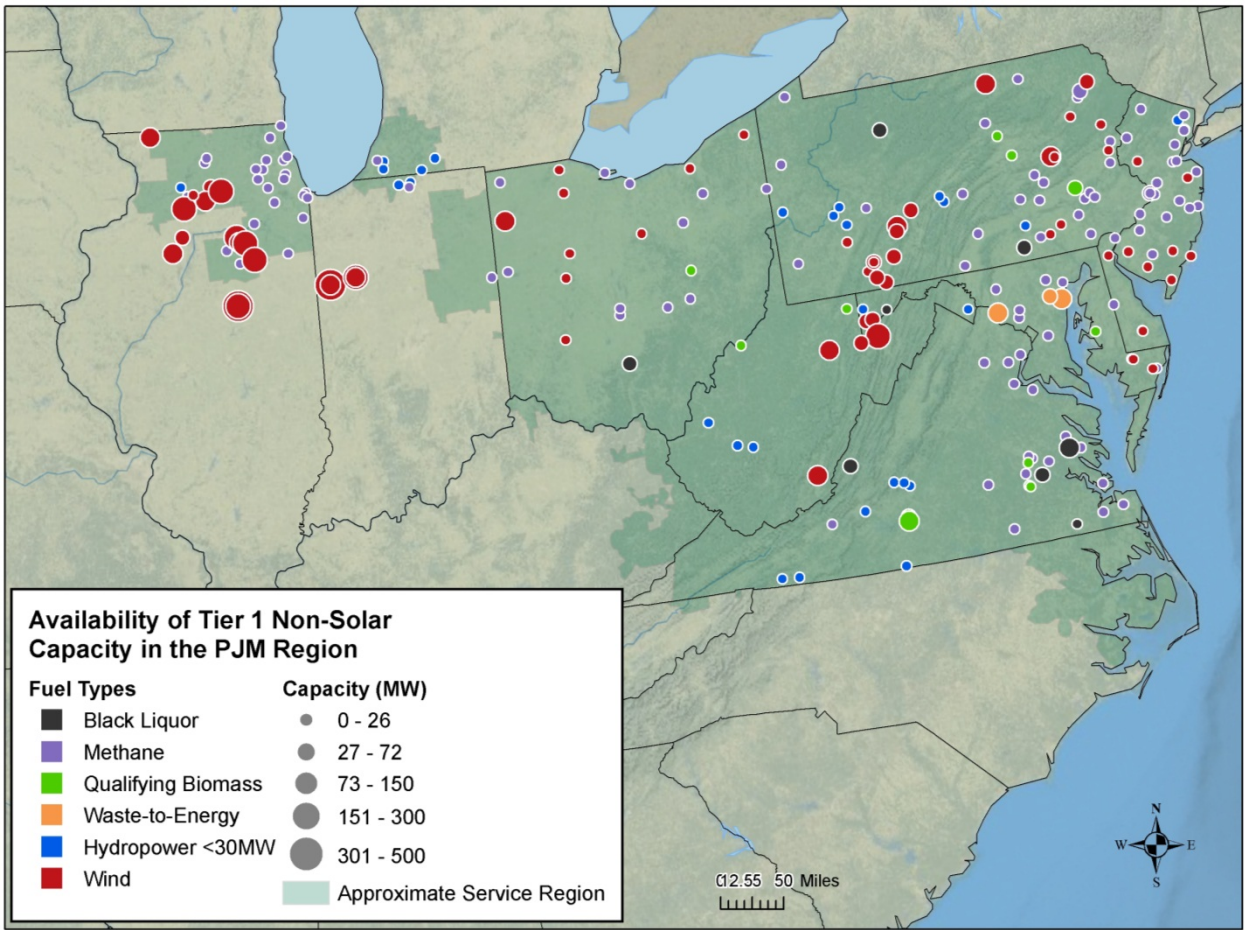


Figure C-14 Solar Capacity in West Virginia



B. Available Tier 1 Non-Solar Capacity in the PJM Region

Figure C-15 Tier 1 Non-Solar Capacity in the PJM



Created November, 2011

Figure C-16 Tier 1 Non-Solar Capacity in Maryland

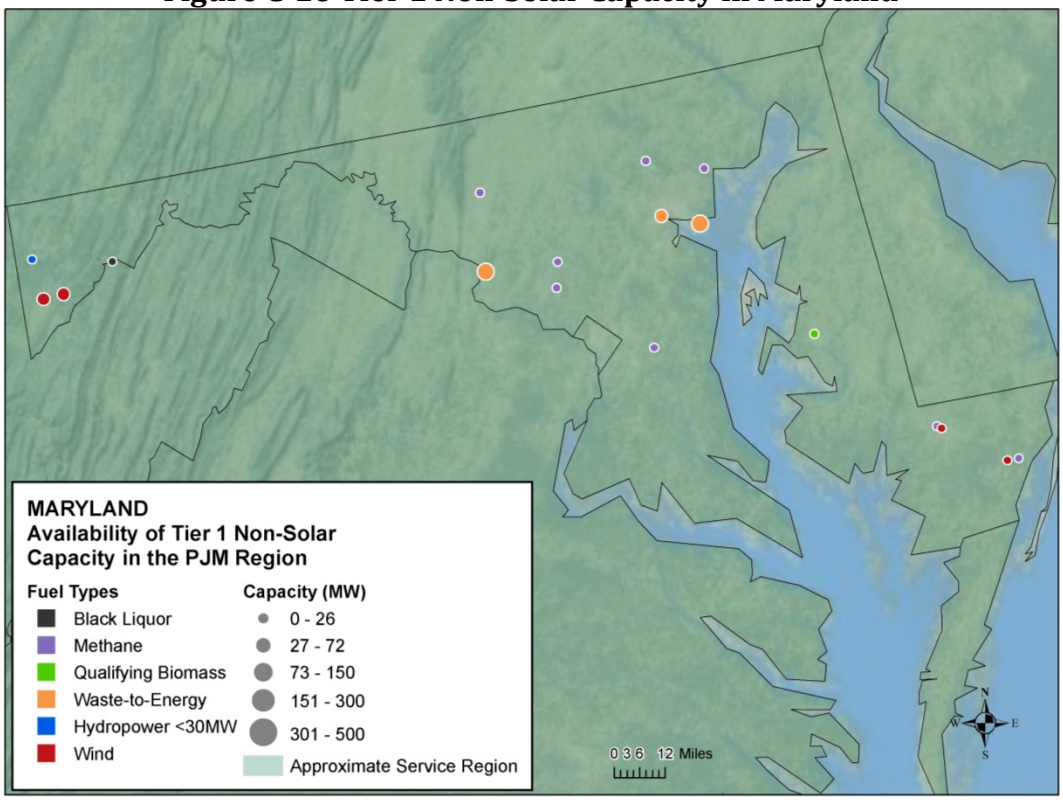


Figure C-17 Tier 1 Non-Solar Capacity in Delaware

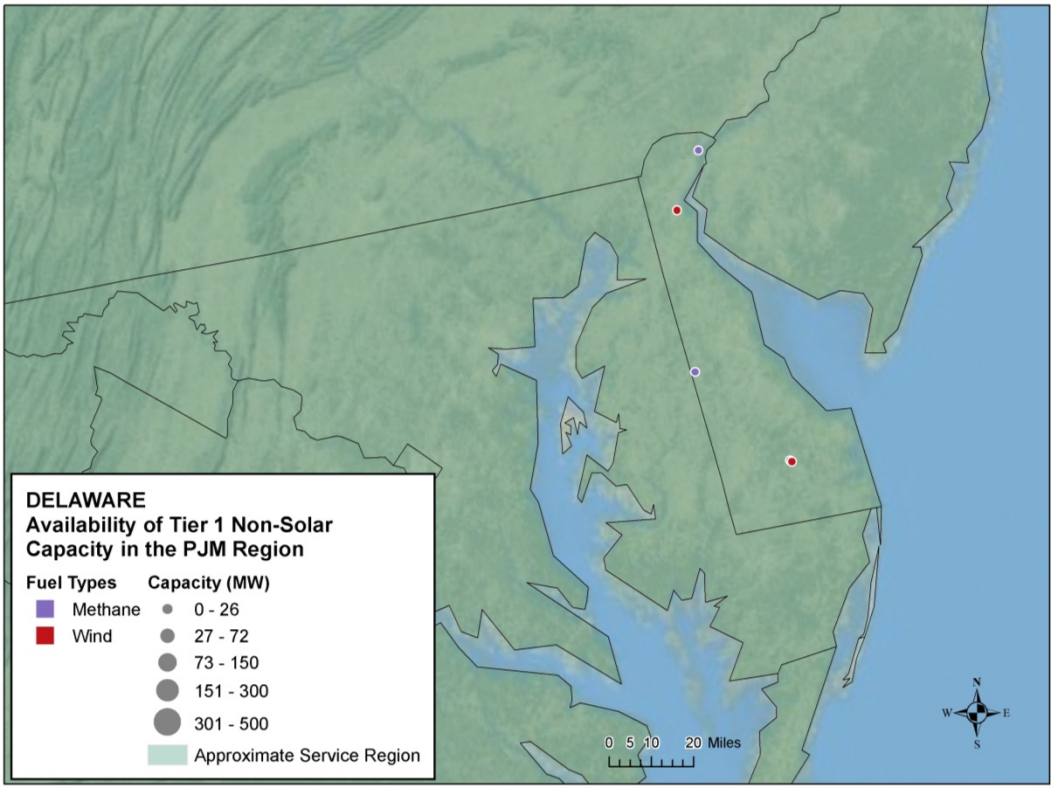


Figure C-18 Tier 1 Non-Solar Capacity in Illinois

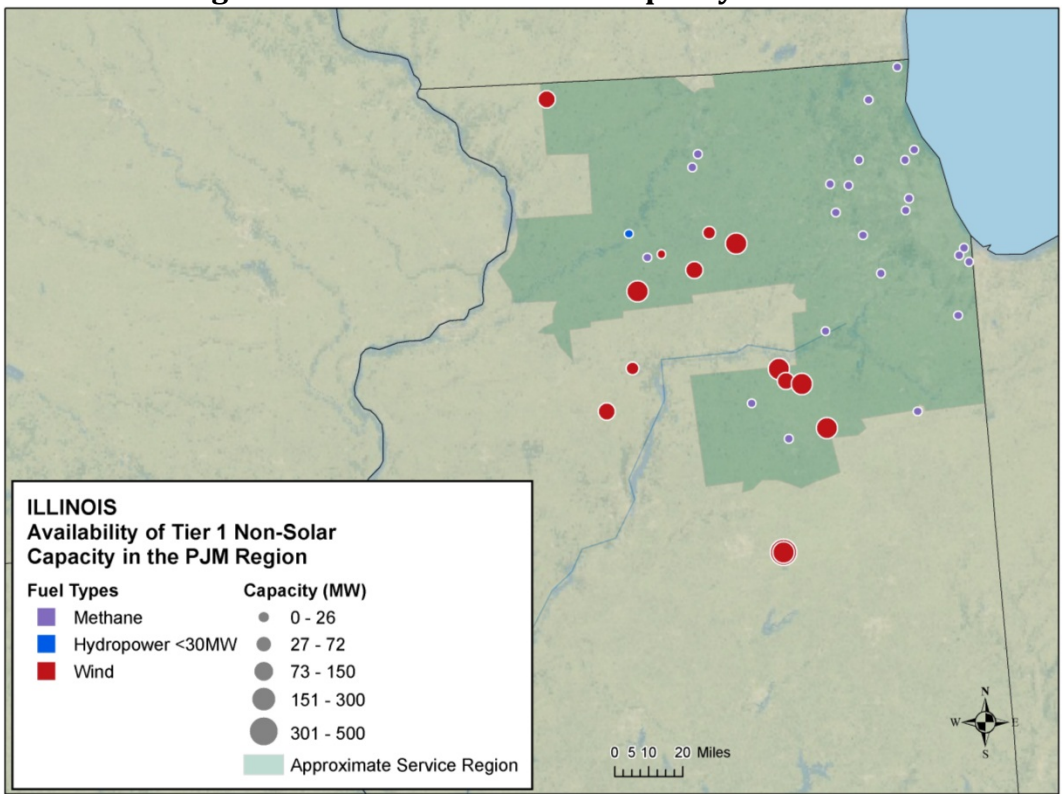


Figure C-19 Tier 1 Non-Solar Capacity in Indiana

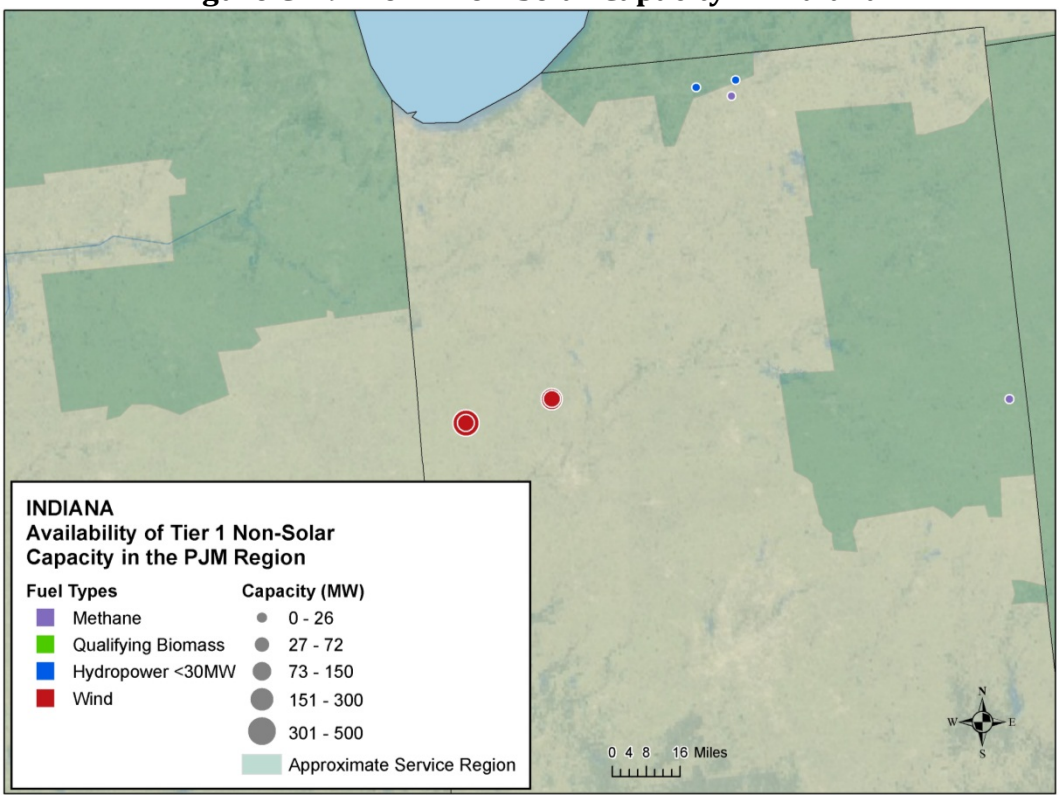


Figure C-20 Tier 1 Non-Solar Capacity in Michigan

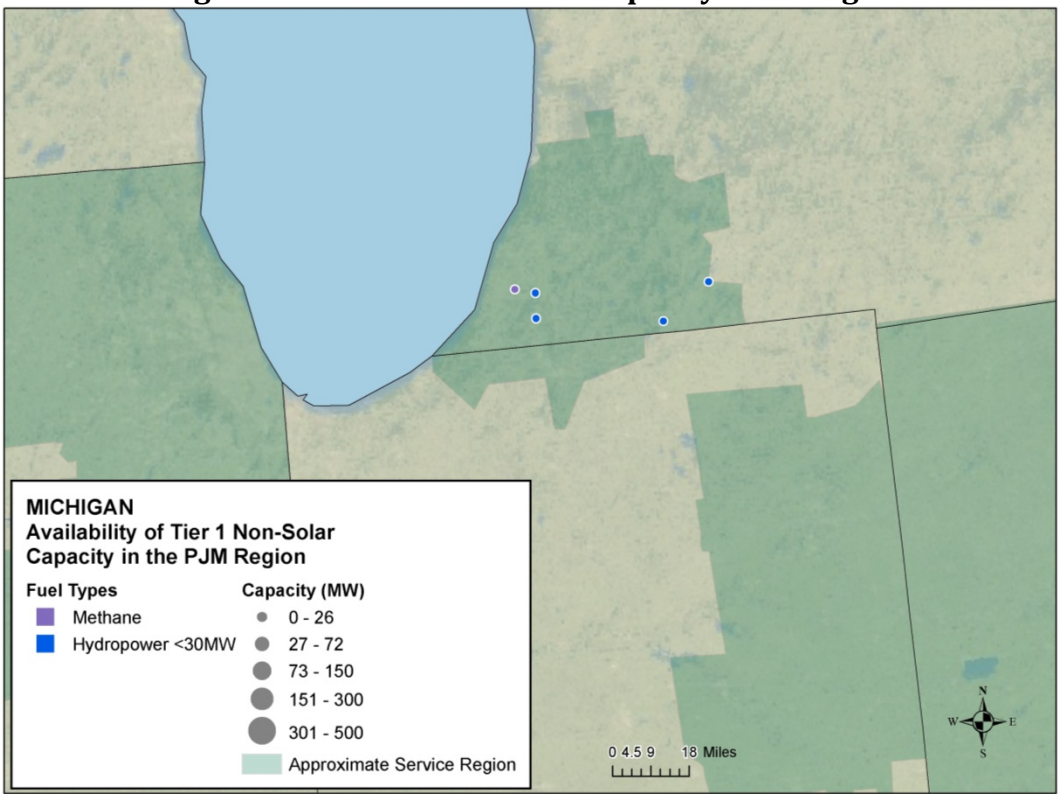


Figure C-21 Tier 1 Non-Solar Capacity in New Jersey

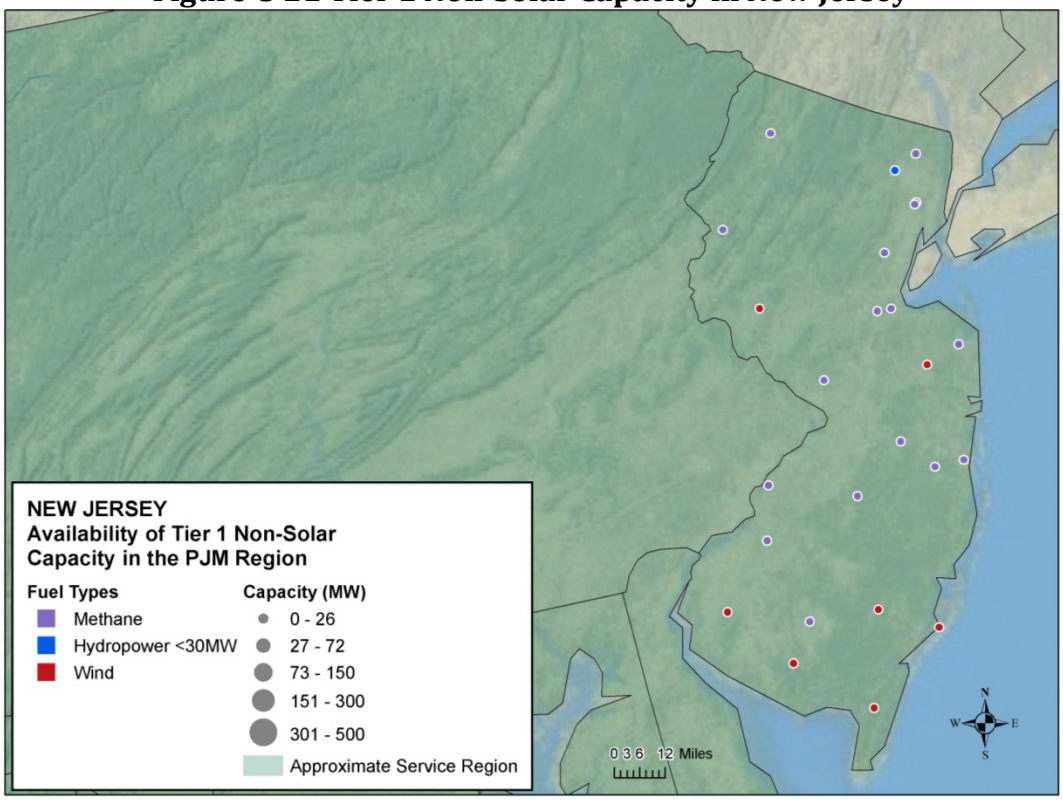


Figure C-22 Tier 1 Non-Solar Capacity in Ohio

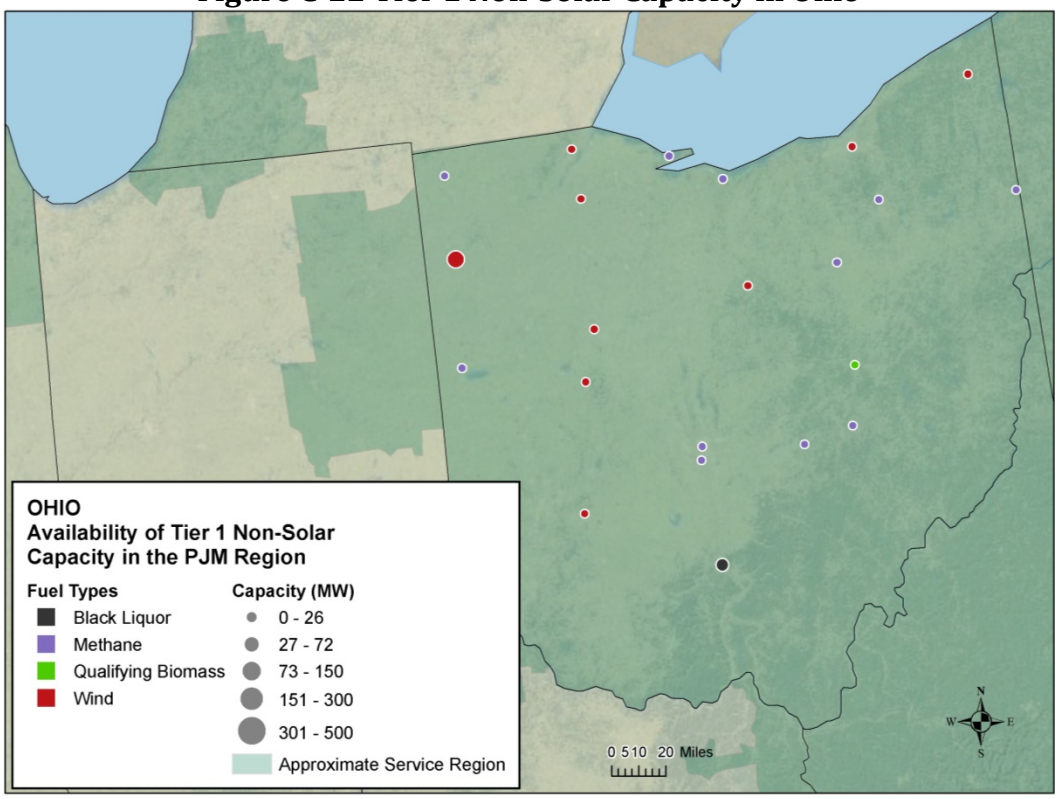


Figure C-23 Tier 1 Non-Solar Capacity in Pennsylvania

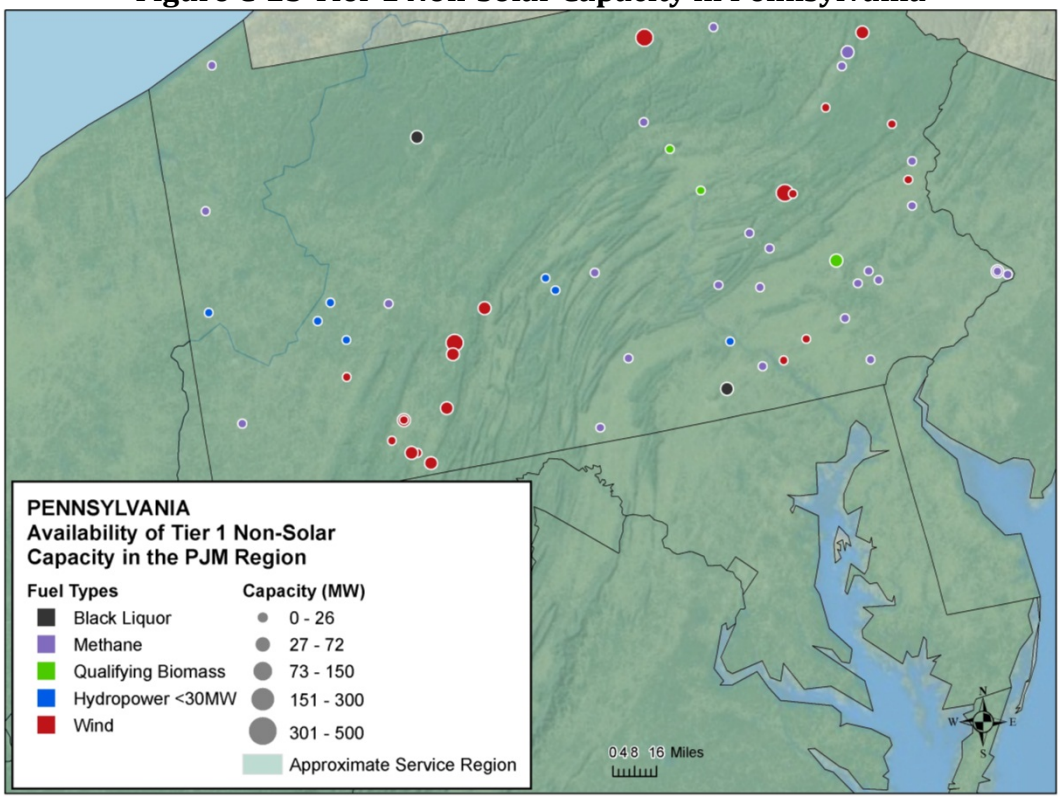


Figure C-24 Tier 1 Non-Solar Capacity in Virginia

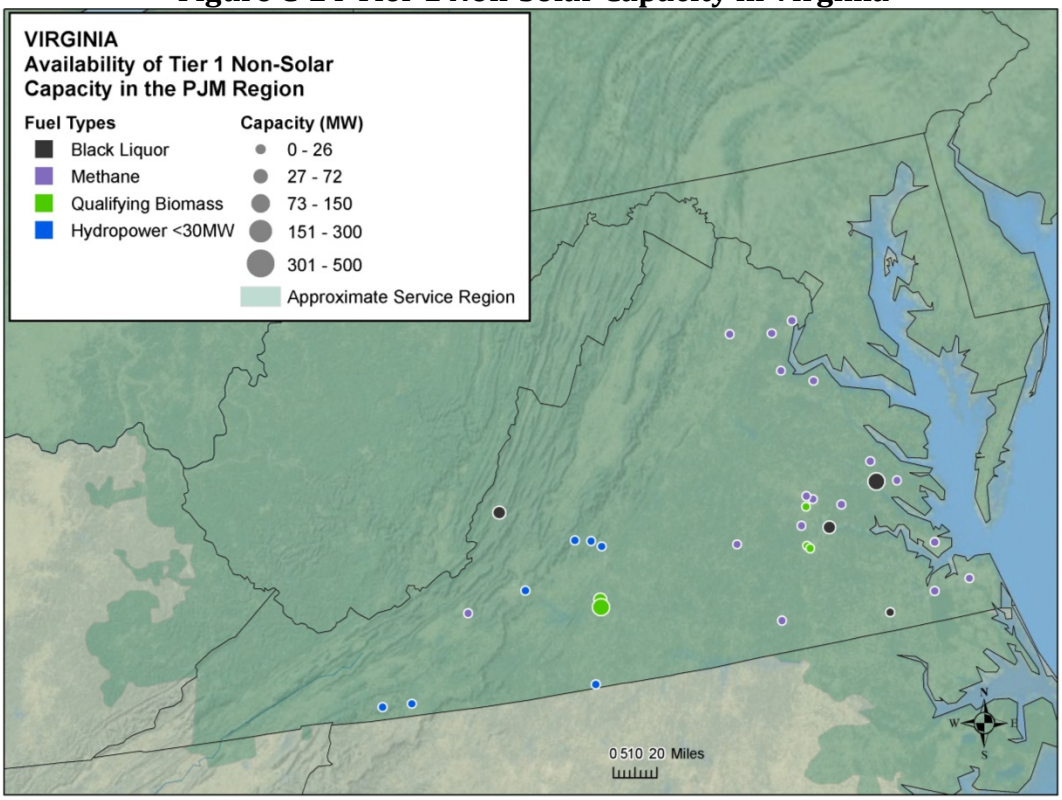
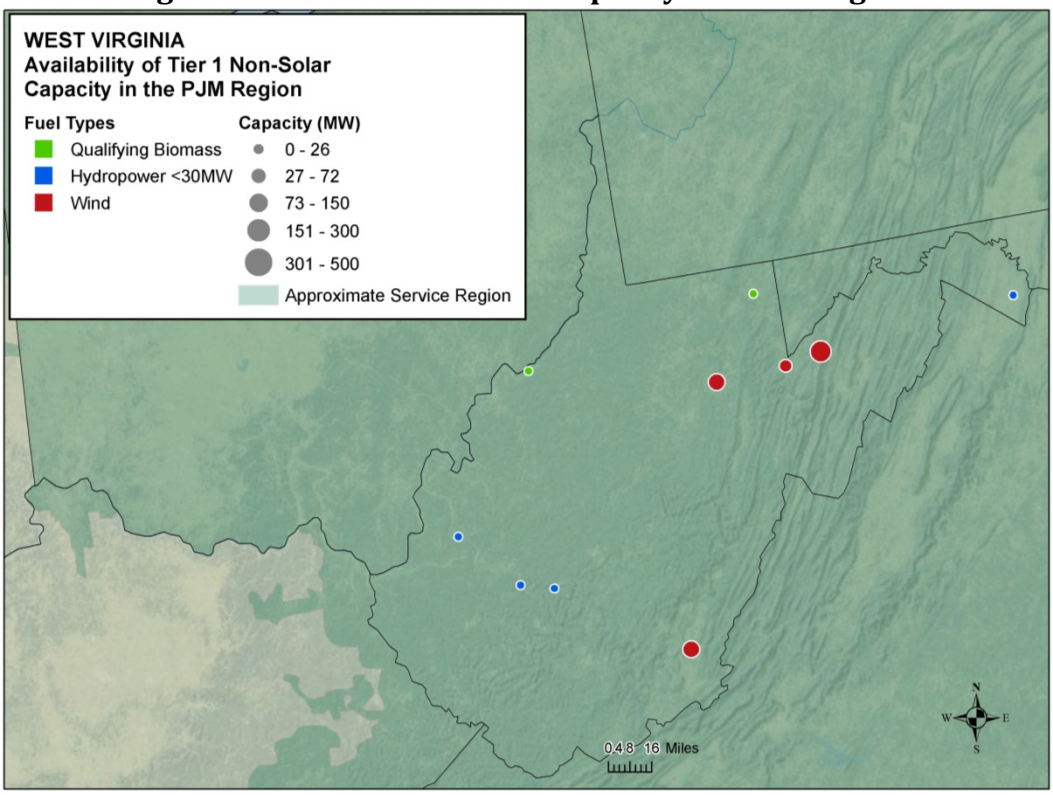


Figure C-25 Tier 1 Non-Solar Capacity in West Virginia



C. Available Tier 2 Capacity in the PJM Region

Figure C-26 Tier 2 Capacity in the PJM