Estimated Ratepayer Impact of Increasing the MD RPS

Prepared for the Maryland Climate Coalition, by Sustainable Energy Advantage, LLC

Executive Summary

Sustainable Energy Advantage, LLC (SEA), an independent renewable energy consulting and advisory firm, found that **the ratepayer impact of increasing Maryland's Renewable Portfolio Standard (RPS) to 25% by 2020 will likely be $0.52 per month per residential ratepayer (in 2014 dollars) in 2020. The residential ratepayer impact of increasing Maryland's RPS to 40% by 2025 would likely be just under $2 per month per residential ratepayer (in 2014 dollars) in 2025.**

The table below provides ratepayer impact results for the "base case" scenario, in 2014 dollars.

Year	Residential		Commercial		Industrial	
	$/Cust/Mo	% Increase	$/Cust/Mo	% Increase	$/Cust/Mo	% Increase
2020	$0.52	0.4%	$5.00	0.4%	$55.82	0.5%
2025	$1.94	1.5%	$18.79	1.4%	$209.16	1.7%

Who is SEA: SEA has been a national leader on renewable energy policy analysis and program design for over 15 years. In that time, SEA has supported the decision-making of more than 100 clients—including more than 20 governmental entities— through the analysis of renewable energy policy, strategy, finance, projects and markets. SEA has contributed to the design, implementation, evolution and/or evaluation of RPS's, or proposals to create such standards, in states including – but not limited to – California, Connecticut, Illinois, Massachusetts, New York, North Carolina, Ohio, Rhode Island, Wisconsin and Vermont. In a number of these states, SEA has performed RPS cost evaluations.

Regional Analysis: This study provides an independent, objective analysis of the potential ratepayer impact of increasing Maryland's Tier 1 RPS target (inclusive of solar and offshore wind carve-outs) from 20% to 40% by 2025. Specifically, SEA estimated the *incremental* cost impact on residential, commercial, and industrial ratepayers – expressed in dollars per month and percentage increase for a typical customer. This analysis recognizes that Maryland's RPS is implemented within the context of a broader (PJM) marketplace that includes other states with similar RPS mandates. These states have overlapping geographic eligibility criteria for renewable resources, so they compete with one another for adequate renewable energy supplies to meet their respective demands. This regional approach is taken into account in the analysis of supply, demand, renewable energy credit (REC) price and rate impact.

Non-solar: SEA assumed that *incremental* Tier 1 non-solar RPS compliance will be met by land-based wind. Due to pricing and historical RPS compliance trends, land-based wind is expected to be a cost-competitive marginal resource. To estimate future costs, SEA constructed a *supply curve* of wind projects that could be located in, or directly interconnected to, the PJM Interconnection to satisfy Maryland – and regional – RPS obligations. The projects assumed to be successfully developed represent about 25% of the region's technical potential, as identified by the National Renewable Energy Laboratory. The only modeled land-based wind not located in, or directly interconnected to, the PJM territory was 1,000 MW assumed to be delivered through new cost-effective transmission capacity expected to come online by 2025.

Solar: Cost of compliance with the solar carve-out program is based on Exeter Associates' *Avoided Energy Costs in Maryland* Report issued in April 2014. This report was prepared for the Maryland Department of Natural Resources' Power Plant Research Program as part of the EmPOWER Maryland Planning process. A solar supply curve was not constructed or relied upon for this analysis. Increased demand for solar – through a carve-out increase of 2% to 4% – may cause solar REC prices to rise in some years relative to the Exeter Report. On the other hand, economies of scale and efficiency gains are expected to continue to exert downward pressure on the delivered cost of solar electricity. This

analysis assumes that the market maintains a solar supply and demand balance similar to that assumed in the *Avoided Energy Costs in Maryland* Report. Like the Exeter report, solar REC prices are constrained by the "alternative compliance payment" where applicable.

"Base Case" Assumptions: In addition to those described above, several key additional policy assumptions were made in the base case scenario. First, federal support for wind energy through the "production tax credit" (PTC) was assumed to be extended at 100% of its current face value through the end of 2015, and then phased down to 60% by 2019, before expiring permanently in 2020. We understand that this policy is not currently in place and would need to be enabled by federal legislation. This report assumes that Congress will enact a sensible phase-down before terminating federal tax support for renewable energy.

Second, the EPA's new carbon regulations for new and existing power plants are expected to affect electricity prices. Starting in 2018, estimated price adjustments based on federal carbon regulations were modeled using Synapse Energy Economics, Inc.'s low-case CO_2 price forecast from spring 2014. This is intended to represent a reasonable estimate of the future price of CO_2 emissions for electric utilities and other stakeholders with long-term planning horizons.

Third, future energy efficiency gains by Maryland investor-owned utilities were assumed to align with their historic 2014 performance under *EmPOWER Maryland*. This assumption is reasonable given that Maryland's Public Service Commission has already held hearings to set efficiency targets beyond the EmPOWER 2015 timeline.

Finally, this analysis assumes that beginning in 2017, 50% of incremental RPS obligations will be secured through long-term contracts with local distribution utilities, and the other 50% will be secured through REC purchases on the "spot market." As a result, an increasingly larger share of the REC market is assumed to be secured through long term contracts from 2017-2025, at a significant discount to spot market purchases. To this end, this report assumes that a long-term contracting policy is developed as a part of, or in parallel to, an expanded RPS policy between now and 2017. The availability of long-term, creditworthy offtake contracts has a material impact on the ability to finance new renewable energy facilities and the resulting Levelized Cost of Energy (LCOE), REC premium and ratepayer impact. Several New England states have implemented long-term contracting programs through their distribution utilities in order to capture these benefits. Numerous utilities in the central United States (including states with no RPS) enter long-term contracts with wind generators based on economics alone. While such opportunities for long-term contracting have not been widely available in PJM in the past, experiences like these in other RPS markets have shown an increasing appetite among policymakers to support – through competitive solicitations by local utilities – the stable and competitive long-term prices offered by many renewable energy resources. To the extent that long-term contracts are utilized to comply with RPS obligations, they place downward pressure on consumer electricity prices and the ratepayer impact of the RPS.

More Information: More information on the assumed base case scenario as well as additional details on each of the input assumptions can be found in the remainder of this report. In addition to the base case scenario, the body of this report also contains a "high rate impact sensitivity" scenario, which varies the CO_2 price forecast to assume that the existing RGGI program will meet EPA 111(d) standards, no future changes will be made to the RGGI program rules, and that federal tax support through the PTC or any other mechanism will expire permanently after December 31, 2014. The report also details some of the study's limitations, as well as factors not included in this analysis.

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This study provides an independent, objective analysis of the potential ratepayer impact of increasing Maryland's Tier 1 RPS target (inclusive of solar and offshore wind carve-outs) from 20% to 40% by 2025.

SUMMARY RESULTS

This report estimates the *incremental* impact on MD ratepayers *beyond* the current RPS obligation.

Base Case Rate Impact Results

Year	Residential		Commercial		Industrial	
	$/Cust/Mo	% Increase	$/Cust/Mo	% Increase	$/Cust/Mo	% Increase
2020	**$0.52**	**0.4%**	**$5.00**	**0.4%**	**$55.82**	**0.5%**
2025	**$1.94**	**1.5%**	**$18.79**	**1.4%**	**$209.16**	**1.7%**

Table 1: Weighted Average Bill Impact (in 2014$), Base Case

REC Price Impact Results:

- 2025 Est. Weighted Average REC Price = ~$8.50 (a blend of long-term and spot purchases)
- Estimated impact of increased RPS targets on 2025 REC spot market = ~$1/MWh
  - 2025 Est. Spot Market REC Price, Without RPS Target Increase = ~$16/MWh
  - 2025 Est. Spot Market REC Price, With RPS Target Increase = ~$17/MWh

Key Assumptions (*explained in detail below*)

- Production Tax Credit (PTC) extended through 12/31/2015, then phased to zero by 2020.
  - Enabling legislation is assumed to be in place during either the 2015 or 2016 session.
- CO2 price forecast taken from *Synapse 2014* (Low-Case) as a proxy for impact of EPA 111(d).
- Maryland investor-owned utilities assumed to continue energy efficiency gains at 2014 levels, which is equivalent to a gross energy savings rate of 2.2% over 10 years.
- *Grain Belt Express Clean Line* assumed completed, delivering 1,000 MW of wind (nameplate).
- Half of incremental RPS compliance beyond 2016 assumed achieved through long-term contracts – enabled by the assumed adoption of a new long-term contracting policy.

High Rate Impact Sensitivity

Year	Residential		Commercial		Industrial	
	$/Cust/Mo	% Increase	$/Cust/Mo	% Increase	$/Cust/Mo	% Increase
2020	**$1.84**	**1.4%**	**$17.53**	**1.3%**	**$195.85**	**1.6%**
2025	**$3.11**	**2.4%**	**$30.10**	**2.3%**	**$335.17**	**2.7%**

Table 2: Weighted Average Bill Impact (in 2014$), Policy Sensitivity

REC Price Impact Results:

- 2025 Est. Weighted Average REC Price = ~$17.50 (a blend of long-term and spot purchases)
- Estimated impact of increased RPS targets on 2025 REC spot market = ~$1/MWh
  - 2025 Est. Spot Market REC Price, Without RPS Target Increase = ~$21/MWh
  - 2025 Est. Spot Market REC Price, With RPS Target Increase = ~$22/MWh

Key Assumptions

- 2014 PTC expiration assumed permanent. No other federal tax credit support is assumed.
- CO2 price forecast assumes the existing RGGI program will meet EPA 111(d) standards – RGGI cost embedded in regional electricity forecast. No future changes in RGGI rules are forecasted.
- Maryland investor-owned utilities assumed to continue energy efficiency gains at 2014 levels, which is equivalent to a gross energy savings rate of 2.2% over 10 years.
- *Grain Belt Express Clean Line* assumed completed, delivering 1,000 MW of wind (nameplate).
- Half of incremental RPS compliance beyond 2016 assumed achieved through long-term contracts.

DETAILED ASSUMPTIONS

- **RPS Targets:** BAU @ 20% by 2025; Increased Target @ 40% by 2025
  - Targets normalized to calendar years (from June-May schedule) where applicable

- **Load Forecast and Impact of Energy Efficiency**
  - Regional load informed by PJM 2014 Load Forecast Report
  - RPS demand calculated by allocating regional load among PJM states (e.g. MD = 8.6%), taking into account energy efficiency forecasts and MD RPS load exemptions
  - Energy efficiency assumptions from *MD PSC Ten-Year Plan (2014-2023)*, and aggregate proposed utility energy efficiency gains from their 2015-2017 EmPOWER plans.
  - **Analysis Assumption** = EE gains will align with historical 2014 EmPOWER achievement, which is equivalent to a gross energy savings rate of 2.2% over 10 years.

- **Federal Tax Incentives**
  - **Base Case:** PTC extended @ 100% of current face value for 2 years (through 12/31/2015), and then phased to 60% of full value by 2019, zero thereafter. This policy is not currently in place and would require enabling legislation. Congress is assumed to enact a sensible phase-down of federal tax support.
  - **High Rate Impact Sensitivity:** 2014 PTC expiration assumed permanent.
  - "Under Construction" eligibility criteria allow projects to effectively capture PTC for 2 years beyond the nominal expiration date

- **Cost of Compliance with CO2 Regulation**
  - Based on *Synapse CO_2 Price Report, Spring 2014*
  - Synapse Price Report forecasts the national cost of carbon emissions, assuming that state, regional and federal carbon polices would increase the costs of operating carbon-emitting resources. Forecasts reflect both near- and long-term regulatory and legislative approaches to emissions reduction. When designing this forecast, Synapse reviewed proposed federal regulatory measures to limit CO_2 emissions, state CO_2 pricing policies, and carbon price forecasts from the most recent IRP efforts of 46 utilities.
  - **Base Case:** EPA 111(d) expected to increase the cost of new carbon regulation compliance (up from RGGI Cap) beginning in 2020 – with CO_2 prices starting to increase 2 years prior (reflects early banking). **Based on Synapse *CO_2 Price Report, Spring 2014 Low-Case*.** This forecast represents a scenario in which federal carbon policy—either regulatory or legislative—exists but is not aggressive.
  - **High Rate Impact Sensitivity:** The existing RGGI program is expected to be sufficient to meet new standards; the cost of RGGI compliance is already embedded in our electricity price forecast. No future changes in RGGI rules are forecasted.

- **RPS Eligibility**
  - Only considered resources within PJM (except for Grain Belt supply)
    - Some states allow generation outside PJM; omission is a conservative assumption
  - Assume all states compete at the margin for new supply beginning 1/1/2017

- Incremental supply is all wind
- Other generation, if available at lower cost, is ignored ➔ conservative assumption

- **Existing & Pipeline Supply**
  - Existing RPS-eligible supply plus projects in the near-term pipeline, *including banked RECs*, are assumed sufficient to satisfy regional RPS demand obligations through 12/31/2016.
  - Analysis focuses on long-term cost of new entry and RPS compliance cost in 2025; the market's transition from supply- and demand- to long-term cost of entry-based REC pricing may result in near-term values that differ from this report.

- **Wind Resource Potential**
  - Used published estimates of technical potential for wind development in the region to cap development potential (NREL Eastern Wind Dataset, 2012 EWITS Update)
    - This analysis applies a further derate for permitting challenges in each state (50-75% depending on location of wind resources and level of urbanization)
    - Benchmarked against NREL Wind Resource Potential Analysis – capped development in any state at the minimum of the derated dataset above and the maximum technical potential from this study
      - ➢ Sum of derated dataset = ~25% of NREL 100m technical potential

Figure 2. PJM Wind Supply: Est. of Technical Potential versus SEA Adjusted Supply Assumptions (1)

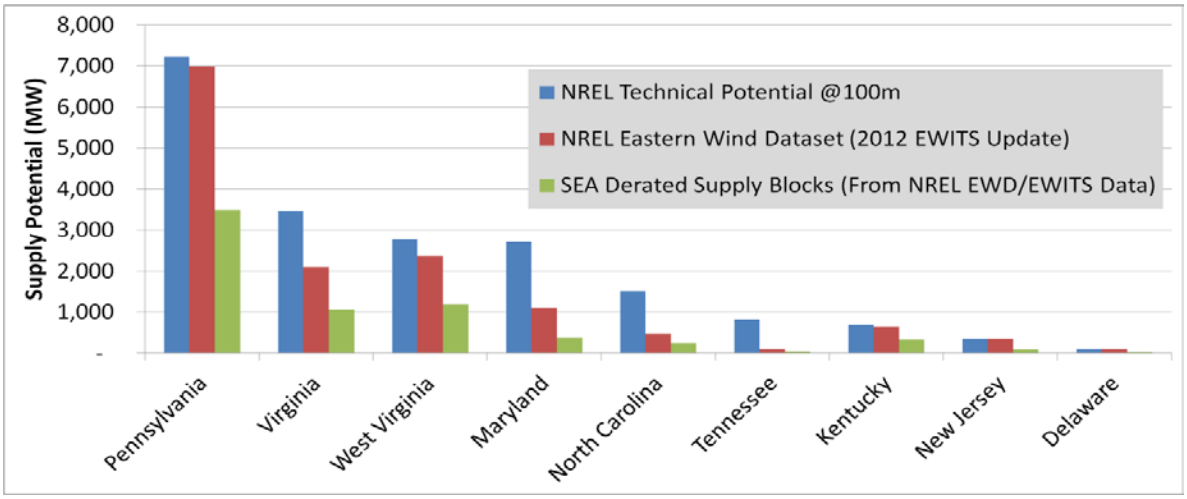
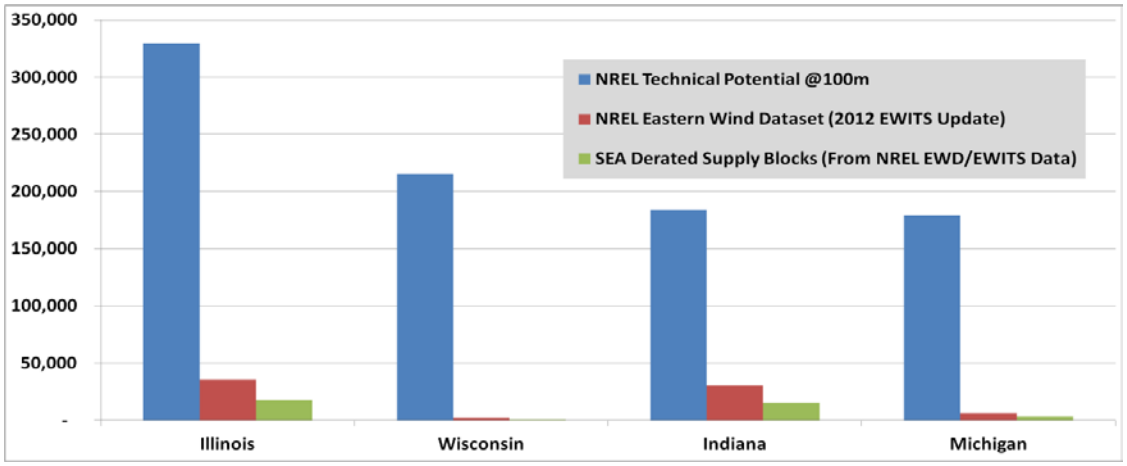


Figure 3. PJM Wind Supply: Est. of Technical Potential versus SEA Adjusted Supply Assumptions (2)



Grain Belt Express Clean Line

- Assumed to deliver 1,000 MW of wind (nameplate) under long-term contracts
- Additional wind supply (up to 3,500 MW) is possible → could further reduce cost impact
- Assumed to deliver wind power to PJM, reducing the cost of RPS compliance by offsetting higher priced marginal in-region supply
- Phased-in 2020 – 2021; net annual capacity factor ~55%; applied to all cases

- **Long-Term Wind Installed Cost Forecast**
  - Informed by historic cost data reported in LBNL 2013 Wind Technologies Market Report
  - Analysis applies a 50/50 weighting of actual costs for "Interior" and "Great Lakes" projects.
  - Adjusted up by 5% in mountainous states and by 7.5% in heavily urbanized states to account for permitting and construction challenges.
  - Transmission & interconnection costs differentiated by state
  - Wind integration costs estimated, by scenario, based on penetration[1] and are assumed borne by generators
  - Wind turbine cost experience curve from LBNL 2013 Wind Technologies Market Report
  - Balance of plant and interconnection costs escalated using blended CPI/metals/commodities index (EIA AEO 2014)
  - 2025 capital costs reflect a net nominal 27% decrease compared to 2013 values
  - O&M Costs and escalation informed by LBNL 2013 Wind Technologies Market Report and SEA Market Research, escalated by inflation and levelized over project life

- **Long-Term Contracts**
  - This analysis assumes the adoption of a new long-term contracting policy sufficient to satisfy 50% of incremental RPS demand beginning in 2017.
  - Long-term is defined as sufficient to enable financing at the most attractive rates (20-yrs)
  - Contracts are assumed to be bundled (energy + RECs);

[1] *Interpolated from GE PJM Renewable Integration Study*

- Provides long-term price certainty; ratepayer hedge against fuel volatility;
- Enables acquisition of RECs at a discount to spot market
- Impact of REC disposition options on cost to ratepayers
  - Assuming 100% sale of RECs into the spot market would increase cost and tend to over-estimate ratepayer impact
  - Assuming unlimited access to long-term contracts would decrease cost and tend to under-estimate ratepayer impact.
  - **This analysis assumes 50% of incremental RPS obligations beyond 2016 are secured through long-term contracts with local distribution utilities. Ratepayer impact is based on the weighted average (long-term and spot) REC price for RPS compliance in each year.**
- Because Maryland has a competitive electricity market, the availability of long-term contracts will likely depend on additional policy mechanisms directed at distribution utilities. Other competitive electricity states, particularly in New England, have required their utilities to solicit large volumes of renewable energy through long-term contracts while also providing remuneration opportunities for those utilities.

- **Supply Curve & REC Prices**
  - Wind assumed as exclusive marginal resource
  - For each year, 50% of the incremental demand is assumed to be locked in at a value equal to the 20-year levelized cost of entry of the marginal wind generator, mirroring a fixed-price long term contract over that term. The remaining 50% of incremental RPS demand is assumed fulfilled through spot market purchases.
  - As a result, an increasingly larger share of the REC market is assumed to be secured through long term contracts from 2017-2025, at a significant discount to spot market purchases.

Figure 4. Share of REC Supply Hedged/Acquired through Spot Market

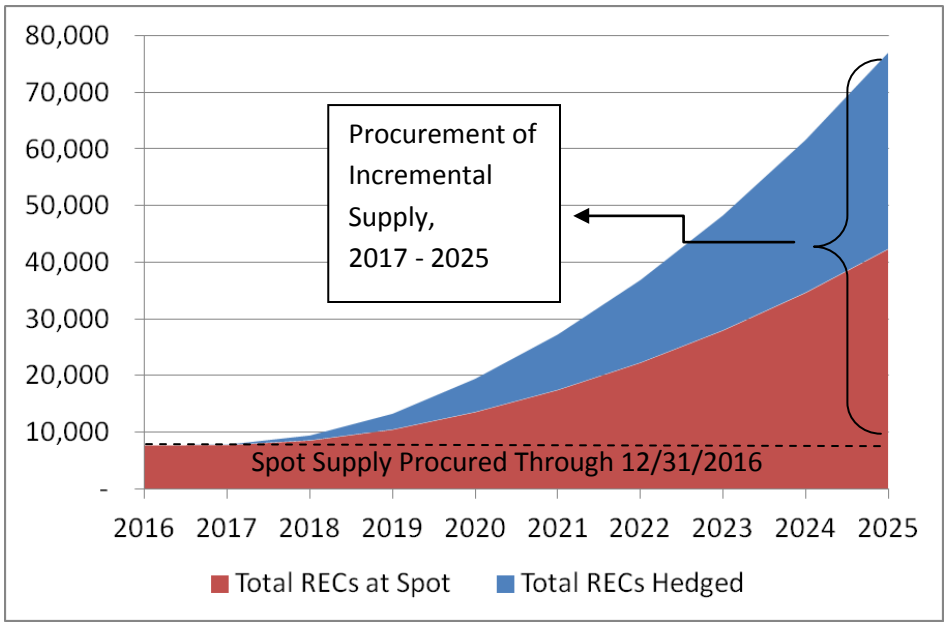


Table 3: Est. of Spot and Weighted Average REC Prices for Incremental Supply, by case, for 2025

	Base Case		High Rate Impact Sensitivity	
$/MWh	BAU	MD RPS Increase	BAU	MD RPS Increase
Spot REC Price, 2025	**$16.22**	**$17.00**	**$21.14**	**$22.22**
Wtd. Avg. REC Price, 2025	**$8.48**	**$8.66**	**$18.26**	**$17.65**

- **Commodity Market Revenues**
  - Starting point based on historic zonal electricity market prices from PJM, then weighted using PJM wind production profiles to develop a wind-weighted market value of production.
  - Wind-weighted zonal values then trended using an index derived from an average of the selected zonal price forecasts in Exeter Associates' *Avoided Energy Costs in Maryland Report* issued April 2014.
  - Assumed Capacity Value of wind: 13%, then derated by 50% based on current regulatory uncertainty for renewable energy projects' access to PJM capacity markets.

Table 4: Wind-Weighted Market Value of Production

Wind-Weighted Market Value of Production (Energy + Capacity) (Nominal $/MWh)										
Year	PJM-APS	PJM-AEP	PJM-ATSI	PJM-MidE	PJM-SW	PJM-CE	PJM-S	PJM-DEOK	PJM-EPA	PJM-WPA
2014	**$51.95**	**$46.88**	**$46.88**	**$68.50**	**$55.67**	**$40.19**	**$58.56**	**$43.54**	**$61.60**	**$53.16**
2015	**$60.40**	**$54.74**	**$54.74**	**$74.82**	**$60.29**	**$47.26**	**$67.78**	**$51.00**	**$67.40**	**$61.74**
2016	**$67.44**	**$61.26**	**$61.26**	**$79.85**	**$64.32**	**$53.11**	**$75.48**	**$57.18**	**$72.12**	**$68.90**
2017	**$71.38**	**$65.15**	**$65.15**	**$84.73**	**$68.77**	**$56.93**	**$79.49**	**$61.04**	**$75.67**	**$72.86**
2018	**$71.71**	**$65.44**	**$65.44**	**$87.11**	**$69.37**	**$57.16**	**$79.87**	**$61.30**	**$76.18**	**$73.19**
2019	**$73.00**	**$66.66**	**$66.66**	**$87.16**	**$75.49**	**$58.29**	**$81.26**	**$62.47**	**$77.90**	**$74.50**
2020	**$72.59**	**$66.14**	**$66.14**	**$89.23**	**$71.79**	**$57.63**	**$80.99**	**$61.88**	**$79.82**	**$74.12**
2021	**$77.11**	**$70.45**	**$70.45**	**$92.10**	**$74.93**	**$61.65**	**$85.79**	**$66.05**	**$82.31**	**$78.69**
2022	**$78.96**	**$71.97**	**$71.97**	**$100.05**	**$83.18**	**$62.75**	**$88.07**	**$67.36**	**$92.08**	**$80.62**
2023	**$84.95**	**$77.67**	**$77.67**	**$101.03**	**$82.23**	**$68.05**	**$94.44**	**$72.86**	**$90.46**	**$86.68**
2024	**$87.55**	**$80.04**	**$80.04**	**$104.40**	**$84.59**	**$70.12**	**$97.33**	**$75.08**	**$93.45**	**$89.33**
2025	**$88.70**	**$80.96**	**$80.96**	**$107.82**	**$88.59**	**$70.73**	**$98.79**	**$75.85**	**$96.86**	**$90.54**

- **Price Suppression**
  - The price suppressive effect of wind additions was not modeled.
  - All else equal, this would tend to overstate the rate impact of increasing the RPS, because the injection of additional renewable energy will tend to reduce energy prices to all customers.

- **Offshore Wind**
  - Assumes a single 200 MW project with COD 1/1/2018, in all modeling cases

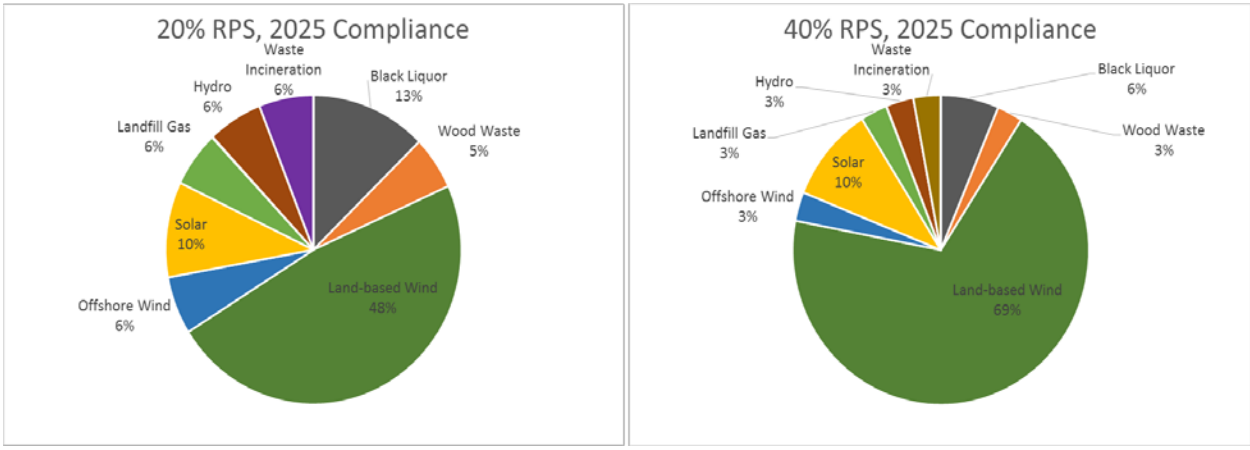
- **SREC Price Assumptions**
  - Cost of compliance with MD solar carve-out program based on Exeter Associates' *Avoided Energy Costs in Maryland Report* issued in April 2014. Prices assumed constant between Business as Usual and Increased Targets cases.
  - Increased demand for solar may cause SREC prices to rise in some years relative to the Exeter Report. On the other hand, economies of scale and efficiency gains are expected to continue to exert downward pressure on the deliver cost of solar electricity. This analysis assumes that the market maintains a solar supply and demand balance similar to that assumed in the *Avoided Energy Costs in Maryland* Report. Like the Exeter report, solar REC prices are constrained by the "alternative compliance payment" where applicable.

Table 5: SREC Price Assumptions

SREC Price Forecast (Nominal $/MWh)	
Year	$/MWh
2017	**$107**
2018	**$98**
2019	**$90**
2020	**$80**
2021	**$76**
2022	**$73**
2023	**$50**
2025	**$50**
2025	**$50**

- **Composition of 2025 Supply**

Figure 5. Estimate of Composition of 2025 Renewable Energy Supply



Retail Rate Impact: The following tables summarize the estimated bill impact for typical residential, commercial and industrial customers in Maryland in 2015. These results are a weighted average of BGE, DPL, PE and PEPCO utility territories.

Table 6: Retail Rate Impact by year and rate class, Base Case, 2014$

2014$	Residential	Commercial	Industrial
2017	$0.00	$0.00	$0.00
2018	$0.15	$1.42	$15.85
2019	$0.33	$3.17	$35.44
2020	$0.52	$5.00	$55.82
2021	$0.82	$7.80	$87.02
2022	$1.67	$16.06	$179.00
2023	$1.68	$16.18	$180.50
2024	$1.82	$17.55	$195.54
2025	$1.94	$18.79	$209.16

Table 7: Retail Rate Impact by year and rate class, High Rate Impact Sensitivity, 2014$

2014$	Residential	Commercial	Industrial
2017	$0.00	$0.00	$0.00
2018	$0.42	$3.97	$44.47
2019	$1.10	$10.49	$117.20
2020	$1.84	$17.53	$195.85
2021	$2.36	$22.56	$251.62
2022	$2.57	$24.65	$274.81
2023	$2.61	$25.12	$280.13
2024	$2.88	$27.76	$309.31
2025	$3.11	$30.10	$335.17

Potential Additional Mechanisms to Reduce Cost

- **Policy**: Adopt a long-term, stable and transparent policy structure → for example, provide clarity with respect to what happens to the RPS after 2025.
- **Procurement**: Enable long-term contracts through distribution utilities
  - Offered through competitive procurements on a known schedule
  - With creditworthy counterparties
  - Bundled (developer preference) or unbundled
  - Alternatives to utility competitive procurement
    - Standard Offer Tariff: assured access to off-take contract; reduced transaction cost
    - Hedging options (to reduce market price risk)
- **Other**: Expedited permitting, loan guarantees

Study Limitations

Modeling Decision	Implication: Would tend to…		Notes
	Over-state rate impact	Under-state rate impact	
Wind-only supply curve	✓		More cost-competitive, non-wind/non-PJM supply may be available.
PJM-only supply curve	✓		
Price suppressive effect of wind additions not modeled	✓		Additional renewables will tend to reduce energy and capacity market prices to all customers
Reduction in wind revenue due to price suppression not modeled		✓	Smaller than magnitude or prior row, since only applies to a portion of market energy
Potential future natural gas price volatility	✓	✓	Could cause rate impact to go down **or** up, but more room for natural gas prices to rise than fall
Wholesale market prices not reduced in High EE case	✓		
Impacts of potential additional network transmission upgrades beyond interconnection and integration costs assumed, and/or wind curtailment due to transmission constraints		✓	Magnitude unknown
Solar REC Price forecast held constant in increased solar target case	✓	✓	Increased demand/RPS obligations for solar may cause solar REC prices to rise relative to the price assumed in this analysis. However, this would not impact the final forecasted cost of RPS compliance.