REPORT OF THE THERMAL ENERGY TASK FORCE

Maryland Energy ADMINISTRATION

Powering Maryland's Future

Executive Summary

The General Assembly created the Thermal Energy Task Force ("Task Force") during the 2013 Legislative Session through the passage of SB 797/HB 1084. The legislation requires the Task Force to (1) analyze how to restructure the Renewable Portfolio Standard ("RPS") to incorporate thermal energy sources, including energy generated by wood-derived biomass; (2) determine whether it is appropriate to create a separate compliance tier for thermal energy; (3) determine a method for awarding renewable energy credits ("RECs") for thermal energy sources; and (4) determine any other changes to State law the Task Force deems appropriate to incorporate thermal energy into the RPS.

Responding to its charge, the Task Force held three meetings over the course of several months. Chaired by the Maryland Energy Administration, the Task Force consisted of representatives from the Maryland General Assembly, State agencies, energy industry, and environmental community. After extensive deliberations, the Task Force reached consensus on six recommendations, summarized below.

(1) **Recommendation 1**: The Task Force recommends that the General Assembly create two new thermal tiers in Maryland's RPS for systems that deliver useful and beneficial thermal energy to an end use location in Maryland. The Task Force also recommends the General Assembly move newly created systems utilizing non-solar Tier 1 technologies, including geothermal heating and cooling, animal manure-based biomass, and qualifying biomass technologies, into a primary thermal tier (Thermal 1), while moving some existing qualifying biomass generators into a secondary thermal tier (Thermal 2).

(2) **Recommendation 2:** In order to minimize ratepayer cost impacts while maximizing benefits, the Task Force recommends limiting Alternative Compliance Payments ("ACP") to the extent that the market has supplied Thermal Renewable Energy Credits ("TRECs"). The Task Force recommends that electricity suppliers be required to purchase available TRECs, but should not need to make ACP payments for thermal obligations that were not delivered to the market.

(3) **Recommendation 3:** To effectively grow thermal renewable energy production while minimizing ratepayer impacts, the Task Force recommends that the Thermal 1 tier gradually ramp up to 2% of electricity sales in 2024. Additionally, the Task Force recommends that the ACP for Thermal 1 start at $30 in 2015 and decline to $20 in 2019, while the ACP for Thermal 2 start at $0.25 in 2015 and decline to $0.05 in 2019.

(4) **Recommendation 4:** To ensure maximum greenhouse gas reduction benefits from woody biomass thermal systems, the Task Force recommends incorporating a 65% minimum efficiency requirement for woody biomass thermal systems, while limiting eligible feedstocks.

(5) **Recommendation 5:** In order to be eligible to satisfy the RPS, the Task Force recommends that thermal energy in Thermal 1 be required to displace electricity or a non-renewable fuel in an application in which electricity or a non-renewable fuel would have otherwise been used for a useful thermal application.

(6) **Recommendation 6:** The Task Force recommends that animal-manure biomass and geothermal heating and cooling systems registered with the Public Service Commission to receive Tier 1 RECs before the creation of the two thermal tiers remain eligible to receive Tier 1 RECs for the remaining life of the systems. The Task Force also recommends that the owners of these systems be permitted to re-register their systems for Thermal 1 TRECs if they elect to do so.

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A. Introduction

Maryland's Renewable Portfolio Standard ("RPS") was originally signed into law in May 2004 and has undergone numerous enhancements since that time. Thanks to this policy, and the focus placed on it by the O'Malley-Brown Administration, Maryland has seen significant deployment of in-State renewable energy systems. This has reduced carbon emissions, created good paying jobs, and continues to transition Maryland's energy system towards a more distributed, equitable, and sustainable future.

While solar and wind technologies have been particularly well-positioned to take advantage of the RPS, the RPS as it was originally written did not address the largest use of energy in Maryland homes and businesses: thermal-based heating and cooling systems. According to the Energy Information Administration's Residential Energy Consumption Survey, heating and cooling of ambient air and water account for 65.4% of an average home's energy use. Further, more than 40% of Maryland households rely on electric resistance for their home heating needs. This is one of the most expensive, least efficient, and carbon intensive methods of heating a home or business.

In 2011 and 2012, the General Assembly passed two separate bills incorporating solar water heating and geothermal technologies into the RPS. The challenge, however, is that these bills incorporated thermal technologies into the RPS with electricity technologies. The RPS is not designed to address thermal technologies. This resulted in inconsistencies in statutory language and did not address the fundamental distinction between the properties of electric power and thermal energy.

To rectify this issue, in 2013 the General Assembly passed legislation creating the Thermal Energy Task Force ("Task Force"). Chaired and staffed by the Maryland Energy Administration ("MEA"), the General Assembly entrusted the Task Force with holistically reviewing and recommending alterations to the RPS to address the challenge of incorporating thermal energy in a comprehensive manner. Additionally, the General Assembly charged the Task Force with recommending a responsible and effective means of incorporating thermal woody biomass systems into the RPS. A more encompassing approach towards incorporating thermal energy sources into the RPS will reduce costs to ratepayers, spur in-State economic development, and reduce dangerous greenhouse gas emissions.

This report represents the work of the Task Force. Where the Task Force reached consensus, it includes policy recommendations for further legislative action. This report stems from the work of key stakeholders in the geothermal, solar thermal, and biomass industries, members of the Maryland House of Delegates and Maryland Senate, representatives from Maryland's Department of Natural Resources, Maryland Department of the Environment, and Public Service Commission, and members of the environmental community. This report would not have been possible without the thoughtful, expert input of these key members.

B. Task Force Directive

The General Assembly passed SB 797/HB 1084 during the 2013 Legislative Session. Signed into law by the Governor shortly thereafter, the legislation required the Task Force to:

(1) Analyze how to restructure the renewable energy portfolio standard under Title 7, Subtitle 7 of the Public Utilities Article to incorporate thermal energy sources, including energy derived from wood–derived biomass;
(2) Determine whether it is appropriate to create a separate compliance tier for thermal energy sources;
(3) Determine an appropriate method of awarding renewable energy credits for thermal energy sources, including energy derived from wood–derived biomass; and
(4) Determine any other changes to State law that the Task Force deems appropriate to incorporate thermal energy sources in the renewable energy portfolio standard.

When conducting its analysis and making its recommendations, the legislation also required the Task Force to consider the State's ability to:

(1) Meet the greenhouse gas reduction goal under § 2–1204 of the Environment Article;[1]
(2) Achieve the goals set forth in the State's renewable energy portfolio standard under § 7–703 of the Public Utilities Article;[2] and
(3) Utilize wood–derived biomass to help meet the State's renewable energy goals, consistent with § 5–102 of the Natural Resources Article.[3]

C. Structure of Task Force Meetings

The initial meeting of the Task Force consisted of presentations offered by the chair and staff of the Task Force. These presentations provided background information on the directives of the Task Force and reviewed the development and expansion of the RPS. The Task Force staff also presented a "50 State Survey" of other states that have incorporated thermal energy into their renewable portfolio standards. A streamlined version of this "50 State Survey" is included as Appendix C to this report.

Following this background information, the Task Force chair provided a more in-depth presentation on the role of the RPS as a market stimulant, as well as a primer on market-based incentives. The Task Force then discussed this information. The staff of the Task Force ended the meeting by providing a number of threshold questions for the Task Force's consideration. Summaries of the answers to these questions are provided in Section E of this report.

[1] This portion of the Greenhouse Gas Reduction Act requires the State to "reduce statewide greenhouse gas emissions by 25% from 2006 levels by 2020."
[2] This portion of the RPS sets forth general REC procurement requirements.
[3] This statute sets forth the forestry goals of the State, including "[a]cheiving no net forest loss" and "promoting renewable energy policies and markets with increased emphasis on the use of in-State woody biomass."

The Task Force reviewed the threshold question responses at the second meeting. A roundtable discussion followed, after which the chair asked for consensus on the threshold questions. Based on the consensus reached by the Task Force at this meeting, the Task Force chair and staff completed a first draft of the report. The Task Force reviewed this draft at its third meeting. Recommendations on which the Task Force reached consensus are included in this report.

D. Threshold Questions

At the end of the first Task Force meeting, the Task Force staff asked members six important "threshold questions" that would help frame and target the meetings of the Task Force, as well as this report. Specifically, the staff asked the Task Force:

(1) Should renewable thermal energy be in Tier 1 or a separate thermal tier?
(2) What is the supply potential for thermal energy?
(3) Should there be fuel displacement requirements?
(4) Should there by efficiency and metering requirements?
(5) What pricing and demand structure makes sense?
(6) How should existing thermal facilities be handled?

The Task Force discussed the threshold questions at its second meeting. Some answers to threshold questions on which the Task Force reached consensus are included as recommendations in Section E below. The answers received by the Task Force staff are included in Appendix B to this report.

E. Task Force Recommendations

After three meetings, the Task Force reached consensus on six recommendations, explained below. The Task Force believes these recommendations outline a path forward for Maryland to incorporate thermal energy sources into its RPS in a way that maximizes benefits to Marylanders while providing significant ratepayer impact safeguards. Importantly, the Task Force views the recommendations below holistically, with the assumption that they will be adopted together as part of the same process. By taking a comprehensive approached to integrating thermal energy sources into the RPS, the Task Force believes Maryland can foster new industries and save individuals and businesses money, all while protecting our forests and reducing dangerous greenhouse gas emissions.

(1) **Recommendation 1**: The Task Force recommends that the General Assembly create two new thermal tiers in Maryland's RPS for systems that deliver useful and beneficial thermal energy to an end use location in Maryland. The Task Force also recommends the General Assembly move newly created systems utilizing non-solar Tier 1 technologies, including geothermal heating and cooling, animal manure-based biomass, and qualifying biomass technologies, into a primary

thermal tier (Thermal 1), while moving some existing qualifying biomass generators into a secondary thermal tier (Thermal 2).

The Task Force focused considerable attention on determining the best method to incorporate thermal energy into the RPS. The majority of this debate centered on whether it is more appropriate to incorporate thermal energy into the existing Tier 1 or to create a separate thermal tier structure. Currently, solar hot water heating systems can receive Solar Tier RECs for thermal energy, while geothermal heating and cooling systems and animal manure-based biomass systems (which can be co-fired with woody biomass) can receive Tier 1 RECs for thermal energy. These systems are incorporated directly into the RPS with systems that generate electricity.

The Task Force eventually concluded that creating a new tier structure to support thermal technologies has several advantages over expanding eligibility for thermal technologies in the existing Tier 1. To start, creating a separate thermal tier allows thermal technologies to compete on their own terms. As discussed above, the ACP, supply, and demand help set prices in a particular RPS tier. If thermal energy were to be included in Tier 1, thermal systems would need to compete with millions of other RECs that are available from a broad geographic region.

Additionally, it is important to note that renewable thermal energy can operate like a demand reduction program by reducing demand for electricity. However, thermal energy can also replace non-renewable fuels directly, such as natural gas, propane, fuel oil and a number of other energy feedstocks. As a result, thermal energy is not directly targeted by existing incentives because it exhibits traits somewhere between an energy efficiency measure and renewable energy source. Creating a thermal tier recognizes this unique trait of thermal energy.

Creating a separate tier will also allow the State to balance an effective incentive with minimal ratepayer impacts. By moving thermal technologies into a separate tier, the State can better control the variables that impact price and supply, while mitigating the down-side of ACP costs if systems are not built as quickly as projected. A distinct carve-out will allow for appropriate and nuanced management of these technologies and therefore minimize their rate impact, while providing an attractive economic incentive.

Finally, creating a separate thermal tier better allows the State to realize the unique operational benefits of thermal energy. Thermal energy systems often run at very high efficiencies, with some boilers exceeding 85% efficiency levels, and are economical for direct use in commercial and industrial processes. Furthermore, unlike electricity, thermal energy is necessarily used on-site or in close proximity to a thermal source. Unlike with the bulk power grid, thermodynamics prevents the long distance transfer of thermal energy. This will ensure benefits accrue directly to Marylanders and also enable to the State to accommodate some support for existing biomass thermal generators in Maryland while mitigating potential constitutionality issues.

Given these considerations, the Task Force recommends creating two new thermal tiers, called “Thermal 1” and “Thermal 2.” At the same time, the Task Force recommends moving certain technologies from

the existing Tier 1 to the new thermal tiers. Thermal 1 will be used to support newly constructed thermal facilities that produce thermal energy delivered to a facility in Maryland and will be the primary focus of economic development of this policy. The Task Force recommends that all thermal technologies that currently qualify for Tier 1 RECs – geothermal heating and cooling, animal manure-based biomass, and qualifying biomass technologies – be moved into Thermal 1.

With this switch, some facilities that currently create Tier 1 RECs through combined heat and power ("CHP") applications using qualifying biomass would not qualify for either Tier 1 or Thermal 1. As such, the Task Force recommends creating a Thermal 2 tier that will provide temporary financial support to these facilities. Thermal 2 will exist for 5 years, and will be set at a level that corresponds to the average output of existing qualifying biomass facilities that deliver thermal energy for end use in the state.

Functionally, Thermal 1 and Thermal 2 will work in a manner similar to existing Tier 1 and Tier 2 obligations, with a few important distinctions. Suppliers will be required to calculate their obligation based on a percentage of sales method, and will need to purchase Thermal Renewable Energy Credits ("TRECs") through bilateral contracts or in the market at the going rate. As discussed in Recommendation 3 below, the percentage will increase over time and there will be an ACP that will decrease over time. Owners will register their systems in PJM-GATS, and suppliers will retire TRECs along with SRECs and Tier 1 and Tier 2 RECs.

(2) **Recommendation 2:** In order to minimize ratepayer cost impacts while maximizing benefits, the Task Force recommends limiting Alternative Compliance Payments ("ACP") to the extent that the market has supplied Thermal Renewable Energy Credits ("TRECs"). The Task Force recommends that electricity suppliers be required to purchase available TRECs, but should not need to make ACP payments for thermal obligations that were not delivered to the market.

As discussed above, one of the benefits of creating separate thermal tiers is that it gives the General Assembly more control over the ACP and, as a corollary, the relationship between ratepayer impacts and incentive effectiveness. To ensure that ratepayers and compliance entities are protected from paying the ACP for a lack of generated TRECs, the Task Force recommends that ACP payments be limited only to the extent that the market has supplied TRECs.

Under the current RPS, for electricity RECs, if a supplier does not retire sufficient RECs, they are obligated to pay the ACP. Ultimately, this cost (as well as costs for purchasing RECs) is included in the cost of electricity service that the supplier offers to customers. From a policy respective, requiring an ACP from electricity suppliers for electricity generation is appropriate. Suppliers are in the business of generating, buying, and/or selling electricity. Suppliers have the choice of purchasing RECs from existing projects or developing new projects on their own. If the market is not providing sufficient RECs to meet the supplier's obligations, they have the ability to develop and/or own projects. By requiring an ACP for electricity RECs, suppliers can help continue the development of the market that allows them to meet their compliance obligation.

The situation is not as straightforward, however, when translated to thermal technologies. Unlike the obligation to generate or procure electricity for their customers as part of their standard business practice, electricity suppliers have no obligation to generate or procure thermal energy for their customers. Furthermore, while suppliers or power marketers arguably would have expertise that could be applied in the development of renewable electricity generation, the same expectation for expertise in thermal energy development does not exist.

For these reasons, the Task Force recommends that ACP payments be limited only to the extent that the market has supplied TRECs. In other words, under this structure, electricity suppliers will be required to purchase all available TRECs, but would not have to make ACP payments for an obligation that was not delivered by the market. In order to facilitate this demand structure, the Task Force recommends requiring the PSC to establish or adopt an electronic system where producers of TRECs may publish TRECs for sale to electricity suppliers. This system will provide a central clearinghouse so that the PSC can determine the exact purchase obligation for electricity suppliers. It is likely this process can leverage the preexisting GATS system.

Under the current RPS structure, suppliers must demonstrate compliance by April 1 for the previous year. In this proposal, if sufficient TRECs were generated to fulfill the previous year's TREC retirement obligation in full for each electricity supplier, electricity suppliers must either purchase the TRECs necessary to meet their obligation or pay an ACP. However, in the event that some TRECs have been registered by April 1, but there are not enough TRECs available to fulfill the previous year's TREC retirement obligation in full for each electricity supplier, the retirement obligation would be adjusted automatically based on available TRECs and each electric supplier's previous year of electricity sales. This calculation will be performed by the PSC, which provide the adjusted requirement to the suppliers in sufficient time to meet the April 1 compliance deadline. Electricity suppliers would be required to either fulfill this adjusted retirement obligation or pay an ACP that is also adjusted to match the reduced obligation.

As a simple example, suppose that there are 80 TRECs total available on the electronic system. If there are two electricity suppliers that would be required to retire 50 TRECs for their previous year's Thermal 1 obligation. However, with only 80 TRECs available on the electronic system, their retirement obligation would be adjusted to 40 TRECs each. If either electricity supplier choose not fulfill this obligation, they would need to pay an ACP up to only 40 TRECs, rather than 50 TRECs. This process will help support TREC prices, but will not incur costs that the supplier was in little to no position to prevent.

The Task Force believes it is appropriate to allow electricity suppliers to contract to purchase TRECs throughout the entire year, even though ultimate TREC retirement obligations may not be known until one to two months in advance of the TREC retirement deadline. This will provide electricity suppliers with flexibility to contract to purchase TRECs in advance if they determine doing so is appropriate. If an electricity supplier purchases TRECs in excess of its maximum or adjusted retirement obligation for a given year, it can bank the remaining TRECs for use in following years in a manner similar to the banking of electricity RECs.

(3) **Recommendation 3:** To effectively grow thermal renewable energy production while minimizing ratepayer impacts, the Task Force recommends that the Thermal 1 tier gradually ramp up to 2% of electricity sales in 2024. Additionally, the Task Force recommends that the ACP for Thermal 1 start at $30 in 2015 and decline to $20 in 2019, while the ACP for Thermal 2 start at $0.25 in 2015 and decline to $0.05 in 2019.

The percentage of electricity sales that electricity suppliers must cover with TRECs each year will determine the size of the TREC market. Furthermore, the ACP set forth in statute for TRECs will set the maximum price of TRECs. The price will fluctuate based on supply and demand, but as long as there is not a glut of TRECs, the expectation is that prices will float near the ACP. Since these two factors (demand and price ceiling) are defined in legislation, they can be set to target specific funding levels both at the aggregate level for the overall policy and, to a somewhat lesser degree, at the individual system level.

The Maryland Department of Natural Resources has developed some initial estimates on the availability of cost-effective woody biomass fuel supply. MEA has data from the Clean Energy Grant Program for geothermal and solar water heating systems, which industry experts participating in the Task Force have supplemented. Based on this information, the available fuel supply of thermal systems does not appear to be a limiting factor in the near term. That is, there is sufficient qualifying biomass fuel to power systems well in excess of the scale that we anticipate being developed by the industry in the next decade. Geothermal and solar thermal resources are functionally infinite.

Given that fuel supply is not likely a limiting factor, we can project what type of market penetration may occur in the coming years. Based on initial estimates from MEA and feedback from industry participants in the Task Force, the table below contains a projection of the number of TRECs that might be generated as a result of new projects installed because of the new Thermal 1 tier.

Figure 1 – Projection of Available Thermal 1 TRECs

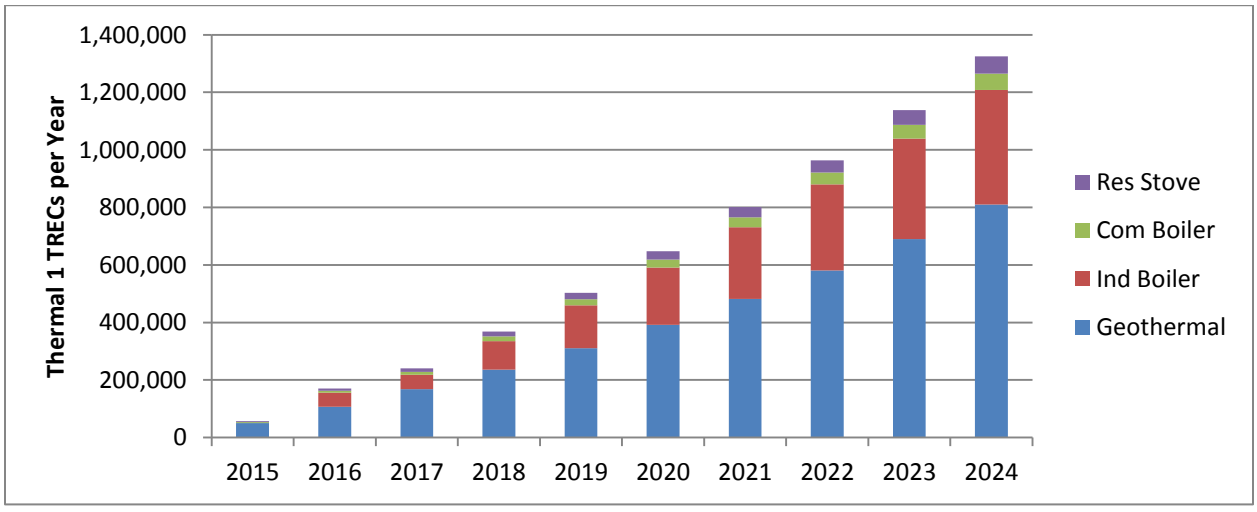


Table 1 – Projection of Available Thermal 1 TRECs

Technology	Per Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Geothermal	23.1	50,820	106,723	168,215	235,857	310,263	392,109	482,141	581,175	690,113	809,944
Ind Boiler	49,810	0	49,810	49,810	99,619	149,429	199,238	249,048	298,857	348,667	398,476
Com Boiler	1,314	2,627	6,569	10,510	15,765	21,020	27,588	34,157	40,726	48,608	56,490
Res Stove	7.5	3,736	7,845	12,365	17,337	22,807	28,823	35,441	42,721	50,729	59,538
Total TRECs		**57,183**	**170,946**	**240,900**	**368,578**	**503,518**	**647,759**	**800,787**	**963,479**	**1,138,116**	**1,324,448**

With these projections, it is possible to determine an appropriate percentage requirement for the Thermal 1 tier. Since the RPS requires that a certain percentage of electricity sales be covered by RECs (where one REC covers 1 MWh of delivered electricity), the next step is to project the total electricity sales per year in Maryland until 2024. The table below includes this projection, based on data from the publically available by the Energy Information Administration, an independent statistical division of the United States Department of Energy.

Table 2 – Projection of Load Growth in Maryland (2013–2024)

Year	MWh Delivered in Maryland
2013	62,071,647
2014	62,772,728
2015	63,496,322
2016	63,983,269
2017	64,628,609
2018	65,147,969
2019	65,756,426
2020	66,027,844
2021	66,443,924
2022	66,946,306
2023	67,288,327
2024	67,584,116

Using this data, it is then possible to determine how the growth potential for the thermal technologies outlined in Figure 3 above can be expressed as a percentage of yearly electricity sales. Given this relationship, the Task Force recommends that Thermal 1 should start at 0.1% in 2015 and ramp up to 2% by 2024. This ramp up is projected to cost the average ratepayer, at maximum, $0.03/month in 2015, while rising to $0.15/month in 2024. These ratepayer impacts are necessarily limited by the amount of the ACP, which creates a maximum price per TREC and thus keeps ratepayer impacts within this range. The phase-in schedule proposed by the Task Force is reproduced below.

Figure 2 – RPS Obligations with Addition of Thermal 1

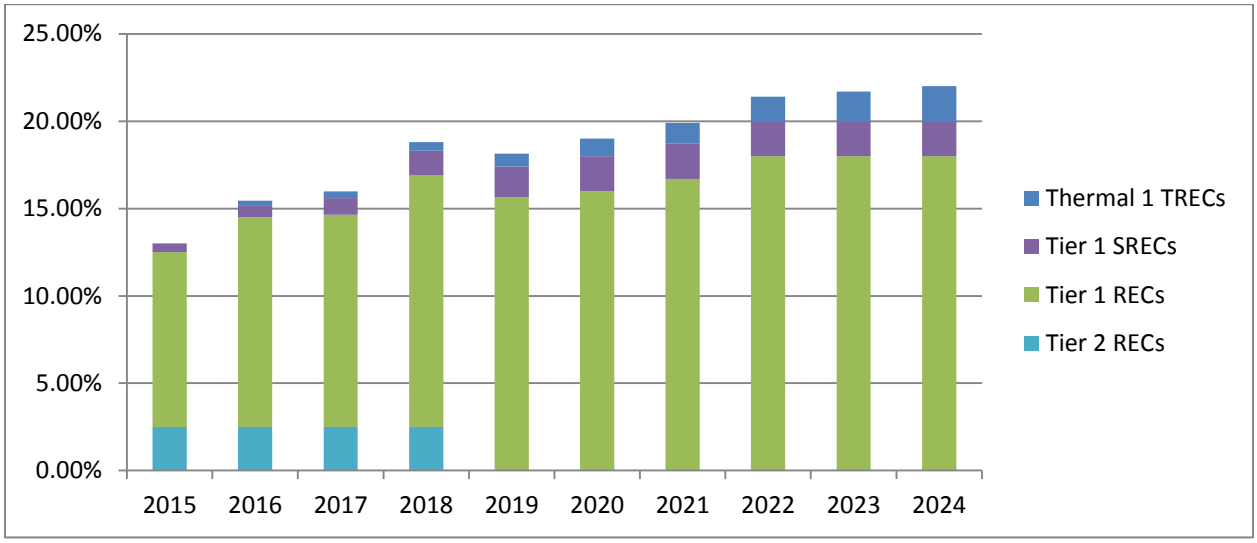


Table 3 – RPS Obligations with Addition of Thermal 1

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Thermal 1 Tier	0.10%	0.25%	0.38%	0.50%	0.75%	1.00%	1.20%	1.40%	1.70%	2.00%
Tier 1 SRECs	0.50%	0.70%	0.95%	1.40%	1.75%	2.00%	2.00%	2.00%	2.00%	2.00%
Tier 1 RECs	10.00%	12.00%	12.15%	14.40%	15.65%	16.00%	16.70%	18.00%	18.00%	18.00%
Tier 2 RECs	2.50%	2.50%	2.50%	2.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

The Task Force recommends that the ACP for Thermal 1 start at $30 in 2015 and decline to $20 in 2019, while the ACP for Thermal 2 start at $0.25 in 2015 and decline to $0.05 in 2019. This level of ACP will provide substantive financial support to newly developed and certain existing systems facilities without placing an undue burden on ratepayers.

(4) **Recommendation 4:** To ensure maximum greenhouse gas reduction benefits from woody biomass thermal systems, the Task Force recommends incorporating a 65% minimum efficiency requirement for woody biomass thermal systems, while limiting eligible feedstocks.

Using woody biomass to generate useful thermal energy taps the energy stored by photosynthesis, which uses sunlight, water, and carbon dioxide to produce oxygen and fix carbon in the wood. Combusting this wood releases the stored carbon, and the continued growth of the forest "recaptures" the carbon over time. However, the timing of the combustion and recapture varies based on a number of factors. Combusting large volumes of woody biomass at single sources with low efficiencies can in some situations create a "carbon debt" that takes an extended period to "pay off" before greenhouse gas reduction benefits are realized.

For example, one study in the Southeast found that expanded use of woody biomass for electricity generation at rates exceeding forest in-growth would create a carbon debt taking 35–50 years to

recover before leading to lasting carbon reduction benefits.[4] This is due to the large volumes of woody biomass that need to be combusted at utility scale electric plants. The facilities often require more wood than local forest industries produce as by-products, thus requiring the need to harvest trees specifically for fuel. Further, the woody biomass is often combusted in low-efficiency boilers that only convert a small fraction – sometimes as little as 25% – of the energy in the fuel to useful energy while still releasing all the carbon.

Since it takes time for forests to regenerate and store carbon dioxide after they are cut down, the scale and efficiency of the combustion process is just as important to the carbon cycle of forests as is the acreage of forests and their growth rates.[5] Generally speaking, the amortization period for carbon debt decreases with: (1) increased system efficiency and (2) the sustainability of the feedstock used in the system. The Task Force took this relationship into account when making the recommendations below.

First, the Task Force recommends limiting eligible thermal biomass systems to those that meet a minimum system efficiency of 65%. Compared to biomass systems that generate only electricity, thermal and combined heat and power ("CHP") biomass systems are extremely efficient, thus keeping carbon debt to a minimum. However, the Task Force determined that it is appropriate to set a base-line level of minimum efficiency to ensure maximum environmental and economic benefits accrue to the State. An efficiency requirement for technologies with a feedstock that is functionally finite and emits carbon is required to ensure the resource is utilized in the most productive way while minimizing greenhouse gas emissions.

Commercially available thermal and CHP biomass technologies today surpass 65% efficiency. The Task Force believes this is an appropriate, realistic minimum efficiency level. Additionally, it is important to note that geothermal technology relies on functionally infinite resources like the constant temperature of the earth and has low full-cycle GHG emissions compared to the fuel source it replaces. Therefore, no efficiency requirements are necessary for those technologies. Finally, the Task Force does not recommend imposing an efficiency requirement for Thermal 2 systems. The purpose of Thermal 2 is to provide temporary support for existing systems that may or may not meet the 65% efficiency threshold.

Second, the Task Force recommends limiting the scope of eligible woody biomass feedstocks to those that will ensure meaningful and near term greenhouse gas reduction benefits and allow a viable thermal woody biomass industry to develop in Maryland, all while protecting local air quality. An important component of this goal is to prevent the burning of treated wood and other hazardous wood-waste, while encouraging the use of clean and untreated wood residues that would otherwise release additional greenhouse gases, including methane, if not used to generate thermal energy. Another goal is to maximize the carbon sequestration attributes of forests.

Intermediate cutting of Maryland's woodlands such as thinning, pruning, salvage, sanitation and release are an important component of responsible forest management. These forest management techniques

[4] Biomass Supply and Carbon Accounting for Southeastern Forests, Biomass Energy Resource Center 9 (2012), *available at* http://www.southernenvironment.org/uploads/publications/biomass-carbon-study-FINAL.pdf.
[5] *Id.*

improve habitat and species diversity, remove dead or dying trees, mitigate risk of wildfire and facilitate sequestration of more carbon – as younger trees with more available water, light and nutrient resources grow faster, capturing carbon and releasing oxygen in correlation with their growth.

Utilization of bio-products that would otherwise be wasted is another consideration for inclusion in the RPS. Waste wood, such as untreated urban waste, scrap wood and pallets create an excellent opportunity to reduce wood waste in landfills, which upon decomposition release methane and carbon into the atmosphere. Agricultural crops and residues also can have positive impacts on the agro-economy and carbon emissions in the State, if managed appropriately. Finally, while liquid biofuels and biogas are a quickly developing market (with substantial economic potential in the transportation and other industries that may preclude their use in thermal applications), they remain a clean and efficient option for thermal applications.

Given these considerations, the Task Force recommends limiting woody biomass systems eligible for Thermal 1 compliance to those that utilize following feedstocks: (1) clean and untreated wood; (2) agricultural crops; (3) biogas generated from clean and untreated wood and agricultural crops; and (4) liquid biofuels generated from clean and untreated wood and agricultural crops. Additionally, the Task Force recommends excluding from eligibility materials derived in whole or in part from construction and demolition debris and liquids derived from mill residues.

The Task Force recognizes that the combustion of woody biomass results in greenhouse gas emissions. While the alternative of natural decomposition has net-negative greenhouse gas implications when compared to efficient combustion, Recommendation 4's requirement of a 65% efficiency threshold and the exclusion of certain biomass feedstocks is intended to prioritize support for biomass systems that are the most environmentally beneficial. It is the aspiration of the Task Force that biomass systems realize tangible greenhouse gas reduction benefits in an appropriate and achievable time-frame based on the best available lifecycle carbon accounting practices.

(5) **Recommendation 5:** In order to be eligible to satisfy the RPS, the Task Force recommends that thermal energy in Thermal 1 be required to displace electricity or a non-renewable fuel in an application in which electricity or a non-renewable fuel would have otherwise been used for a useful thermal application.

The Task Force considered whether thermal energy should be required to displace electricity or a non-renewable fuel in order to be eligible for inclusion in the RPS. Proponents of an offset requirement argued the General Assembly created the RPS with the intent of displacing non-renewable sources of electricity. By this logic, renewable thermal energy should displace nonrenewable sources of energy that would otherwise be used for thermal purposes. Opponents of this approach argued that requiring an offset would limit demand and hamper market efficiency. Eight states with thermal energy in their RPS laws require thermal energy to displace electricity for eligibility purposes. Arizona requires renewable thermal energy to either displace conventional electricity or fossil fuels directly.[6]

[6] For more information on state policies, please see Appendix C to this report.

The Task Force believes that direct use of thermal energy should be encouraged to displace electricity for thermal purposes where appropriate and cost effective as this may provide significant savings to participating ratepayers while reducing greenhouse gas emissions. In many instances, ratepayers utilize inefficient electric systems for thermal end-uses such as heating. Switching to the direct use of renewable thermal technologies may offer significant cost savings in the long term. Additionally, since the majority of electricity in Maryland comes from fossil fuels, displacing electricity with thermal renewable applications will reduce greenhouse gas emissions.

Additionally, the Task Force believes that thermal energy from renewable resources should be encouraged over the use of thermal energy from non-renewable fuel sources – such as heating oil and propane – because doing so targets energy use that has not been a central focus of either the State's renewable energy or energy efficiency policies. By replacing non-renewable energy sources that are used for thermal purposes with renewable sources, the State will further reduce greenhouse gas emissions in a previously untargeted sector. So long as thermal energy is contained in a separate compliance tier, the Task Force believes it is appropriate for the RPS to involve end uses that directly replace the use of fossil fuels.

Ultimately, the Task Force recommends that thermal energy be required to displace electricity or a non-renewable fuel in an application in which electricity or a non-renewable fuel would have otherwise been used for a useful thermal application. The Task Force believes this approach is consistent with the original intent of the RPS to displace non-renewable energy sources, resulting in reduced greenhouse gas emissions compared to the business-as-usual path. In order to ensure that the thermal tier targets only thermal energy applications, the term "useful thermal application" should be defined as thermal energy used for heating, cooling, humidity control, or process use.

(6) **Recommendation 6:** The Task Force recommends that animal-manure biomass and geothermal heating and cooling systems registered with the Public Service Commission to receive Tier 1 RECs before the creation of the two thermal tiers remain eligible to receive Tier 1 RECs for the remaining life of the systems. The Task Force also recommends that the owners of these systems be able to re-register their systems for Thermal 1 TRECs if they elect to do so.

The Task Force also considered how to address the thermal systems already registered with the PSC as non-solar Tier 1 sources under the existing RPS. Currently, thermal-only systems that utilize geothermal heating and cooling systems and thermal biomass systems using primarily animal waste as a feedstock can also apply for and receive non-solar Tier 1 RECs. While to date very few of these systems have been registered with the PSC, any legislation contemplated by the General Assembly may take a while to be enacted. It was therefore important to consider how these systems should be handled with a potential change in law.

The Task Force recommends that animal-manure biomass and geothermal heating and cooling systems registered with the Public Service Commission to receive Tier 1 RECs before the creation of the two thermal tiers remain eligible to receive Tier 1 RECs for the remaining life of the systems. Grandfathering

these existing systems will retain the expected economics for existing projects and demonstrate to developers that the General Assembly will use caution when considering any future changes to the existing standards. This will to signal to developers that the General Assembly takes investment backed expectations of developers into account when adding to or modifying the RPS.

The Task Force also recommends that the owners of animal-manure biomass and heating and cooling systems be able to re-register their systems as Thermal 1 systems if they elect to do so.

F. Conclusion

Thermal energy is used to meet a substantial share of Maryland's total energy requirements, and contributes significantly to energy costs and greenhouse gas emissions. Like it has before with the original RPS, the General Assembly has an opportunity to foster development of a new industry that will target many of the State's policy goals such as lower energy costs, reduced greenhouse gas emissions, increased energy independence, and economic development.

As described in this report, the formation of two new thermal energy tiers in the RPS can help meet these goals. By creating a new mechanism to support newly constructed thermal or CHP systems that use renewable fuels, Maryland can target an underdeveloped industry, create new jobs, and move forward towards a lower carbon energy future.

MEA would like to thank the many participants of the Task Force for their involvement and thoughtful attention to these issues.

Appendix A: Overview of Renewable Portfolio Standard

At its heart, the RPS is a compliance mechanism that relies on a market-priced commodity to ensure that a certain quantity of electricity sold in the state is covered by energy generated by approved renewable sources. The RPS statute defines this obligation as a percentage of sales for each year. The current RPS consists of two tiers – Tier 1 and Tier 2 – with a separate carve-out for solar technologies within Tier 1.[7] Each electricity supplier, otherwise known as load serving entities ("LSEs"), must demonstrate to the Public Service Commission ("PSC") that they are in compliance with the RPS statute.[8] The commodity used for compliance with this requirement is called a renewable energy credit ("REC"). Each REC represents the environmental attributes of 1 megawatt-hour ("MWh") of electricity that is produced by a qualified renewable resource, and has a shelf life of three years.

Each state has its own list of qualified technologies, and some place further geographic restrictions on where RECs can be produced and used for compliance. The following table summarizes Maryland's REC qualifications. Note that the tiers have a hierarchy, meaning SRECs can be used for Tier 1 non-solar compliance or Tier 2 compliance, and Tier 1 RECs can be used for Tier 2 compliance, but Tier 2 RECs cannot be used for Tier 1 compliance.

Table 4 – REC Qualifications Under Maryland RPS

Solar	Tier 1 Non-Solar		Tier 2
Solar PV*	Wind	Poultry litter*	Hydro (>30 MW)
Solar Water Heating*	Landfill/Wastewater Treatment Plant Gas	Waste-to-energy*	
	Qualifying Biomass	Refuse-derived fuel*	
	Geothermal*	Thermal energy from thermal biomass**	
	Ocean	Hydro (< 30 MW)	

* Must be "connected to the distribution grid serving Maryland"

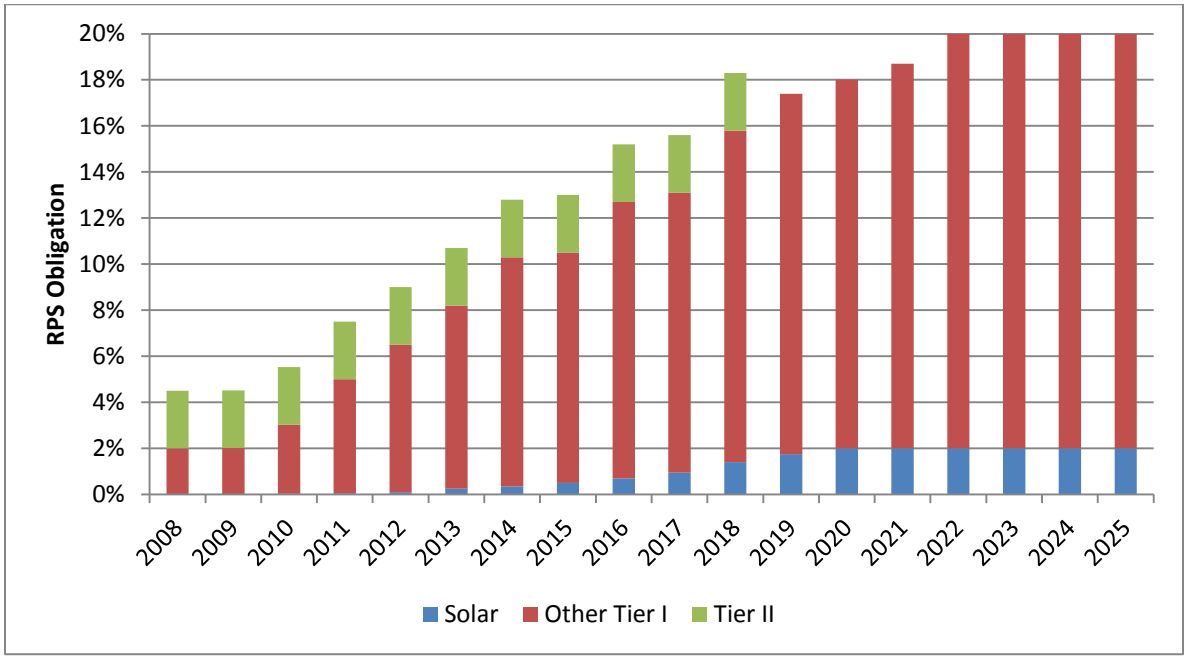
** Must be "used in the State"

The following chart shows the current obligation for each tier of the RPS. Note that the Tier 2 obligation sunsets in 2019, the solar carve-out reaches 2% in 2020, and the total RPS obligation reaches 20% in 2022. After 2022, the obligation for each tier remains constant. This means that under current law the RPS obligation will remain at 20% indefinitely from 2022 on, or until the General Assembly changes the obligation.

[7] There is also statutory language to create a carve out for offshore wind, but the mechanics of that carve out are more complex and will not be discussed in detail in this document.

[8] The PSC is the State regulatory agency responsible for oversight of LSEs, as well as electric distribution companies (i.e., Pepco and BGE).

Figure 3 – RPS Obligations Under Existing Law



Each year, every electricity supplier must demonstrate compliance with their obligation. This is done by "retiring" RECs through a mechanism created by the PSC. Suppliers must purchase RECs from the market, or must own generating assets that produce RECs. Each April, all RECs must be retired for the previous compliance year. As mentioned earlier, each REC has a shelf life of three years, meaning it can be used for compliance in the year it was generated and the following two years. So a REC produced in 2012 can be used for 2012, 2013, or 2014 compliance, after which it expires.

By April 1 of a given year, the supplier must have purchased sufficient RECs and SRECs to meet their obligation for the previous compliance year, and must retire them through PJM-GATS[9], the tracking system that is used for RPS policies for many states in PJM. If they do not retire enough RECs, they are subject to an Alternative Compliance Payment ("ACP") that varies by REC type and year.

The obligation for each supplier can be calculated by multiplying the total quantity of sales measured in MWh by the corresponding RPS obligation percentage for that year. Suppose a supplier sells 1,000,000 MWh in the Maryland market in 2013, and owns a solar generating asset that produces 1,000 MWh or 1,000 SRECs a year. The following table shows how their obligation is calculated and how many RECs and SRECs the supplier must retire to demonstrate compliance:

[9] PJM-GATS is the Generating Asset Tracking System that is used for compliance by multiple states in the PJM region. Generating system register their facilities to produce RECs, and PJM-GATS is used to issue and track specific RECs through serial numbers. It is also where LSEs retire RECs for their state RPS obligations.

Table 5 – Example of Supplier REC Obligation Calculation

	Sales (MWh)	RPS Obligation	RECs Needed	RECs Owned	RECs Purchased
LSE Sales	1,000,000				
Solar		0.25%	2,500	1,000	1,500
Tier 1 Non-Solar		7.95%	79,500	0	79,500
Tier 2		2.50%	25,000	0	25,000

Prices for RECs vary based on the tier and any carve out, and are set by a competitive marketplace or through contracts between parties. Because the ACP is the maximum that a supplier is willing to pay for a REC, it acts as a price ceiling.[10] For example, the ACP is currently $400 for SRECs, $40 for Tier 1[11] RECs, and $15 for Tier 2 RECs. If SRECs were trading at $500, a supplier would be better off paying the $400 ACP rather than purchasing the SREC.

Like any market, REC prices are set by supply and demand. However, due to the shelf life of a RECs, geographic and technology eligibility constraints, and a lack of perfect transparency and/or market information, the market dynamics of the REC market are very complex to model. Experience in Maryland and other states shows that when the market is undersupplied (i.e. there are not enough RECs available for purchase), prices rise towards the ACP. When the market is oversupplied, prices fall.

In the early years of Maryland's solar carve out, SRECs were in short supply and prices were over $350. As the market matured, supply caught up with increasing demand and prices have stabilized in the $120-$140 region. Tier 1 RECs have up to this point in time been plentiful, due in part to the wider geographic qualification and strong construction of wind farms during the ARRA years. As such, prices for Tier 1 RECs traded around $1-2 until recently. However, most states within PJM have similar geographic constraints for wind RECs, and the RPS obligation in most states are increasing rapidly. Thus, the oversupply in Tier 1 RECs is easing, and new generation will be needed to continue to meet increasing RPS obligations. This will in turn put upward pressure on prices. In 2012, prices increased to around $4, and projections by PPRP[12] show that Tier 1 RECs may increase to $10-15 in the coming years.[13] This price will be set by the marginal new resource, which for a variety of reasons is projected to be primarily wind projects in the near term.

[10] In reality, the most a supplier will pay for a REC is the ACP minus some small transaction cost.
[11] For simplicity, going forward Tier 1 implies Tier 1 non-solar technologies.
[12] Power Plant Research Program *Long Term Electricity Report Update.*
[13] The clearing price of RECs is driven by the revenue requirement of the marginal generator. This figure is calculated by subtracting other revenue sources (such as electricity and capacity sales, tax credits, and depreciation benefits) from the levelized cost of building a new generator, including a reasonable return on equity. In other words, it is the price a developer must receive in REC revenue in order to make the decision to build the generator.

Appendix B: Full Summary of Threshold Questions

At the end of the first Task Force meeting, the Task Force staff asked members six important "threshold questions" that would help frame and target the meetings of the Task Force, as well as this report. The responses to these questions received by the Task Force staff are paraphrased below. The Task Force discussed the threshold questions at its second meeting. Some answers to threshold questions on which the Task Force reached consensus are included as recommendations in the body of this report.

(1) **Threshold Question 1:** Should renewable thermal energy be in Tier 1 or a separate thermal tier?

Member	Comment
House	Yes, renewable thermal energy should be in a separate thermal tier, with existing in-State wood-waste and black liquor plants in a second thermal tier.
Biomass	No, thermal renewable energy should be included as a Tier 1 resource under the existing RPS because it gives utilities the option to choose renewable energy sources based on affordability.
Geothermal	Yes, both geothermal installations equipment and loop field should be considered under a separate thermal tier to allow greater flexibility for geothermal technologies to count towards the development and strength of RECs and incentives. Importantly, thermal renewable energy credits should be tied to the loop field and additional RECs should be to the actual geothermal equipment for points above the minimum EER and COP set by Energy Star. In addition, the statute to bar RECs for replacing "Energy Star" CAC units should be stricken as to what is Energy Star today will become outdated in just a few years.
MDE	Yes, a separate thermal tier is appropriate because: (1) thermal energy will not always displace electricity, the original focus of the RPS; (2) some thermal units are not as clean as other renewables; (3) placing thermal energy in Tier 1 would remove the incentive for load serving entities to procure RECs from more expensive, but cleaner, sources of energy. If the decision is made to tuck thermal units under Tier 1, it would be prudent to make such units qualify for only a small percentage of Tier 1 and only if they meet exacting eligibility requirements.
Forestry	No, thermal energy should be part of the existing Tier 1 sources eligible for the RPS because it provides load serving entities with more flexibility for RPS compliance.
Solar	No matter whether a separate thermal tier is created, the incentive should (1) facilitate system deployment by ensuring economics provide a reasonable rate of return and (2) be stable, thus enabling companies to forecast growth appropriately.

(2) **Threshold Question 2:** What is the supply potential for thermal energy?

Member	Comment
House	Estimated available accessible thermal renewable energy credits from woody biomass are estimated to be 1 million per year.
Biomass	N/A
Geothermal	The average annual number of residential geothermal installations in Maryland had been 2,200 or below prior to 2010. Given current shipments to Maryland of 2,700 units at 4 tons each that would indicate roughly 11,000 tons of new GHP installations per year. At a conservative rate of 0.5 kW/ton reduction at peak load, and 450 hours of peak load cooling

	per year, that translates to savings of about 2,500 MWh in incremental power reduction per year. Given the right type of incentives, these numbers can easily double or even triple.
MDE	N/A
Forestry	Wood biomass supply in Maryland can provide a maximum of 1.5 million thermal renewable energy credits if all available wood is fully applied to thermal systems, which is the equivalent of less than 15% of the total tier 1 REC pool predicted for 2022. Assuming that only 10% of available wood is converted to thermal energy, 160,000 thermal renewable energy credits are available, which is 3% of the REC pool expected in 2016.
Solar	A combination of renewable thermal technologies can supply nearly 100% of demand for thermal energy.

(3) **Threshold Question 3:** Should there be fuel displacement requirements?

Member	Comment
House	Yes, existing systems should be required to displace electricity.
Biomass	Yes, the RPS is put in place to advance renewable energy and thermal energy systems can be a direct replacement for existing systems.
Geothermal	Yes, the power producers who supply power should have annual megawatt goal reductions and a percentage of those reductions should come from new geothermal installations.
MDE	Yes, there should be a displacement requirement. Furthermore, such a requirement should not be overly burdensome.
Forestry	Yes, there should be a fuel displacement requirement because it ties in to the original purpose of the RPS: displacing non-renewable sources of fuel.
Solar	No, there should not be a fuel displacement requirement because it limits demand, which is economically inefficient. The goal should be to reduce carbon emitting fuel sources and greenhouse gas emissions.

(4) **Threshold Question 4:** Should there by efficiency and metering requirements?

Member	Comment
House	There should be a metering requirement and 65% minimum efficiency for woody biomass.
Biomass	Efficiency standards should be set to encourage potential customers to adopt the best available technology available. The requirement should be set at 70% net efficiency. Metering would allow the State to know where it is in regards to the RPS' requirements.
Geothermal	The only efficiency requirement should be initial studies to validate efficiency performance claims of individual system technologies. Such studies need to have a cross section of all HVAC technologies available to the end users. The studies should be conducted by true third party research groups to maintain arms-length distance from industry participants. The studies can be repeated in a 5-year cycle to keep data relevant to evolving technologies. With geothermal, rigorous manufacturer standards and testing by AHRI and the US DOE ensure consistent performance.
MDE	Having a minimum efficiency requirement is prudent because it helps promote the use of thermal technologies that tend to be cleaner. Metering should be required where it makes sense to do so from a technology and a practically standpoint.
Forestry	There should be a minimum of 60% net efficiency.
Solar	Metering should be utilized and incentivized wherever possible, especially for large non-residential systems. However, metering should not inhibit or have a significant negative

	economic impact on technologies, or prohibit technologies from entering the market if metering is currently not available, or widely accepted, in the marketplace.

(5) **Threshold Question 5:** What pricing and demand structure makes sense?

Member	Comment
House	A thermal tier should be phased in and a system must be required to deliver heat to a customer in Maryland.
Biomass	Thermal renewable energy credits need to be priced so that they encourage investment.
Geothermal	Pricing should be tied to the savings of kWh production to include the avoided cost of building new power plants, new transmission lines or upgrades to transmission lines, the avoided cost for local distribution upgrades, including avoided upgrades to local neighborhood electric substations. The positive attributes of savings should be reflected in each member of the supply chain from the power producer down to the distribution company and energy supplier. In addition, the cost of cleaning the air from carbon should be considered.
MDE	N/A
Forestry	N/A
Solar	Each thermal technology should have REC prices set individually based on the levelized cost of energy and price requirements for each technology. The pricing structure should also analyze and assess the CAPEX versus OPEX requirements for system deployment relative to different renewable thermal technologies.

(6) **Threshold Question 6:** How should existing thermal facilities be handled?

Member	Comment
House	Existing facilities should be put into a second thermal tier.
Biomass	Existing facilities should be allowed to participate in the thermal renewable energy credit market and should be viewed as early adopters.
Geothermal	Assuming the geothermal loop fields and equipment are made individually eligible for thermal renewable energy credits, existing geothermal loop field installations (prior to 2013) should be offered REC credits. The equipment portion should not receive credits. However, when the existing geothermal equipment is changed at the end of its life-cycle or for replacement upgrade to a higher efficiency geothermal system, the equipment portion should be added. In this way Maryland's geothermal renewable energy credit will have a built-in function to encourage true efficiency improvements, and at the same time recognize the value of existing loop fields.
MDE	N/A
Forestry	Existing thermal systems should be permitted to participate in the RPS.
Solar	Currently deployed systems should be grandfathered under existing rules. New incentives should be available to systems installed after a date certain.

Appendix C: Fifty State Survey of Thermal Energy in RPS Programs

This appendix offers a fifty state survey of how states have incorporated thermal energy into their renewable portfolio standards. This appendix is adopted from a memorandum designed to inform the Task Force on the practices of other states as it conducted its analysis and wrote its final report. This appendix focuses on four key features from each pertinent RPS. First, it focuses on what specific thermal technologies can participate. Second, it focuses on the requirements each law places on systems to qualify for participation, including whether the thermal energy must displace electricity or a non-renewable fuel. Third, it focuses on how each RPS creates RECs – either through the MWh of electricity displaced or a BTU to MWh conversion. Finally, it focuses on whether each RPS creates a thermal tier, offers a multiplier for thermal energy, and/or eventually phases out thermal energy. The first portion of the appendix recounts significant observations and recurring themes from the survey. The second section summarizes the key components of each RPS.

I. Significant Observations

1. Eight states require thermal energy to displace electricity for eligibility purposes. Arizona requires renewable thermal energy to either displace conventional electricity or fossil fuels directly (i.e., natural gas used for heating). The only state (besides Maryland for solar water heating systems and biomass) that does not require an electricity or non-renewable fuel offset of any kind is Indiana, which has a voluntary RPS.

2. Six states create RECs for thermal energy based on the MWh of displaced electricity, while five states create RECs for thermal energy based on a BTU to MWh conversion. Nevada does both, using electricity displaced for geothermal and BTU to MWh for solar thermal applications.

3. Only four states incorporate thermal biomass technologies into their RPS laws.

4. New Hampshire is the only state with a distributed thermal carve out (.2% of Class I RECs increased annually to 2.6% by 2025) and utilizes a lower ACP for thermal technologies ($55/MWh compared to $25/MWh in 2013). Arizona and New York include thermal as part of "distributed generation tiers," but those tiers also include distributed electricity systems. Pennsylvania includes solar thermal water heating as a Tier II energy efficiency measure. North Carolina includes solar thermal as part of its .2% solar carve out.

5. Nevada and Pennsylvania incorporate thermal technologies as energy efficiency measures that satisfy RPS requirement rather than as renewable energy technologies. Nevada incorporates geothermal as an energy efficiency measure and Pennsylvania incorporates solar thermal as an energy efficiency measure.

II. Summary Table

1. Arizona	
Qualifying technologies	Biomass thermal (any raw or processed plant-derived organic matter available on a renewable basis); biogas thermal; commercial solar pool heaters; geothermal space heating and process heating systems; solar daylighting; solar industrial process heating and cooling; solar space heating; solar water heaters. Eligible biomass and biomass thermal systems specifically exclude "biomass and wood stoves, furnaces, and fireplaces."
Qualification requirements	Must offset a "conventional energy resource," defined as "an energy resource that is non-renewable in nature, such as natural gas, coal, oil, and uranium, or electricity that is produced with energy resources that are not Renewable Energy Resources." Biomass thermal systems must comply with EPA Certification Programs or must be "permitted by state, county, or local air quality authorities."
REC creation	3,415 BTUs equals one REC
Thermal tier/multiplier/phase-out	Biomass and biogas thermal systems can only satisfy the statute's distributed energy tier, which is 30% of the state's 15% target for 2025.
2. Hawaii	
Qualifying technologies	Solar water heating; sea-water air-condition district cooling systems; solar air-conditioning
Qualification requirements	Must offset electricity consumption
REC creation	Each MWh electricity offset equals one REC
Thermal tier/multiplier/phase-out	Phases out on January 1, 2015
3. Indiana	
Qualifying technologies	Dedicated crops grown for energy production; Organic waste biomass, including any of the following organic matter available on a renewable basis: agricultural crops, agricultural wastes and residues, wood and wood wastes, including wood residues, forest thinnings and mill residue wood; Animal wastes; Animal byproducts; Aquatic plants; Algae. Excludes general household, institutional, commercial, industrial, lunchroom, office, and landscape waste, as well as treated and painted lumber.
Qualification requirements	"Useful thermal energy" must be used for heating, cooling, or mechanical work

REC creation	1 REC for 3,412,000 BTU of "useful thermal energy produced." The useful thermal energy can either be measured directly by meter or determined by a provided "default equation." The default equation is $$CECs\ Generated = \frac{Q \times \Delta H}{3.412 \times 10^6} \times (1 - e_L)$$ CECs Generated = Quantify of CECs generated (MWh) Q = Quantity of steam or hot water delivery (lbs) ΔH = Change in enthalpy from point of delivery to end of thermal energy use (BTU/lb) Default for steam = 830 BTU/lb Default for hot water = 300 BTU/lb e_L =Energy loss from point of delivery to point of use (fraction) Default = 0.15
Thermal tier/multiplier/phase-out	N/A
4. Maryland	
Qualifying technologies	Solar hot water systems, geothermal heating and cooling, thermal biomass systems using primarily animal waste as a feedstock but not woody biomass systems do not.
Qualification requirements	Thermal biomass systems must be located in-State. Thermal biomass systems must comply with all applicable State and federal statutes and regulations. Solar water heating systems must be comprised of glaze liquid-type flat plate or tubular solar collectors as defined and certified in the OG-100 standard of the Solar Ratings and Certification Corporation. Solar water heating systems must generate energy using solar radiation for the purpose of heating water. Solar water heating systems must not feed electricity back into the grid. Geothermal systems must meet or exceed current federal Energy Star product specification standards. Geothermal systems must be manufactured, installed, or operated in accordance with applicable government and industry standards. Geothermal systems must not feed electricity into

	the grid. Geothermal systems must replace or displace inefficient space or water heating systems whose primary fuel is electricity or a non-natural gas fuel source and that do not meet federal Energy Star product specification standards.
REC creation	For all eligible thermal technologies, 3,415 BTUs equals one REC. Solar water heating systems must be metered; geothermal RECs are modeled.
Thermal tier/multiplier/phase-out	Solar hot water systems qualify for SRECs.
5. Nevada	
Qualifying technologies	Direct geothermal as an energy efficiency measure that counts towards RPS compliance; solar thermal as a renewable resource that counts towards RPS compliance.
Qualification requirements	For both geothermal and solar thermal, must offset electricity consumption.
REC creation	For geothermal, each MWh electricity offset equals one REC For solar thermal, to calculate the number of equivalent kilowatt-hours attributable to the system not rated by the SRCC or a system which has an SRCC rating of 34 million BTU or more, electricity providers must use a thermal energy meter. For solar water heating systems with SRCC ratings of less than 34 million BTUs, electricity providers can either use an energy meter or the annual performance estimates of the SRCC.
Thermal tier/multiplier/phase-out	N/A
6. New Hampshire	
Qualifying technologies	Geothermal, hydrogen from biomass fuels or methane gas, methane gas, solar thermal energy, biomass
Qualification requirements	RECs available only for “useful thermal energy,” which is renewable energy from a qualifying technology that: (1) can be metered; and (2) is delivered into New Hampshire to an end user in the form of direct heat, steam, hot water, or other thermal form that is used for heating, cooling, humidity control, process use, or other valid thermal end use energy requirements. Must offset electricity consumption. For biomass, must have begun operation after January 1, 2013.

REC creation	To convert electricity from thermal energy into RECs, the statute provides that a "qualified producer of useful thermal energy shall provide for the metering of useful thermal energy produced in order to calculate the quantity of megawatt-hours for which renewable energy certificates are qualified, and to report to the public utilities commission under [its regulations]. Monitoring, reporting, and calculating the useful thermal energy produced in each quarter shall be expressed in megawatt-hours, where each 3,412,000 BTUs of useful thermal energy is equivalent to one megawatt-hour."
Thermal tier/multiplier/phase-out	Employs a distributed thermal carve out (.2% of Class I RECs increased annually to 2.6% by 2025). Employs a reduced ACP for thermal sources. More specifically, the RPS statute creates a general Class I ACP of $55/MWh in 2013, but a reduced Class I Thermal ACP of $25/MWh in 2013. The New Hampshire PUC adjusts these rates annually using the federal Consumer Price Index.
7. New York	
Qualifying technologies	Solar thermal hot water systems
Qualification requirements	Must offset electricity
REC creation	Each MWh electricity offset equals one REC
Thermal tier/multiplier/phase-out	Solar thermal hot water systems can only be used to satisfy the "customer-side tier," which will satisfy 6% of the state's 29% by 2015 goal.
8. North Carolina	
Qualifying technologies	CHP; Solar thermal including include solar hot water, solar absorption cooling, solar dehumidification, solar thermally driven refrigeration, and solar industrial process heat.
Qualification requirements	For CHP, must offset electricity consumption. For CHP, must come online after January 1, 2007.
REC creation	The thermal energy must be measured by meter, or if that is not practicable, by other industry-accepted means that show what measurable amount of useful thermal energy the system or facility is designed and operated to produce and use. One renewable energy certificate equals 3,412,000 BTUs of useful thermal energy produced.
Thermal tier/multiplier/phase-out	Solar thermal counts towards the statute's 0.2% solar carve out.
9. Pennsylvania	
Qualifying technologies	Solar thermal water heating
Qualification requirements	Must offset electricity consumption

REC creation	Each MWh electricity offset equals one REC
Thermal tier/multiplier/phase-out	Incorporated as a Tier II demand-side management technique. 10% of all electricity must come from Tier II resources by 2020.
10. Utah	
Qualifying technologies	Solar thermal
Qualification requirements	Must be (1) owned by consumers of electricity and (2) offset electricity consumption
REC creation	Each MWh electricity offset equals one REC
Thermal tier/multiplier/phase-out	Credit multiplier: a system state that derives its energy from solar photovoltaic and solar thermal energy receives a credit for 2.4 kilowatt-hours of qualifying electricity for each 1.0 kilowatt-hours generated.
11. Wisconsin	
Qualifying technologies	Solar water heating; direct solar applications such as solar light pipe technology; geothermal energy; biomass; biogas; synthetic gas created by the plasma gasification of waste; densified fuel pellets
Qualification requirements	Must offset electricity consumption
REC creation	Each MWh electricity offset equals one REC
Thermal tier/multiplier/phase-out	N/A

Appendix D: Task Force Members and Staff

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