Economic Benefits of the Proposed Coolidge Solar I Solar Project

An Assessment of a 20 MW Utility-Scale Solar Project in Vermont

Prepared for Coolidge Solar I, LLC

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EXECUTIVE SUMMARY

As part of its plan to develop a 20 megawatt solar facility in Ludlow, Vermont, Coolidge Solar commissioned Synapse Energy Economics, Inc. (Synapse) to evaluate several aspects of the project's impacts within the state of Vermont and regionally.

With the closure of multiple aging power plants, the region's independent system operator ISO New England faces a challenging time ahead as it seeks to maintain reliability and reasonably priced electricity as it balances energy supply and demand. On a local level, utilities face similar challenges in ensuring that energy needs and capacity constraints are addressed reliably and cost-effectively. Intensifying these challenges, New England states have all set ambitious targets and adopted corresponding policies to increase renewable energy sources and decrease greenhouse gas emissions.

In Vermont, utility-scale projects such as the Coolidge Solar Project can help address these energy and environmental needs; but they must first meet certain criteria before they can obtain approval as beneficial to the state. Synapse analysis of the Coolidge Solar Project, within the context of Vermont's standards for such renewable energy projects, found the following:

- **The project would provide substantial economic benefits for Vermont residents over its 20-year contract period.** These include an estimated 245 job-years, more than $15 million in labor income, and more than $25 million in GDP for the state.
- **The project would benefit Vermont's electricity customers over the long term in several ways.** Vermont's method for determining prices paid to this type of project, known as avoided cost rates, ensures that the rates are equivalent to wholesale market rates after adjusting for line losses. Rather than be exposed to rapid or long-term price swings, consumers will reap the hedging benefits of an affordable, long term, stably priced purchase agreement.
- **The project would help meet clearly demonstrated electricity needs both in Vermont and in the region as a whole.** Most notably, it would alleviate the well-documented gap between needed and available capacity – primarily during the summertime peak – that the region will face in forthcoming years.
- **The project would be part of a diversified solution to the region's clean energy challenges as New England seeks to reduce its dependence on natural gas and other fossil fuel resources over time.** In particular, it would qualify as both a Tier 1 resource within Vermont and as a Class I Renewable Energy Credit resource throughout New England, thus addressing an ever-increasing demand for renewable energy resources to meet legislated targets.

The Coolidge Solar Project is a small project in the overall New England energy landscape, and yet there is increasing recognition that a diverse portfolio of small, geographically distributed energy generators will play a significant role in transitioning the region to a clean energy economy. Moreover, many of these projects contribute to Vermont's economy in ways that fossil fuel-based resources cannot.

1. INTRODUCTION

Coolidge Solar I, LLC ("Coolidge Solar") is developing a 20 megawatt (MW) solar electric generating project to be located primarily in Ludlow, Vermont, adjacent to the Vermont Electric Power Company, Inc., ("VELCO") 345 kV/115 kV high voltage substation (the "Project"). Coolidge Solar has asked Synapse Energy Economics, Inc. ("Synapse") to analyze the need for the Project and as well as its economic benefits.

The results of Synapse's analysis, described in detail throughout this report, show that the Project is needed by Vermont and the region and will result in an economic benefit to the state.[1] Section 2 addresses the regional and Vermont need for the Project. Section 3 summarizes the results of Synapse's analysis of the Project's economic impacts in Vermont. Section 4 provides an overview of Synapse's findings on the utility cost impact of the Project, with consideration of avoided cost rates and a comparison of power purchase agreement rates for other solar projects. Section 5 describes the Project's likely effects on the region's wholesale electricity and capacity markets, and what that will mean for electricity customers. And finally, Section 6 discusses the role that the Project would play in Vermont's and New England's efforts to meet their clean energy goals.

Under Vermont law, developers of this type of project must demonstrate that a proposed project is "is required to meet the need for present and future demand for service which could not otherwise be provided in a more cost-effective manner through energy conservation programs and measures and energy-efficiency and load management measures…"[2] As explained in Section 5 of this report, below, the demands and clean energy requirements both in Vermont and for other New England utilities purchasing electricity from the New England regional electricity grid determine the need for the Project. Vermont utilities need both energy and capacity. In addition, Vermont and every other New England state have set challenging targets for procuring both renewable energy and energy efficiency. The resulting policies ensure strong and annually increasing demand for renewable energy certificates for the foreseeable future.

Vermont also requires that developers demonstrate that a Project will result in an economic benefit to the state, and recently amended Section 248 to require that the Public Service Board give due consideration to a project's impacts upon greenhouse gases.

[1] The Project has a 25 MW DC nameplate capacity, however it will deliver 20 MW AC to the electric grid. Therefore, this report treats the Project as 20 MW.

[2] 30 V.S.A. § 248(b)(2).

To address these issues, Synapse analyzed the following:

- The need for Vermont utilities to obtain more energy and capacity
- The need for Vermont utilities and the utilities in the region to obtain more renewable energy
- The extent to which the Project meets these needs, including the proposed Project's effect on Vermont and other New England states in their efforts to meet Renewable Energy Standards or Renewable Portfolio Standards
- The extent to which the Project contributes to economic activity in-state
- Whether power from the Project is economic, based on avoided cost rates, market rates, and other solar power purchase agreement prices
- The Project's likely impacts on the regional wholesale energy and capacity market
- The Project's likely impacts on rate stability for electricity customers
- The Project's likely impact on Vermont's greenhouse gas emissions

While the Project is only a small part of a much bigger equation, it can perform a useful role in achieving the state's recognized goal of creating a cleaner energy system in a way that is beneficial to ratepayers and local communities. Moreover, the region's existing policies and goals point to a long-term and continuously increasing demand for a range of renewable energy projects such as this one.

2. NEED FOR THE PROJECT

There is need for capacity, energy, and renewable generation, both in Vermont and New England-wide. These energy needs, however, manifest in different ways in Vermont and regionally. In both instances, the need for energy *per se* is reflected in the capacity need (the ability to meet peak load); but the regional New England marketplace has an additional need for energy price stability. The region needs energy sources with stable prices to provide a hedge against average wholesale prices shifting upward and against high peak prices. These peak prices occur during summertime peaks and, more recently, in wintertime when natural gas price surges drive extremely high hourly wholesale electricity prices. Regarding capacity, Green Mountain Power (GMP) has stated that it lacks sufficient committed capacity resources to meet its obligations in future years. Furthermore, New England marketplace forecasts showed insufficient capacity even before the recent announcement by Entergy that it would retire its

680 MW Pilgrim Nuclear Power Station no later than June 1, 2019.[3] Finally, both the state and the region need substantially more renewable generation to meet the renewable resource requirements both within Vermont and in each of the other five New England States.

2.1. Capacity

Both Vermont and New England as a whole have a need for additional capacity. While forecasts predict that load will grow by only 0.5 percent per year in New England between 2015 and 2024[4] the region expects substantial retirements of generating units whose capacities will have to be replaced.

In Vermont, the retirement of the Vermont Yankee nuclear plant resulted in the loss of 604 MW of capacity. Elsewhere in New England, already-retired units and units slated to retire by mid-2019 include the Pilgrim nuclear plant (680 MW), the coal-fired Mount Tom Station (143 MW), the coal- and oil-fired Salem Harbor (749 MW) and Brayton Point (1,535 MW) stations, and the oil-fired Norwalk Harbor Station (342 MW) and Bridgeport Unit 2 (146 MW). These retirements total 4,200 MW of summertime capacity. Note that a generator's summertime capacity is the relevant metric when considering capacity in all New England states because the system demand peaks in the summer.

The Coolidge Solar Project adds summertime capacity, and therefore contributes to reliability within Vermont and New England. For planning and capacity market purposes, ISO New England credits solar photovoltaic (PV) generators with 40 percent of their nameplate capacity, thus the Coolidge Solar Project's 20 MW nameplate capacity would result in an additional 8 MW of summertime capacity.[5] As Douglas Smith testified on July 15, 2015, GMP has a projected capacity gap of "over 200 MW in the near term, growing to about 350 MW … over most of the next decade."[6] Mr. Smith was testifying about the 5 MW Williston solar project, and his comments below apply equally to the 20 MW Coolidge Solar Project:

> This Project will meet a small portion of the energy and capacity needs of GMP's customers, most likely by operating as a "load-reducer" within GMP's service territory. Specifically, during hours when the Project is producing net output, that output will offset the hourly load requirements that GMP needs to purchase from the ISO-NE energy market. In turn, reductions in GMP's hourly load requirements at the time of the ISO-NE annual hourly peak load will reduce GMP's share of regional capacity obligations in the [Forward Capacity Market (FCM)]. By reducing GMP's net load requirements from ISO-NE, the Project will also tend to reduce GMP's allocation of ISO-NE ancillary service

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[3] Entergy Corporation. 2015. "Entergy to Close Pilgrim Nuclear Power Station in Massachusetts No Later than June 1, 2019." *Pilgrim Nuclear Power Station*. Last modified October 13, 2015. http://www.pilgrimpower.com/entergy-to-close-pilgrim-nuclear-power-station-in-massachusetts-no-later-than-june-1-2019/.

[4] ISO New England. 2015. "CELT Report: 2015-2024 Forecast Report of Capacity, Energy, Loads, and Transmission." Table 1.1, Row 1.3. http://www.iso-ne.com/static-assets/documents/2015/05/2015_celt_report.pdf.

[5] ISO New England. 2015. "Final 2015 Solar PV Forecast Details." Page 31. http://www.iso-ne.com/static-assets/documents/2015/04/2015_solar_forecast_details_final.pdf.

[6] Smith, Douglas. 2015, July 15. "Prefiled Direct Testimony of Douglas Smith." Vermont Public Service Board Docket No. 8562. Page 5.

> costs, although the value of these savings will likely be quite small relative to energy and capacity.[7]

Within Vermont, GMP faces a capacity gap even after a recent long-term power purchase agreement between GMP and NextEra for an additional 150 MW of NextEra's Seabrook nuclear generating station. Docket No. 8445's July 9, 2015 order states that "GMP's projected open capacity and energy positions will still be substantial after the [Seabrook] Agreement is in place," and that "the proposed [Seabrook] Agreement would provide roughly one third of those needs, leaving roughly 300 MW to be met with future supply- and demand-side resources."[8] The utility has made a "conscious decision to purchase its projected needs gradually,"[9] and the Coolidge Solar Project's contribution to those needs would be in line with this decision.

New England also has a demonstrated need for capacity. The 2014 Connecticut Integrated Resource Plan observed that "beginning in 2017, the region will face a capacity shortage of 143 MW, primarily due to the announced retirement of 4,100 MW of non-gas generation resources and a reduction in capacity imports."[10] The *Avoided Energy Supply Costs in New England: 2015* study's Exhibit 6-1 shows the need for new generic natural gas combustion units to meet New England capacity needs starting in 2019.[11] ISO-NE's *2015 Regional Electricity Outlook* similarly identifies over 3,500 MW of coal- and oil-fired generation retiring by 2018 with several thousand additional MW at risk by 2020.[12] None of these three capacity shortage forecasts include the retirement of the Pilgrim nuclear unit in June 2019. In light of the retirements, ISO New England stated the following:

> Retirements can drive up prices in the capacity market, too. The region's Forward Capacity Market (FCM) allows the ISO to purchase commitments from resources three years in advance to provide power when needed. Before the eighth FCM auction was conducted [in] early 2014, more than 3,000 MW of resources announced plans to retire. This resulted in a small deficit in resources needed for 2017/2018, as well as in an insufficient level of participating resources, which triggered administrative pricing rules designed to prevent market manipulation. The result was higher prices, with the 2017/2018 market value estimated at $3.05 billion. The region could see high prices in future auctions because of additional resource retirements, particularly if new

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7 Smith, Douglas. 2015, July 15. "Prefiled Direct Testimony of Douglas Smith." Vermont Public Service Board Docket No. 8562. Pages 5-6.

8 Vermont Public Service Board. 2015, July 9. Docket No. 8445 Order. Page 8.

9 Smith, Douglas. 2015, July 15. "Prefiled Direct Testimony of Douglas Smith." Vermont Public Service Board Docket No. 8562. Page 7.

10 Connecticut Department of Energy and Environmental Protection. 2015. "2014 Integrated Resources Plan for Connecticut." Page iii.http://www.ct.gov/deep/lib/deep/energy/irp/2014_irp_final.pdf.

11 Hornby, R. et al. 2015. "Avoided Energy Supply Costs in New England: 2015 Report." Exhibit 6-1. http://ma-eeac.org/wordpress/wp-content/uploads/2015-Regional-Avoided-Cost-Study-Report.pdf.

12 ISO New England. 2015. "2015 Regional Electricity Outlook." Page 21. http://www.iso-ne.com/static-assets/documents/2015/02/2015_reo.pdf.

generators or transmission projects face siting and permitting challenges that cause significant delays.[13]

It is clear that New England as a whole will face substantial capacity challenges in the years to come. The Coolidge Solar Project would help address that need both in Vermont and region-wide, particularly during the summertime peak when the system is most constrained.

2.2. Energy

Vermont's electric reliability needs are reflected in the capacity discussion above. To the extent that Vermont and New England have adequate capacity, there will be access to sufficient electric energy. Adequate capacity does not ensure prices that are low or stable, however. Vermont needs energy prices that are protected against both short-term and longer-term spikes.

Short-term spikes can occur any time of the year, and are often the result of a combination of unexpectedly high demand and a lack of adequate resources at that time. This spike could occur during a summer heatwave, a winter cold snap, or if a number of large generation or transmission resources were in a state of planned or forced outage. Solar PV is likely to reduce the market clearing price surge in all cases:

- During a heat wave, solar PV facilities are typically generating at a high capacity factor.
- During a cold snap, solar PV output reduces pressure on gas pipelines and gas storage, thereby reducing the need to shift to oil-fired generators instead of natural gas or to use LNG or propane storage injections.
- As for large generation and transmission outages – these aren't correlated with PV output at all, meaning PV can serve as a hedge against those potential price spikes as well.

The Coolidge Solar Project would also serve as a hedge against upward drifting wholesale energy prices in the long run. To the extent that any large generators with low marginal costs retire after the avoided cost rate is set, there will be upward pressure on wholesale markets *even if the capacity is replaced with a combined-cycle gas plant* (see Section 4.1 for an explanation of avoided cost rates). For example, when calculating the avoided cost rates established in Docket N0. 8010, La Capra likely presumed that Massachusetts' 680 MW Pilgrim nuclear plant would operate until its operating license expired in 2032.[14] Pilgrim has since been scheduled to retire by June 2019. Even if the full 680 MW are replaced by a combined-cycle natural gas plant, the wholesale clearing price will be higher than it would have been

[13] Ibid.

[14] La Capra relied on the ISO New England 2014 *CELT Report* for generating capacity (Docket No. 8010, Order Entered February 9, 2015 at 15) which includes Pilgrim within its entire study time horizon (2013 – 2023); the *Avoided Energy Supply Costs in New England: 2015 Report* includes Pilgrim until its operating license expires in 2032; the *2014 Integrated Resources Plan for Connecticut* includes Pilgrim for its entire study horizon (2014 – 2024); and Green Mountain Power's *2014 Integrated Resource Plan* doesn't include Pilgrim in its list of retirements.

with Pilgrim. Solar generation such as the 20 MW project in question results in the utility locking in the energy price. This provides a hedge against the long run price increase stemming from unexpected retirements of large, low marginal cost units. Because the Coolidge Solar Project is a Qualified Facility under the Public Utilities Regulatory Policies Act of 1978 (PURPA), Vermont's GMP will reap 100 percent of the short-term and long-term wholesale energy hedging benefits offered by the Project.

2.3. Renewables

Public policy initiatives to curb emissions, technical advances and price reductions in renewable technologies, and market forces are all driving demand for new renewable resources.[15] As emphasized in the Comprehensive Energy Plan:

> Over the last decade, Vermont ratepayers have used electricity from resources with relatively stable prices and relatively low emissions. Going forward, we will face many challenges if we are to continue to deliver electricity 'in a manner that is adequate, reliable, secure, and sustainable; that assures affordability and encourages the state's economic vitality… that is environmentally sound.'[16]

In 2005, the Vermont General Assembly set aggressive greenhouse gas reduction goals for the state: reducing emissions of greenhouse gases from 1990 levels by 50 percent by 2028 and 75 percent by 2050.[17]

In 2011, the Department of Public Services (DPS) issued the Comprehensive Energy Plan, setting out a broad vision for the state to acquire 90 percent of all energy from renewable sources by 2050.[18]

> These goals, the product of broad political and stakeholder deliberation, illustrate the importance Vermont places on addressing the climate challenge while recognizing the potential economic benefits and energy security associated with renewable energy resources. Renewable resources are more likely to be local, and with resources directed toward upfront capital expenditures rather than ongoing fuel costs, the impacts on Vermont's economy are expected to be beneficial.[19]

According to a very recent report presented by Asa Hopkins, DPS Director of Energy Policy and Planning to the Vermont Solar Siting Task Force, the Comprehensive Energy Plan's 90 percent renewable goal

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[15] ISO New England. 2015. "2015 Regional Electricity Outlook." Page 13. http://www.iso-ne.com/static-assets/documents/2015/02/2015_reo.pdf.

[16] Vermont Department of Public Service. 2011. "Comprehensive Energy Plan 2011." Vol.2, page 64 (quoting 30 V.S.A. § 202a).

[17] 10 V.S.A. § 578(a).

[18] Vermont Department of Public Service. 2011. "Comprehensive Energy Plan 2011." Vo1, pages 3-4; Vol. 2, pages 64-65.

[19] Vermont Public Service Department. 2014. "Total Energy Study: Final Report on a Total Energy Approach to Meeting the State's Greenhouse Gas and Renewable Energy Goals." Page 1.

reflects Vermont's "[s]trong desire to become energy secure, ensure stable prices *and as much as possible to rely on resources indigenous to Vermont.*"[20]

Finally, in 2015 the Vermont General Assembly enacted a new Renewable Energy Standard (RES), under which Vermont utilities are required to own bundled renewable energy and/or Renewable Energy Credits (RECs) equivalent to 55 percent of retail sales in 2017, escalating steadily by 4 percent every third year until reaching 75 percent on or after 2032.[21] The RES legislation specifies three distinct categories of required resources to meet the RES requirements, including total renewable energy (Tier 1), and two distinct carve-outs (Tier 2 and Tier 3). The carve-outs combine to represent 3 percentage points of the 55 percent requirement in 2017, growing to 22⅔ percentage points of the 75 percent in 2032. In Vermont, between 2017 and 2032, there is a need for approximately 50 percent of electric sales to come from "a technology that relies on a resource that is being consumed at a harvest rate at or below its natural regeneration rate"[22] within New England.

At the same time, the remainder of New England is also transitioning to generation from renewable resources. Indeed, the five other states in the region have similar renewable energy policies: Maine increases its target until 2017, Connecticut and Rhode Island until 2020, New Hampshire until 2025, and Massachusetts indefinitely. Although Maine has been able to comply with its Renewable Portfolio Standard (RPS) at a very low cost, the high price for Class I RECs in other New England states demonstrate a clear need for additional renewable generation.[23]

The Coolidge Solar Project will generate RECs that can be used for compliance either with the Vermont RES Tier I requirement or for compliance with the RPS policy in any other New England state. With the exception of Maine, all New England states demonstrate a clear need for the emissions-free, renewable generation that the Project provides.

3. Economic Benefits to Vermont Residents

3.1. Summary of Economic Impacts

The Project will have positive economic benefits for Vermont. Synapse has quantified some of these impacts, although there are additional, unquantified economic and societal benefits. This analysis is for

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[20] Hopkins, Asa. Vermont Public Service Department, Planning & Energy Resources Division. 2015. "Vermont Comprehensive Energy Plan: Public Forum" (emphasis added). http://publicservice.vermont.gov/sites/psd/files/Pubs_Plans_Reports/State_Plans/Comp_Energy_Plan/2015/PSD%20CEP%20intro%20v4.pdf

[21] 30 V.S.A. § 8005(d)(4)(A).

[22] Vermont Bill H.40. 2015. http://legislature.vermont.gov/assets/Documents/2016/Docs/BILLS/H-0040/H-0040%20As%20Passed%20by%20Both%20House%20and%20Senate%20Official.pdf.

[23] See Figure 4: Average Monthly REC Price (2015$)

the 20-year term of the contract. However, in the likely event that the project's useful life extends beyond that period, the project will continue to generate economic benefits for Vermont.

Synapse estimates that, over the 20-year contract term, the Project will generate 245 job-years,[24] more than $15 million in labor income, and more than $25 million in GDP in Vermont. Shown in Table 1, these impacts are generated by both the construction and operation of the Project, including:

- **Direct impacts** representing the short-term construction labor and materials used on the Project site, as well as long-term plant workers and supplies needed to maintain the facility;
- **Indirect impacts** representing the industries in Vermont that supply the materials needed to construct and operate the Project; and
- **Induced impacts** representing the activity generated by employees re-spending their wages within the Vermont economy.

Further detail on the economic impacts of the construction and operating phases of the Project are shown on pages 11 and 13, respectively.

Table 1: Total economic impacts in Vermont (20-year period)

Type of Impact	Employment (Job-Years)	Income (2015$)	GDP (2015$)
Direct	112	$7,658,000	$14,034,000
Indirect	59	$4,462,000	$5,630,000
Induced	74	$3,195,000	$5,637,000
Total	**245**	**$15,315,000**	**$25,301,000**

Sources: IMPLAN[25], Coolidge Solar, NREL JEDI Model, Synapse

The Project will generate an estimated $4 million in increased state and local tax revenues within Vermont. These revenues are generated by sales taxes on construction materials, income taxes paid by workers and landowners, and annual property taxes—shown in Table 2.

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[24] A job-year is the equivalent of one job over one year. This report presents job-years in order to combine construction and operating activities which occur over different time periods.

[25] IMPLAN categories used include: "Sheet metal work manufacturing," "Wiring device manufacturing", and "Maintenance and repair construction of nonresidential structures" for Balance of Plant; "All other miscellaneous electrical equipment and component manufacturing" for Miscellaneous O&M; "Insurance agencies, brokerages, and related activities" for Insurance; "Employment and payroll of state govt, non-education" for LC Fee; "Proprietor Income" for Landowner payments; and "Labor Income" for labor costs.

Table 2: Tax revenue in Vermont (20-year period)

Tax Type	Tax Revenue (2015$)
Sales Tax	$1,622,000
Income Tax	$606,000
Property Tax	$1,716,000
Total Tax Revenue	**$3,940,000**

Sources: Coolidge Solar, VT Department of Taxes[26], U.S. Bureau of Economic Analysis[27]

3.2. Methodology

To estimate the economic impact of the Project, Synapse used a combination of data provided by Coolidge Solar on its planned spending on labor and materials in Vermont, modeling of solar projects produced by the National Renewable Energy Laboratory's (NREL) JEDI model, and the IMPLAN model of Vermont, developed by IMPLAN Group. Synapse modeled direct spending in IMPLAN in order to capture the in-state indirect and induced impacts (i.e. multiplier effects) of the Project.[28] Synapse estimated the level of indirect activity needed to support the construction and maintenance of the Project, such as increased hiring and supply purchases at the company from which Coolidge Solar obtains its wiring. Synapse also estimated the induced activity from employees of Coolidge Solar and its suppliers spending their wages on local goods and services (e.g. food, haircuts, and other goods). The total economic impact for construction and operation represents the sum of the direct, indirect, and induced impacts for these two stages.

More detail on the economic impacts of the Project during the construction and operating stages is provided below.

3.3. Construction

Coolidge Solar's estimates of labor, materials, and tax expenses related to the construction of the Project are detailed in Table 3. Coolidge Solar expects to spend nearly $30 million on materials and taxes

[26] Vermont Department of Taxes. 2015. "2015 Income Tax Withholding Instructions, Tables, and Charts." http://tax.vermont.gov/sites/tax/files/documents/2015-Withholding-Instructions-Charts-Tables.pdf.

[27] National construction compensation-to-wages ratio (used to calculate taxable income) taken from National Income and Product Accounts Tables 6.2D and 6.3D. Available at http://www.bea.gov/iTable/iTable.cfm?ReqID=9&step=1#reqid=9&step=1&isuri=1

[28] An industry-standard economic input-output model, IMPLAN is able to estimate both indirect and induced impacts from spending on a given industry within a specified region, and provides detailed industry data for that region (including jobs, income, and output).

(including nearly $4 million in Vermont) and nearly $3 million on labor (approximately $1.7 million of which will be used to hire Vermont residents) during the construction phase.[29]

Table 3: Construction spending

Spending Item	Vermont (2015$)	Total (2015$)
Labor	$1,708,000	$2,847,000
Panels	–	$13,002,000
Inverter/Transform Skids	–	$2,915,000
Main Power Transformer	–	$475,000
Balance of Plant	$2,255,000	$11,279,000
Sales Tax	$1,622,000	$1,622,000
Total Costs	**$5,585,000**	**$32,140,000**

Source: Coolidge Solar

The construction of the Project is expected to generate 86 job-years, nearly $6 million in income, and more than $8 million in GDP within Vermont, as shown in Table 4.

Table 4: Economic impacts in Vermont due to construction

Type of Impact	Employment (Job-Years)	Income (2015$)	GDP (2015$)
Direct	32	$2,847,000	$3,722,000
Indirect	32	$2,193,000	$2,805,000
Induced	22	$948,000	$1,674,000
Total	**86**	**$5,988,000**	**$8,201,000**

Sources: IMPLAN, Coolidge Solar, NREL JEDI Model, Synapse

Coolidge Solar's investment during the construction of the Project will also result in an increase of $1.8 million in sales and income tax revenues in Vermont, as detailed in Table 5.

[29] Synapse assumed that sales tax and property tax revenue would support state and local government employment and services. Alternatively, the additional tax revenue could lead to a tax reduction which would also generate economic impacts from residents re-spending disposable income. However, this alternative was not modeled in this study.

Table 5: Tax revenue in Vermont due to construction

Tax Type	Tax Revenue (2015$)
Sales Tax	$1,622,000
Income Tax	$161,000
Total Tax Revenue	**$1,783,000**

Sources: Coolidge Solar, VT Department of Taxes, U.S. Bureau of Economic Analysis

3.4. Operations & Maintenance

Coolidge Solar's estimates of its operating expenditures on the Project are provided in Table 6. Over the 20-year term of the contract, Coolidge Solar expects to spend approximately $4.8 million on labor, $2.2 million to compensate landowners, $1.7 million on property taxes, and $1.3 million on other expenses. The labor expenses will go toward hiring four full-time equivalents (all in-state), resulting in a direct employment impact of 80 job-years over the 20-year contract.

Table 6: Operations and Maintenance spending

Spending Item	Vermont (2015$)	Total (2015$)
Labor	$4,811,000	$4,811,000
Landowners	$2,166,000	$2,166,000
LC Fees	$254,000	$254,000
Insurance	$859,000	$884,000
Miscellaneous	$231,000	$1,860,000
Property Tax	$1,716,000	$1,716,000
Total Costs	**$10,037,000**	**$11,691,000**

Source: Coolidge Solar

Coolidge Solar's spending on operations and maintenance will result in economic benefits for the state of Vermont. These expected benefits are summarized in Table 7. They include 159 job-years, $9.3 million in income, and $17.1 million in GDP over the 20-year contract.

Table 7: Economic impacts in Vermont due to operations (20-year period)

Type of Impact	Employment (Job-Years)	Income (2015$)	GDP (2015$)
Direct	80	$4,811,000	$10,312,000
Indirect	27	$2,269,000	$2,825,000
Induced	52	$2,247,000	$3,963,000
Total	**159**	**$9,327,000**	**$17,100,000**

Sources: IMPLAN, Coolidge Solar, NREL JEDI Model, Synapse

Operating costs associated with the Project will also produce nearly $2.2 million in tax revenue within Vermont, as outlined in Table 8.

Table 8: Tax revenue in Vermont due to operations (20-year period)

Tax Type	Tax Revenue (2015$)
Income Tax	$441,000
Property Tax	$1,716,000
Total Tax Revenue	**$2,157,000**

Sources: Coolidge Solar, VT Department of Taxes, U.S. Bureau of Economic Analysis

4. Cost Impacts on Utilities and Ratepayers

While the previous section demonstrated the positive economic benefits for Vermont residents, this section explores the economics of the Coolidge Solar Project from the perspective of electric utility resource planning. To understand the economics of the Project, it is important to understand how the power contract payment schedule is determined and how the contract compares to recent offers for similar services. It is also important to recognize the additional ratepayer benefits associated with long-term contracts.

4.1. Avoided Cost Rates

The contract prices that utilities – and ultimately ratepayers – would pay for the energy and capacity generated by this solar project are the avoided cost rates established in Docket No. 8010.[30] These are rates determined as a result of PURPA, which was passed as part of the National Energy Act and subsequently amended. PURPA was designed to further three goals: energy conservation, increased utility efficiency, and more equitable electric rates for consumers.[31] The avoided cost rates set in Docket No. 8010 reflect the forecasted levelized market rates over the contract period.

In Vermont, Docket No. 8010 established rate schedules reflecting Vermont utilities' avoided energy and capacity costs. To determine the expected future costs that Vermont utilities will incur, this proceeding considered the existing and expected future fleet of New England generators, prices for fuel such as natural gas, current and expected state and federal future environmental requirements, expected demand for electricity, and a variety of other factors. The rate schedules include five, 10, 15, 20, and 30 year rates for energy and capacity. Most of the rates are firm rates, including the 20-year contract term for which the Coolidge Project anticipates exercising. Table 9, below, lists Vermont's current avoided costs rates, as determined by Docket No. 8010.

[30] Vermont Public Service Board. 2015, February 9. Docket No. 8010 Order. Attachment 1, Page 2. http://psb.vermont.gov/sites/psb/files/orders/2015/2015-02/Attachment%201%20%281%29.pdf.

[31] Edison Electric Institute. 2006. "PURPA: Making the Sequel Better than the Original." http://www.eei.org/issuesandpolicy/stateregulation/Documents/purpa.pdf.

Table 9. Vermont's current avoided cost rates

Docket 8010 Avoided Cost Rates Long-Term Firm Sales			
20 Year Contract Levelized			
	$/MWh	$/MWh	$/kW
Levelized Month	Peak	Off-Peak	Capacity
January	101	75	10.497
February	97	73	10.497
March	73	55	10.497
April	60	45	10.497
May	61	44	10.497
June	71	51	11.310
July	90	56	11.310
August	73	51	11.310
September	61	45	11.310
October	59	44	11.310
November	66	51	11.310
December	84	62	11.310

Source: Vermont Docket 8010[32,33]*.*

By definition, utilities are indifferent to contracts that use avoided cost rates – a utility expects to face the same long-term procurement cost should it purchase through the established avoided cost rates or directly through traditional wholesale market purchases. This indifference implies that any qualified facility willing to accept these fixed avoided cost rates must be economic, because it must be able to provide energy and capacity at prices equal to the competitive marketplace.

4.2. Comparison to Recent Local PV Proposals

Two recent proposals to build ground-mounted solar PV stations in Vermont allow for a reasonable comparison with the Coolidge Solar Project. GMPSolar Williston and GMPSolar Richmond are both 5 MW projects for which Section 248 petitions were submitted in July 2015.

Synapse calculated the expected weighted average levelized price of energy for the Coolidge Solar Project by aligning the expected hourly AC electricity production of the Project with the 20-year levelized monthly on-peak and off-peak energy prices, found in Table A-2. For the Coolidge Solar Project in a typical weather year, the expected annual levelized price of energy is $67.77 per MWh. Capacity payments can also be determined, based on the ISO New England's rules for summertime and

[32] Vermont Public Service Board. 2015, February 9. Docket No. 8010 Order. http://psb.vermont.gov/sites/psb/files/orders/2015/2015-02/8010%20Order%20Re%20Rate%20schedules.pdf.

[33] Vermont Public Service Board. 2015, February 9. Docket No. 8010 Order. Attachment 1.

wintertime capacity. The avoided capacity payments for the Project are calculated at $10.41 per MWh over the course of a year. Therefore, the combined levelized energy and capacity payments for the Coolidge Solar Project are expected to total $78.18 per MWh.

A recent proposal to build ground-mounted solar PV in Vermont allows for a reasonable comparison with the Coolidge Solar Project. GMPSolar Williston envisions a 5 MW installation, at a levelized cost of $121 per MWh over 25 years.[34] The Williston project would provide energy and capacity, as well as RECs, Regional Network Service (RNS) avoidance, avoided losses, avoided ancillary services, supply induced energy and capacity market price suppression (SIPE), and integration costs.

Vermont's PURPA rates, known as Rule 4.100 Rates, include the Project's Power Purchase Agreement rates established in Docket No. 8010 but do not include renewable energy attributes.[35] While the Rule 4.100 Coolidge Solar Project Power Purchase Agreement does not incorporate RECs as part of its $78.18 per MWh cost, it does confer all of the other benefits (and costs) listed for the GMPSolar Williston project. In order to make a reasonable comparison, one can simply remove the expected REC value from the $121 per MWh price of the GMPSolar Williston project. Mr. Douglas Smith, the Director of Power Supply for Green Mountain Power Corporation, testified on July 15, 2015 that the value of the RECs associated with the GMPSolar Williston project are 3.6 cents per kWh ($36 per MWh) on a levelized basis.[36] By subtracting the $36 per MWh value from the GMPSolar Williston price, the two contracts can be reasonably compared, because both projects confer energy, capacity, RNS avoidance, avoided losses, avoided ancillary services, SIPE, and integration costs. The comparison is imperfect for a variety of differing details: the levelized cost analysis is 20 years for the Coolidge Solar Project versus 25 for the GMPSolar Williston project, and there may be less loss avoidance in the Coolidge Solar Project. Nevertheless, the benefits, output and impact of the two projects is very similar on a per-MW and per-MWh basis. The GMPSolar Williston project, argued in July 2015 by Mr. Smith to be "competitive with the very lowest-priced solar options presently available to GMP,"[37] comes in at $85 per MWh with RECs removed. The Coolidge Solar Project is significantly less expensive at $78.18 per MWh. Over the course of 20 years and assuming a 0.5 percent degredation of generating capability per year, the 659,949 MWh generated by the Project at $78.18 per MWh results in a $4.5 million savings (levelized) as compared to the same energy from the GMPSolar Williston project at its implied $85 per MWh without RECs price.

Comparison of the Coolidge Solar Project's levelized cost per MWh (without RECs) with that of the GMPSolar Williston project (also without RECs) clearly shows the economic value of the Coolidge Solar

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[34] Smith, Douglas. 2015, July 15. "Prefiled Direct Testimony of Douglas Smith." Vermont Public Service Board Docket No. 8562. Page 17.

[35] Vermont Public Service Board. 2015, February 9. Docket No. 8010 Order. Attachment 1.

[36] Smith, Douglas. 2015, July 15. "Prefiled Direct Testimony of Douglas Smith." Vermont Public Service Board Docket No. 8562. Page 21.

[37] Smith, Douglas. 2015, July 15. "Prefiled Direct Testimony of Douglas Smith." Vermont Public Service Board Docket No. 8562. Page 5.

Project. The levelized cost of $78.18 per MWh is significantly less expensive than the least-cost options known to GMP less than four months ago.

4.3. Benefits of Long-Term Contracts

Due to the nature of the avoided rate schedule, utilities should see no cost difference between market purchases and long-term contracts with a qualified facility such as a large-scale solar installation. Yet, differences do exist: Long-term contracts offer benefits to utility ratepayers that the market cannot – namely, rate stability for consumers over a multi-year timeframe. It is widely believed that, total cost being equal, customers value price stability as opposed to erratic and unpredictable prices. GMP appears to believe this as well; in its 2014 Integrated Resource Plan, GMP observes that "sources feature[ing] stable prices" result in an "emerging portfolio feature[ing] a substantial degree of long-term price stability,"[38] and that "increase[ing] the committed long-term resource percentage over time … limit[s] the effects of power market escalation."[39] The Project again meets a criteria of Section 248(b)(2) in that it will be long term and stably priced, in accordance with state policy under 30 V.S.A. § 8001(a)(3):

> The General Assembly finds it in the interest of the people of the State to promote the State energy policy established in section 202a of this title by: . . . Providing an incentive for the State's retail electricity providers to enter into affordable, long-term, stably priced renewable energy contracts that mitigate market price fluctuation for Vermonters.

In New England, consumers have had recent experience with the negative consequences of volatile wholesale market prices. Figure 1 shows New England's average locational marginal pricing, and the extent of the region's price volatility, for ISO New England from 2010 to 2015. Looking forward, it appears unlikely that stability will improve given the region's increasing reliance on natural gas and the historical volatility of natural gas prices. See Figure 2, below, for a visualization of natural gas price volatility from 1997 to 2015.

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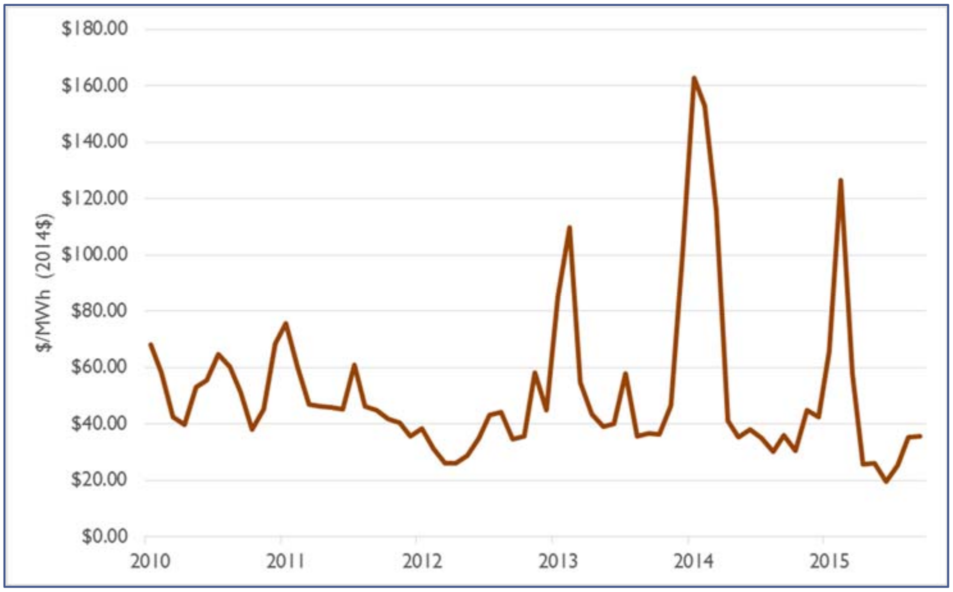
[38] Green Mountain Power. 2014. "2014 Integrated Resource Plan." Page 1-11. http://www.greenmountainpower.com/upload/photos/4771._Executive_Summary.pdf.

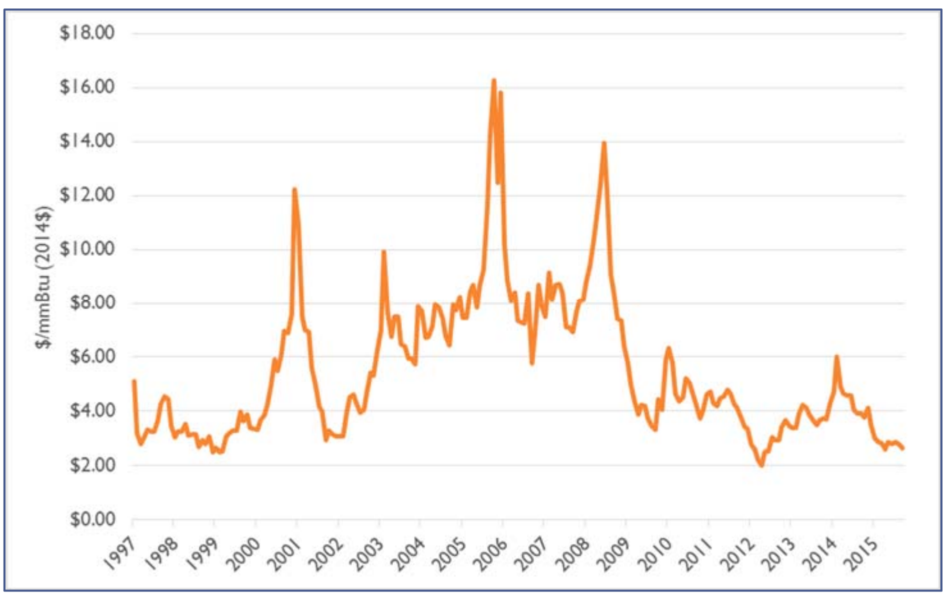
[39] Green Mountain Power. 2014. "2014 Integrated Resource Plan." Page 1-17. http://www.greenmountainpower.com/upload/photos/4771._Executive_Summary.pdf.

Figure 1. ISO New England Hub Average LMP



Source: ISO New England (2015), Monthly LMP Indices, at http://www.iso-ne.com/isoexpress/web/reports/pricing/-/tree/monthly-lmp-indices

Figure 2. Henry Hub Natural Gas Spot Price, 1997-2015



Source: Energy Information Administration (September 2015), at http://tonto.eia.gov/dnav/ng/hist/rngwhhdm.htm

Long-term contracts with generators including qualifying facilities ensure that utilities are protected, in part, from the erratic results of ISO New England energy and capacity markets. This hedge manifests itself in reduced pressure to adjust rates, the mechanism by which electricity consumers ultimately bear the brunt of unstable wholesale market prices. The Public Service Board, when considering a certificate of public good related to a 30 MW wind generation facility, stated that "stably-priced contracts, at reasonable price terms, are particularly beneficial given volatility of the regional power market."[40] GMP chief executive Mary Powell is clearly aware of the value that long-term cost-competitive contracts provided. In an October 1, 2014 press release proclaiming GMP's rate decrease, she stated, "Our long-term energy contracts and local clean energy generation like Kingdom Community Wind allow us to lower energy bills for customers."[41]

The price stability of long-term contracts are a necessary component of projects that provide the economic benefits associated with renewable projects, and it is explicitly recognized by state policy goals.[42] In accordance with §248, contracts that ensure sufficient benefit in promoting the general good of the state should have three basic features:

- The contract must be stably priced;
- The contract must have prices favorable relative to market purchases; and
- A substantial portion of the output of the facility must serve the state. [43]

The 20-year avoided cost contract associated with the Coolidge Solar Project meets all three of these criteria. As a 20-year fixed price contract, it is stably priced. Because the rate schedule is the utilities' avoided market purchase cost and the contract is stably priced and long term, the contract prices are favorable relative to market purchases. Finally, as a project under PURPA, the associated Vermont utility must purchase 100 percent of the Project's output. These considerations combined with the cost competitive energy and capacity payments of $78.18 per MWh suggest that the Coolidge Solar Project would be a cost-effective manner of meeting some of the region's electricity requirements.

5. Effects on the Region's Electricity Markets

Vermont's electricity grids are integrated into the broader New England grid, operated by the region's independent system operator, ISO New England. As such, analysis of the demand for and the impacts of the proposed Project includes assessment of the general electricity and clean energy needs of all six New England states as a group. Region-wide, geographically distributed utility-scale solar projects are increasingly sought after to meet these energy demands.

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[40] Vermont Public Service Board. 2009, April 16. Docket No. 7250 Order. Page 43.

[41] Green Mountain Power. 2014. "Lower Rates for Customers Take Effect Today." http://news.greenmountainpower.com/manual-releases/Lower-Rates-for-Customers-Take-Effect-Today?feed=d51ec270-a483-4f6c-a55e-8e5fbe2238c2.

[42] Vermont Public Service Board. 2010, June 11. Docket No. 7508.

[43] Vermont Public Service Board. 2009, April 16. Docket No. 7250 Order. Page 43.

A recent statement by GMP reflects the positive effects that utility-scale projects are already having locally. In its 2014 Integrated Resource Plan, GMP wrote:

> Declining costs of distributed utility-scale solar projects have made the most attractive projects cost competitive with large-scale renewable resource options like wind, so GMP expects to explore additional volumes through direct [Power Purchase Agreements] and/or project ownership.[44]

Projects such as Coolidge Solar's proposed utility-scale solar installations will impact regional markets in various ways, including the effect of the Project on wholesale market prices through price suppression effects. Conceptually, when low-cost renewable generation displaces higher cost generation in wholesale markets, wholesale electricity prices decrease. This is referred to as price suppression – or in the case of renewables – supply-induced price effects.[45]

The price suppression effect will benefit all customers because the downward wholesale price movement impacts all electricity customer rates. The specific quantification of this effect for energy efficiency, which is similar in principle to that of renewable energy resources, has been documented in various studies in different wholesale markets.[46]

In addition to procuring energy from wholesale day-ahead and spot markets and from long-term contracts or direct ownership of generation resources, Vermont's utilities purchase some portion of their energy requirements in short-term contracts to meet their own energy requirements.[47,48] Each utility's purchases will vary by quantity and duration of such contracts. Because the price of short-term contracts is influenced by the wholesale market, the cost of energy purchased in these short-term contracts will also face downward pressure due to the introduction of renewable resources that displace more expensive generation.

The precise quantification of this effect for the Project requires detailed electric system modeling or regression analysis that is beyond the scope of this study; however, the price effect of the Project is well understood. It will lead to lower electricity prices for all Vermonters.

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[44] Green Mountain Power. 2014. "2014 Integrated Resource Plan." Page 3-24.

[45] Heeter, J. et al. 2014. "A Survey of State-Level Cost and Benefit Estimates of Renewable Portfolio Standards." Technical Report NREL/TP-6A20-61042. Page 61. http://www.nrel.gov/docs/fy14osti/61042.pdf.

[46] Hornby, R. et al. 2015. *Avoided Energy Supply Costs in New England: 2015 Report*. March 27, 2015. Page 7-1.

[47] Green Mountain Power. 2014. "2014 Integrated Resource Plan." Page 3-27.

[48] Burlington Electric. 2012. "2012 Integrated Resource Plan." Page 89. https://www.burlingtonelectric.com/about-us/what-we-do/our-integrated-resource-plan.

6. Role in Achieving Environmental Targets

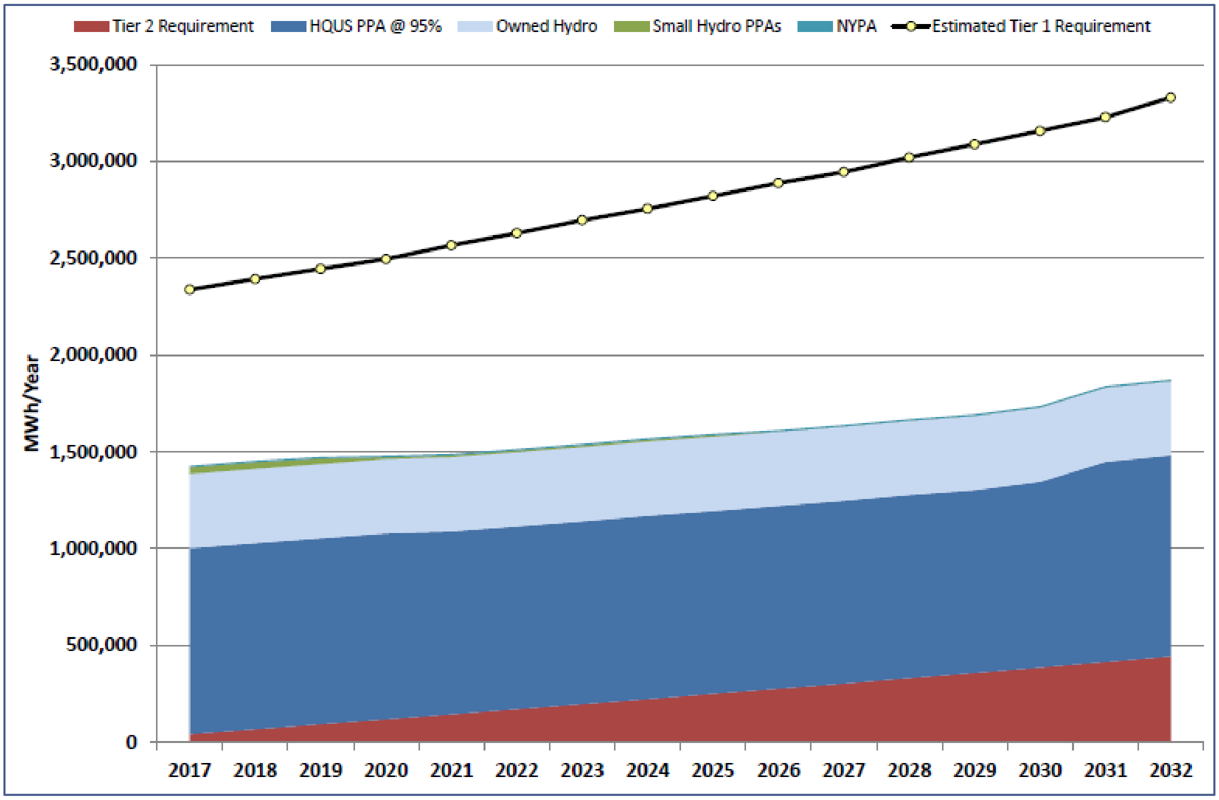
In the section on demonstrating need for solar projects such as the Coolidge Solar Project on page 7, this report discussed Vermont and regional policies to increase the proportion of renewable energy on the grid. These included the goal set by the Vermont General Assembly to reduce greenhouse gas emissions 75 percent from 1990 levels by 2050, and the vison laid out by state's 2011 Comprehensive Energy Plan. Embedded in these goals is a clear preference for a diverse array of renewable resources—with many sourced locally and benefiting local communities—that can help secure reliable, clean, and stably priced electricity into the future.

Corresponding policies and targets in the other New England states mean that even today's rapidly growing renewable energy industries will be hard-pressed to meet the region's need for renewable energy sources and RECs.

The Coolidge Solar Project will help Vermont and the region meet the growing need for new renewable energy supply. Importantly, the Project will qualify as Tier 1 resource in Vermont, and Vermont utilities will have the opportunity to purchase the Project's RECs to satisfy their substantial Tier 1 requirements. In recent testimony filed this summer for two new solar facilities, GMP's testimony describes a "substantial gap for Tier 1 compliance over time," and provides a graphic chart illustrating this significant gap, which is replicated in Figure 3 below:[49]

[49] *See* Smith, Douglas. 2015, July 15. "Prefiled Direct Testimony of Douglas Smith." Vermont Public Service Board Docket No. 8562. Pages 15-16; Smith, Douglas. 2015, July 20. "Prefiled Direct Testimony of Douglas Smith." Vermont Public Service Board Docket No. 8564. Page 15 and Exh. GRP-DCS-4.

Figure 3. Green Mountain Power projected RES Tier 1 resources vs. requirements



Source: GMPSolar Richmond. 2015. Testimony of Douglas Smith. Exhibit GRP-DCS-4. Available at: http://psb.vermont.gov/sites/psb/files/document/2015-07-20 Prefiled Direct Testimony of Doug Smith.pdf.

6.1. Vermont Renewable Energy Standard

Vermont recently replaced its Sustainably Priced Energy Enterprise Development (SPEED) program with an RPS called as the Renewable Energy Standard and Energy Transformation (RES). Enacted in June 2015, H.B. 40 defines renewable technologies as those that use "a technology that relies on a resource that is being consumed at a harvest rate at or below its natural regeneration rate." Under the RES, Vermont utilities are required to retire bundled renewable energy and/or Renewable Energy Credits equivalent to 55 percent of retail sales in 2017, escalating steadily by 4 percent each third year until reaching 75 percent on or after 2032.[50] The RES legislation specifies three distinct categories of required resources to meet the requirements of RES" including: (1) total renewable energy ("Tier 1"), (2) distributed renewable energy ("Tier 2"), and energy transformation ("Tier 3").[51] Tier 1 requires that 55 percent of retail electric sales be obtained from renewable energy sources (broadly defined, including both existing and new renewables) in 2017. This requirement increases to 75 percent renewable in 2032. Tier 2 requires that 1 percent of retail electric sales in 2017 be obtained from new distributed

50 30 V.S.A. § 8005(d)(4)(A)

51 30 V.S.A. § 8005(a).

renewable generation sources, increasing to 10 percent in 2032. This distributed generation requirement represents a subset of the Tier 1 total renewable requirement. New distributed renewable projects must have a capacity of less than 5 MW, and achieve commercial operation on or after July 1, 2015.

As mentioned above, the Coolidge Solar Project will help Vermont address the projected gap shown in Figure 3 between the renewable resources available and the resources required to meet these targets.

Impact of proposed Project

Like many RPS policies, Vermont's RES includes an alternative compliance payment (ACP), whereby the utility may make a set payment in lieu of retiring a REC obtained from its own generator or the REC market. In general, the dollar value of the ACP is the effective price ceiling for a REC within the jurisdiction, and Vermont's RES is no different in this regard. Whereas the ACP for Tier I RECs in New Hampshire and Connecticut is $55, and is $67 in Maine, Rhode Island, and Massachusetts, the ACP in Vermont for Tier I is $10. Due to Maine's permissive policy toward biomass RECs, the spot price for RECs in Maine has fallen steadily, from the mid $40s in late 2012 to approximately $5 as recently as July 2015. However, RECs for the other four New England states have steadily traded near ACP – between $45 and $65 per REC (2015$) since mid-2012.[52]

Because the current value of an REC to utilities in New Hampshire, Connecticut, Massachusetts, and Rhode Island is well in excess of the $10 Vermont Tier 1 ACP, the RECs generated by the Coolidge Solar Project will almost certainly be used for out-of-state compliance over the next few years. Vermont utilities will likely rely on large hydro RECs or the ACP for compliance with Tier 1 in the near term.

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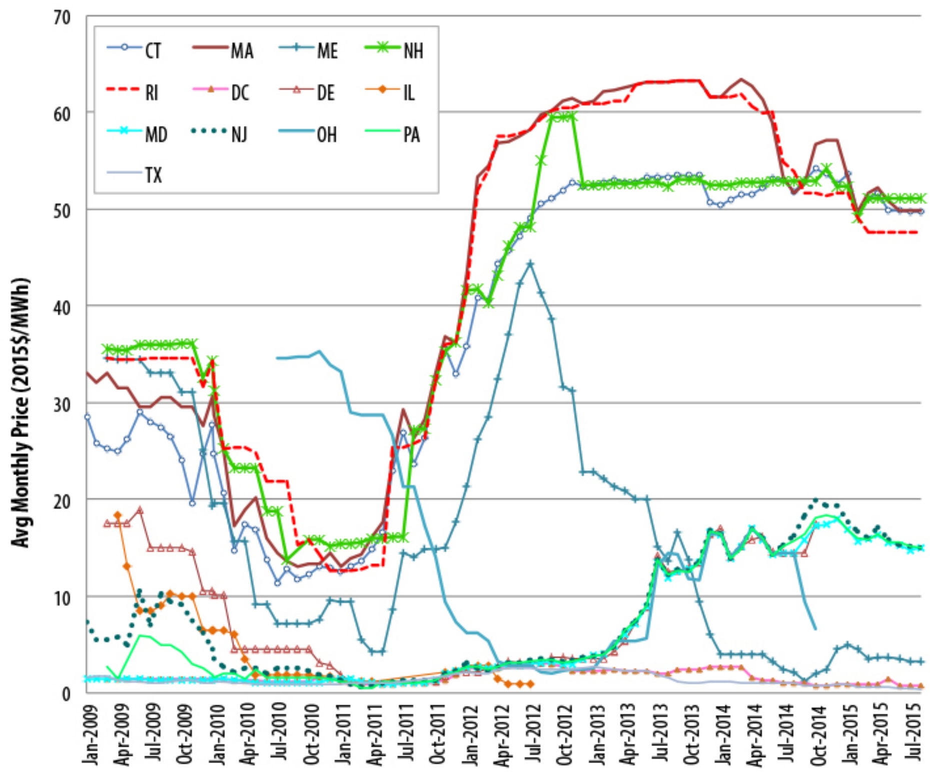
[52] U.S. Department of Energy. 2015. "Renewable Energy Certificates (RECs)." Accessed November 3, 2015. http://apps3.eere.energy.gov/greenpower/markets/certificates.shtml? Page 5.

Figure 4. Average monthly REC price (2015$)



Source: Marex Spectron (2015)

In future years however, the REC markets in New England will likely evolve. Should renewable growth outpace demand for RECs, the spot and long-term contract REC prices across New England will decline. To the extent that prices fall considerably in the future, RECs from the Project may be economic for compliance with the Vermont RPS. Alternatively, should the Vermont legislature change Vermont's RES such that large hydro RECs cannot be used for compliance and increases the Tier 1 ACP to levels similar to the other New England states, RECs from the Project will be needed by Vermont utilities.

6.2. Vermont Emissions Reductions

Numerous Vermont policies demonstrate the value of the reduction of greenhouse gas emissions. One example is the decision to use the environmental compliance and externality values from the avoided energy supply costs in New England studies.[53,54,55] In determining the cost effectiveness of energy efficiency programs, Vermont values avoided carbon emissions at $100 per ton avoided. For the sake of comparison, this value is significantly in excess of the Regional Greenhouse Gas Initiative (RGGI) allowance costs utilities avoid.

Assuming a 0.5 percent degradation of generating capacity per year, the proposed Project will provide an estimated annual production of 33,000 MWh per year of carbon-free energy. Based on a projected contract period of 20 years, the proposed Project will generate approximately 660,000 MWh.

The value in terms of avoided CO_2 emissions will depend on what existing resources will be displaced by the Project. While electricity modeling of the New England electric grid could determine the likely resource displacement (by analyzing marginal electricity generation units with and without the Project), such quantitative analysis is beyond the scope of this report. Qualitatively, if the Project displaces existing renewables then it will achieve no greenhouse gas benefits. However, if the Project displaces natural gas-fired or oil-fired combustion units during peak periods that coincide with the projects performance hours, then it would avoid those associated greenhouse gas emissions.

The benefits attributable to avoided CO_2 emissions would be calculated in the same manner in which GMP calculates the external price of carbon. The utility does this based on the difference between an assumed marginal abatement cost of carbon and the cost of carbon internalized in energy market price forecasts.[56] This methodology is consistent with methodology documented in energy efficiency avoided cost studies produced by Synapse and others.[57,58] The calculation of the avoided CO_2 emissions value would be $ per ton of CO_2 avoided emissions multiplied by the carbon emission rate in lbs of CO_2 per MWh and MWh of solar generation. For illustrative purposes, Synapse estimated the avoided externality value of CO_2 emissions based on (1) the 2015 AESC study results and (2) project output. These illustrative results are shown below:

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53 Malone, E. T. Woolf, K. Takahashi, S. Fields. 2013. "Appendix D: Energy Efficiency Cost-Effectiveness Tests." Readying Michigan to Make Good Energy Decisions: Energy Efficiency. Synapse Energy Economics for the Council of Michigan Foundations. Page 50.

54 Chang, P. Luckow, T. Vitolo, P. Knight, B. Griffiths, B. Biewald. 2013. *Avoided Energy Supply Costs in New England: 2013 Report*. Synapse Energy Economics for Avoided-Energy-Supply-Component (AESC) Study Group.

55 Vermont Public Service Board. 2013. *Avoided Costs: 2013 Changes*, Page 4. Available at: http://psb.vermont.gov/docketsandprojects/eeu/avoidedcosts/2013.

56 Green Mountain Power. 2014. "2014 Integrated Resource Plan Integrated Resource Plan. Page 7-25.

57 AESC 2013.

58 AESC 2015.

Table 10. Illustrative calculation of external carbon value associated with project over 20-year period

External Carbon Emissions Value on 20-year Levelized Basis		
20-year Estimated Generation	659,949	MWh
Avoided External Emissions Value	0.0424	$/kWh
Value (2015$)	$27,974,369	
Notes		
20-year levelized values		
Summer On-peak: Avoided External Emissions	0.0442	$/kWh
Winter On- Peak: Avoided External Emissions	0.0415	$/kWh
Annual Wtd Average: Avoided External Emissions	0.0424	$/kWh
Values based on AESC 2015 Appendix B for VT		
Discount Rate of 6.67% per Docket 8010		
NE marginal emission rate based on Exhibit 4-11		
Assumed degradation of 0.5 percent per annum.		

Source: Synapse with data from AESC and Coolidge Solar.

The emissions reductions provided by the Project are clearly of value to the state. While Vermont is currently ranked as the lowest total carbon emitting state in the nation, its aggressive clean energy and energy efficiency targets suggest that renewable energy projects in general will remain valuable to Vermont and to the New England region.[59]

6.3. New England's Energy Demand

All six New England states have legal requirements for moving their energy mix toward low and zero-emitting sources. Further, customers from residential households to large industrial customers are increasingly seeking out cleaner energy sources via the voluntary REC market. Add to this the pending closure of recent and recently announced retirements of nuclear plants in New England, and the result is a steadily increasing demand for renewable energy sources. This section provides background on the energy landscape in New England that is driving this demand ever higher.

The recent announcement that Entergy will retire the 680 MW Pilgrim nuclear station in 2019 mirrors Vermont's experience when Entergy retired the 620 MW Vermont Yankee generation station in 2014.[60] The retirements of these two New England nuclear units reinforce the need for additional carbon-free resources. GMP recognizes that need in its 2014 IRP implementation plan, stating that it would "acquire

59 U.S. Energy Information Administration. 2015. "Rankings: Total Carbon Dioxide Emissions, 2012." Accessed October 19, 2015. http://www.eia.gov/state/rankings/?sid=VT#series/226.

60 Entergy Corporation. 2015. "Vermont Yankee Nuclear Power Plant." Accessed November 3, 2015. http://www.entergy-nuclear.com/plant_information/vermont_yankee.aspx.

existing renewable generation as opportunities arise, to help fulfill Vermont's Total Renewable Targets."[61]

Several other energy trends contribute to the rising demand for renewable energy demand. They include:

- Coal generation is declining to near-zero due to a convergence of costly environmental requirements and lower prices for competing resources;[62]
- Oil generation is becoming prohibitively expensive and increasingly undesirable due to environmental and energy security concerns;
- The Clean Power Plan and the Regional Greenhouse Gas Initiative's mass-based limits on carbon emissions.

These factors combine to leave a large gap for natural gas and renewable energy to fill. Whatever energy demand is not met by renewable energy and energy efficiency will likely be met by natural gas; and given the relevant policies in play (e.g. RGGI, the U.S Environmental Protection Agency's Clean Power Plan, air quality standards, renewable portfolio standards) and also the region's preferences, there is clearly strong demand in New England for increased renewable energy.

7. CONCLUSION

The Coolidge Solar Project would provide a number of benefits to the state of Vermont. It would address demonstrated energy needs, it would provide tangible benefits to Vermont residents, and it would help Vermont and other New England states meet legislated environmental targets in a way that is cost-effective and fair to electricity ratepayers. Vermont's 2011 Comprehensive Energy Plan vision represents a regional trend in which decision-makers increasingly recognize that fostering clean energy resources can benefit the local economy by providing jobs and keeping energy spending in-state. These same resources provide improved energy security and long-term price stability that would be far from certain in a future with continued heavy dependence on natural gas and other fossil fuel resources. In the case of the Coolidge Solar Project, these benefits come at a cost that is substantially lower than GMPSolar's Williston facility, a comparable solar project for which a petition for a certificate of public good was filed as recently as four months ago. In summary, Synapse analysis found that, overall, the Project would have positive economic and environmental benefits on the state of Vermont and its residents.

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[61] Green Mountain Power. 2014. "2014 Integrated Resource Plan." Page 8-2.

[62] ISO New England. 2015. "2015 Regional Electricity Outlook." http://www.iso-ne.com/static-assets/documents/2015/02/2015_reo.pdf.

APPENDIX A: PROJECT AVOIDED ENERGY AND CAPACITY COSTS

This appendix describes the methodology used by Synapse to estimate the levelized avoided energy and capacity costs, and thus the projected Power Purchase Agreement rates, associated with the Project. First, the Project's hourly electricity output was estimated using the National Renewable Energy Laboratory's PV Watts calculator. The key variables underlying this projected output profile are listed in Table A-1.

Table A-1. PV Watts input variables

Variable	Value
Requested Location:	Coolidge, VT
Location:	CONCORD, NH
Lat (deg N):	43.2
Long (deg W):	71.5
Elev (m):	105
DC System Size (kW):	25574
Module Type:	Standard
Array Type:	Fixed (open rack)
Array Tilt (deg):	25
Array Azimuth (deg):	180
System Losses:	14
Invert Efficiency:	98.1
DC to AC Size Ratio:	1.29
Average Cost of Electricity Purchased from Utility ($/kWh):	0.17
Initial Cost	3.3
Cost of Electricity Generated by System ($/kWh):	0.2

Sources: NREL[63], Coolidge Solar.

Next, Synapse calculated which hours of the year would qualify as peak and off-peak under ISO New England's rules. These rules specify that peak hours are those that fall between 7:00 a.m. and 11:00 p.m. on non-holiday weekdays. All other hours qualify as off-peak.[64] Holidays in ISO New England are the six

[63] National Renewable Energy Laboratory. 2015. "PVWatts Calculator." Accessed November 3, 2015. http://pvwatts.nrel.gov/pvwatts.php.

[64] ISO New England. 2015. "Glossary and Acronyms." Accessed November 2, 2015. http://www.iso-ne.com/participate/support/glossary-acronyms#peakhours.

holidays established by North American Electric Reliability Corporation ("NERC")'s Additional Off-peak Days : New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day.[65] In addition to verifying which hours fall on holidays and weekends, it is necessary to account for the impact that switching between Standard and Daylight Savings Time has on which hours of electrical output fall within peak hours.

After making these adjustments, Synapse used the 20-year contract levelized avoided cost rates listed in Vermont Public Service Board Docket No. 8010[66] to estimate the avoided energy and capacity costs associated with the Project. The relevant avoided cost rates from Docket No. 8010 are reproduced in Table A-2.

Table A-2. Docket No. 8010 avoided cost rates for long-term firm sales: 20-year contract levelized

Levelized Month	Peak ($/MWh)	Off-Peak ($/MWh)	Capacity ($/kW)
1	101	75	10.497
2	97	73	10.497
3	73	55	10.497
4	60	45	10.497
5	61	44	10.497
6	71	51	11.310
7	90	56	11.310
8	73	51	11.310
9	61	45	11.310
10	59	44	11.310
11	66	51	11.310
12	84	62	11.310

Source: Vermont Public Service Board, Docket No. 8010.

To calculate the annual energy costs avoided by the Project, Synapse multiplied the relevant (month- and peak-status-specific) avoided cost rate listed in Docket No. 8010 by the amount of electricity forecasted to be generated in each hour of the year, and summed the hourly avoided costs. The resultant annual value was then divided by the projected annual output of the Project to yield the per-MWh levelized avoided energy cost of the Project.

[65] North American Electric Reliability Corporation. 2014. "Additional Off-peak Days." Accessed November 3, 2015. http://www.nerc.com/comm/OC/RS%20Agendas%20Highlights%20and%20Minutes%20DL/Additional_Off-peak_Days.pdf.

[66] Vermont PSB. 2015. Available at: http://psb.vermont.gov/sites/psb/files/orders/2015/2015-02/Attachment%201%20%281%29.pdf

To calculate the Project's avoided capacity costs, Synapse multiplied the monthly avoided cost rates for June through September first by the 40 percent summer PV Seasonal Claimed Capability assumed by ISO New England,[67] and then by the capacity of the Project. These monthly avoided costs were then summed and divided by the projected annual output of the Project to produce the per-MWh levelized avoided capacity cost of the Project. Finally, the per-MWh avoided energy and capacity costs were added to generate a total levelized avoided cost value. The key components of this calculation are shown in Table A-3.

Table A-3. Components of avoided cost calculations

Component	Value
Annual Levelized Avoided Energy Cost ($/Yr)	$2,261,794
Annual Energy Output (MWh/Yr)	33,785
Levelized Avoided Energy Cost ($/MWh)	$66.95
Nameplate AC Capacity (kW)	20,000
Capacity Levelized Price June-September ($/kW)	$11.31
Summer SCC Factor	40%
Monthly Summer Levelized Avoided Capacity Cost ($/Month)	$90,480
Annual Levelized Avoided Capacity Cost ($/Yr)	$361,920
Levelized Avoided Capacity Cost ($/MWh)	$10.71
Levelized Avoided Energy + Capacity Costs ($/MWh)	**$77.66**

Sources: NREL PV Watts, Vermont Public Service Board, Synapse.

[67] ISO New England. 2015. "Final 2015 Solar PV Forecast Details." Page 31. http://www.iso-ne.com/static-assets/documents/2015/04/2015_solar_forecast_details_final.pdf. Since ISO New England assumes a winter Seasonal Claimed Capability of zero for regional solar projects, the estimated avoided capacity cost in the winter months of October through May is also zero.

APPENDIX B: ABOUT SYNAPSE ENERGY ECONOMICS, INC.

Synapse Energy Economics is an independent research and consulting firm specializing in energy, economic, and environmental topics. Since its inception in 1996, Synapse has grown to become a leader in providing rigorous analysis of the electric power sector for public interest and governmental clients.

Synapse's staff of 30 includes experts in energy and environmental economics, resource planning, electricity dispatch and economic modeling, energy efficiency, renewable energy, transmission and distribution, rate design and cost allocation, risk management, cost-benefit analysis, environmental compliance, climate science, and both regulated and competitive electricity and natural gas markets. Several of our senior-level staff members have more than 30 years of experience in the economics, regulation, and deregulation of the electricity and natural gas sectors, and have held positions as regulators, economists, and utility commission and ISO staff.

Services provided by Synapse include economic and technical analyses, regulatory support, research and report writing, policy analysis and development, representation in stakeholder committees, facilitation, trainings, development of analytical tools, and expert witness services. Synapse is committed to the idea that robust, transparent analyses can help to inform better policy and planning decisions. Many of our clients seek out our experience and expertise to help them participate effectively in planning, regulatory, and litigated cases, and other forums for public involvement and decision making.

Synapse's clients include public utility commissions in U.S. states and Canada, offices of consumer advocates, attorneys general, environmental organizations, foundations, governmental associations, public interest groups, and federal clients such as the U.S. Environmental Protection Agency and the Department of Justice. Our work for international clients has included projects for the United Nations Framework Convention on Climate Change, the Global Environment Facility, and the International Joint Commission, among others.