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# The Economic Impacts of Decommissioning Vermont Yankee

## A Comparison of Two Approaches

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PREPARED FOR




PREPARED BY

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THE **Brattle** GROUP

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This report was prepared for joint petitioners NorthStar and Entergy. All results and any errors are the responsibility of the author and do not represent the opinion of The Brattle Group or its clients.

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## 1. Introduction and Background

At the request of joint petitioners NorthStar and Entergy, the Brattle Group has estimated the economic impacts in Vermont and the neighboring states of Massachusetts and New Hampshire for two decommissioning and restoration approaches for the Vermont Yankee Nuclear Generating Station (“Vermont Yankee”). Vermont Yankee ceased operations in 2014. I have been asked to assume two approaches for decommissioning and restoration of the site as described below:

- **Entergy Approach:** The plan following shut-down of the station in 2014 was for Entergy to begin active decommissioning around 2068 and complete restoration around 2075. Currently, the default approach we now evaluate is for Entergy to retain responsibility for decommissioning Vermont Yankee, assumed to begin around 2053. Entergy is assumed to place the plant in SAFSTOR status and defer decommissioning activity until this time. We assume SAFSTOR preparations are to occur during a five year period beginning in 2015, during which the plant would prepare for long-term safe-storage and oversee the off-loading of spent fuel in the reactor building’s spent fuel storage pool to an on-site dry storage facility (ISFSI). The facility would then enter a dormancy period for approximately 32 years, during which labor would be required to monitor ISFSI operations, conduct surveys, prepare routine regulatory submittals, and oversee grounds and building maintenance. Beginning in as early as 2053, Entergy would then begin active decommissioning and site restoration, including the physical decontamination and dismantling of the plant and associated site facilities and the remediation of the property. Active decommissioning and site restoration would last until around 2060, at which point we assume an 8.25 MW<sub>DC</sub> solar photovoltaic (PV) array would be built on the site. The estimated total cost to complete this approach as of 2014 was \$1.24 billion (2014 dollars), as reported in the Post Shutdown Decommissioning Activities Report (PSDAR), which considers active decommissioning and site restoration beginning in 2068 and completed in 2075. Accounting for expenses already incurred and plan revisions, decommissioning, site restoration, and redevelopment would now cost approximately \$650 million (undiscounted 2016 dollars) to complete.<sup>1</sup>

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<sup>1</sup> This cost includes solar site installation. The \$1.2 billion decommissioning costs presented in the 2014 TLG decommissioning report has been reduced for several reasons: (1) it excludes all cash flows prior to 2019; (2) it assumes spent fuel is moved to the dry cask storage pad by 2018, whereas the 2014 TLG report assumed this would occur in 2020; (3) it moves up active decommissioning from 2068 to 2053, avoiding 15 years of dormancy costs; (4) it excludes \$56 million of low level radioactive waste disposal costs and \$15 million in financing and interest; (5) it excludes fees and corporate costs that are spent

- **NorthStar Approach:** Under the NorthStar approach, NorthStar is assumed to take immediate ownership of the plant and begin decommissioning activities in as early as 2019. Under this approach, decommissioning and site restoration are assumed to be completed by as early as 2026, at which point the client anticipates constructing an 8.25 MW<sub>DC</sub> solar PV array would be built on the site. Decommissioning, restoration, and redevelopment cost for the NorthStar approach as of 2016 is approximately \$587 million (undiscounted 2016 dollars).<sup>2</sup>

Thus, two important differences in these approaches are: 1) a cost difference of \$63 million (undiscounted) and 2) a substantial differences in schedules. An important question is how the acceleration of these costs creates benefits to the economy measured by, among other things, GDP. Figure 1 illustrates the timelines of both options. The Entergy approach calls for about a 32-year dormancy period with active decommissioning beginning in approximately 2053, while the NorthStar approach calls for active decommissioning beginning in as early as 2019. Figure 2 displays the spending pattern associated with these schedules. These notable scheduling differences make it necessary to compare the costs of the two approaches on a present value basis to account for the time value of money. The costs on a present value basis will be influenced by the discount rate applied. The Office of Management and Budget directs that real discount rates of 3% and 7% should be used for regulatory impact analyses.<sup>3</sup> Applying those rates to the estimates and schedules described here results in Entergy approach costs of between \$120 and \$274 million and in NorthStar costs of between \$296 and \$423 million. The NorthStar approach costs are reduced by between approximately \$4 and \$10 million because of solar power revenues beginning in around 2028. As discussed later in this report, the NorthStar approach creates

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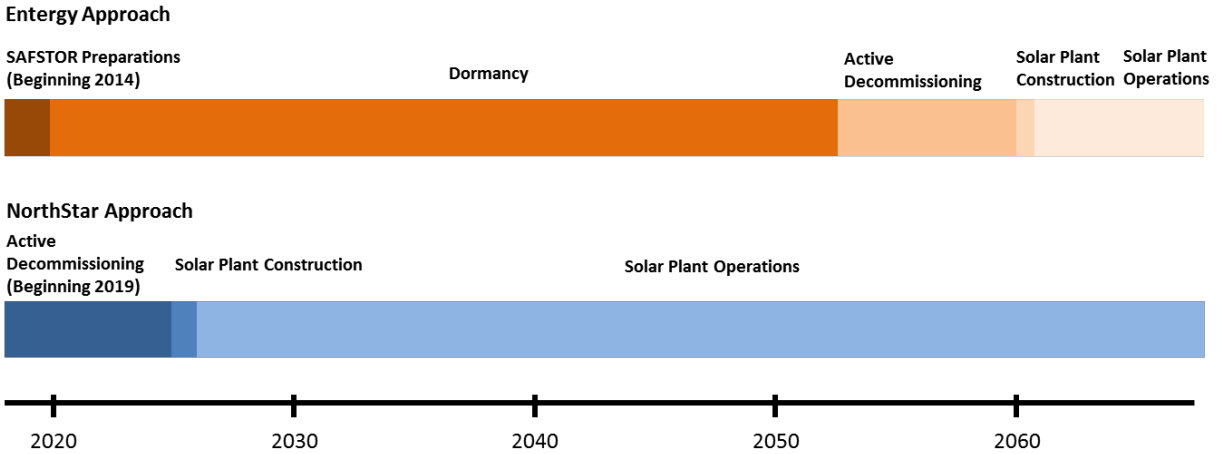
outside of the region; (6) it does not include local property taxes. See TLG Services (2014). Vermont Yankee Nuclear Power Station: Post Shutdown Decommissioning Activities Report. December 2, 2014. Posted at: <http://pbadupws.nrc.gov/docs/ML1435/ML14357A110.pdf>.

<sup>2</sup> This figure excludes costs that have already been incurred and includes costs associated with solar installation, as well as operation and maintenance.

<sup>3</sup> Per White House Office of Management and Budget Circular A-4, Regulatory Impact Analysis: A Primer. p. 11.

greater economic benefits on a discounted basis than the Entergy approach, and these benefits are greater than the difference in discounted costs.<sup>4</sup>

**Figure 1: Timeline of Decommissioning and Restoration Approaches**



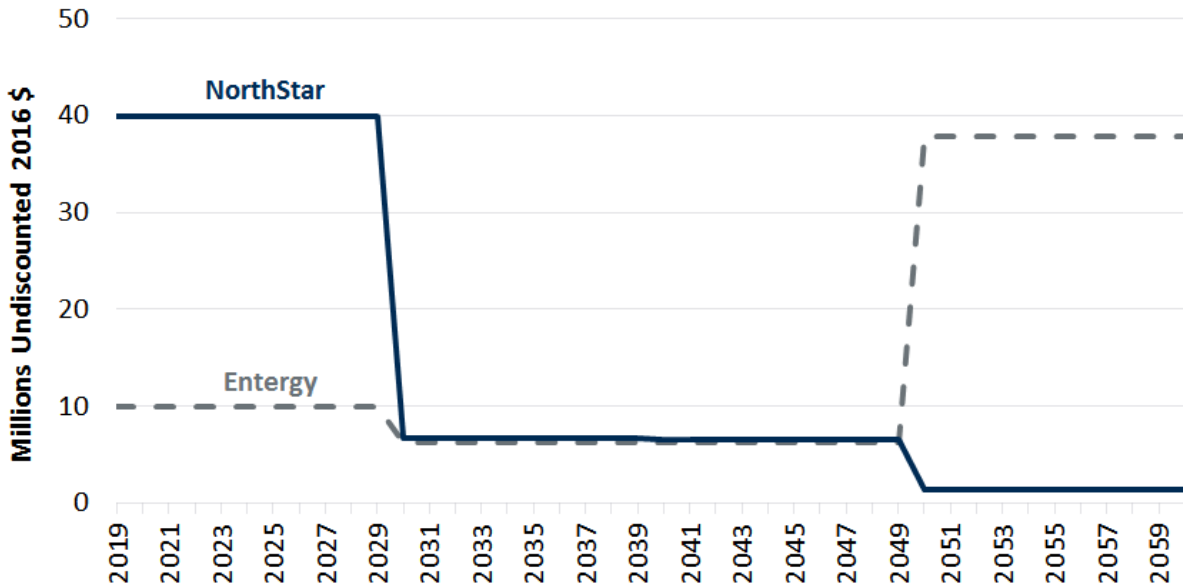
Source:

Entergy and NorthStar project timelines and cost data provided by Entergy.

<sup>4</sup> This report analyzes the economic impacts generated from the work described, and does not attempt to account for the possible economic value to the region’s energy or climate policy, or for any other potential benefits due to earlier site decommissioning and redevelopment.



**Figure 2: Stylized Comparison of Average Annual Expenditures by Decade**



Source and Notes:

Client-provided data. More detailed annual cost trajectory was used in the analysis but is confidential. This figure reflects annual project costs averaged by decade (undiscounted \$2016).

## 2. The Vermont Economy

The Vermont Yankee decommissioning project will be part of the larger Vermont economy. Table 1 summarizes Vermont’s GDP across 15 economic sectors. In 2015, state GDP totaled \$30.4 billion.<sup>5</sup> Five sectors, finance/real estate/leasing, government, education and health care, professional services, and manufacturing account for over 65% of this figure. Ten sectors account for over 91%.

<sup>5</sup> Bureau of Economic Analysis (2016). Interactive Data Application. Posted at <http://www.bea.gov/itable>. NAICS industry categories.

**Table 1: 2015 Vermont State GDP by Industry**

Industry	2015 GDP Contribution	
	(millions 2015 \$)	(% of total)
Finance, insurance, real estate, rental, and leasing	6,062	19.9%
Government	4,550	15.0%
Educational services, health care, and social assistance	3,831	12.6%
Professional and business services	2,804	9.2%
Manufacturing	2,763	9.1%
Retail trade	2,354	7.7%
Arts, entertainment, recreation, accommodation, and food services	1,802	5.9%
Wholesale trade	1,505	5.0%
Construction	1,279	4.2%
Information	837	2.8%
Other services, except government	733	2.4%
Utilities	726	2.4%
Transportation and warehousing	512	1.7%
Agriculture, forestry, fishing, and hunting	451	1.5%
Mining	194	0.6%
<b>Total</b>	<b>30,401</b>	

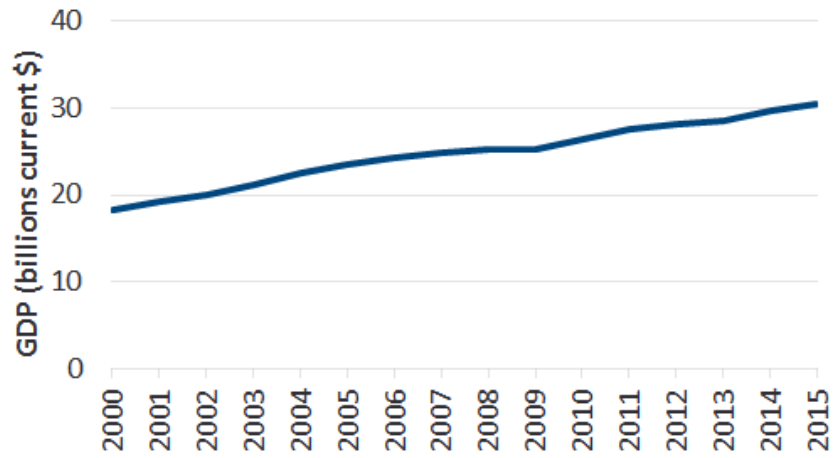
*Sources and Notes:*

Bureau of Economic Analysis (2016). Interactive Data Application. Posted at <http://www.bea.gov/itable> . NAICS industry categories.

Figure 3 displays Vermont’s GDP growth between 2000 and 2015. Annual average real growth over this period is 1.4% or about \$384 million.<sup>6</sup>

<sup>6</sup> Bureau of Economic Analysis (2016). Interactive Data Application. Posted at <http://www.bea.gov/itable>. Real \$2009 dollars converted to 2016 dollars assuming a 13% inflation adjustment, per consumer price index (CPI).

Figure 3: Vermont State GDP, 2000 – 2015



Sources and Notes:

Bureau of Economic Analysis (2016). Interactive Data Application. Posted at <http://www.bea.gov/itable>.

Table 2 breaks down Vermont’s total employment of 434,600 in 2015 into 21 sectors. Five sectors including government, health care, retail, accommodations/food, and manufacturing account for over 50% of this figure. Ten sectors account for 80% of total employment.

**Table 2: 2015 Vermont State Employment by Sector**

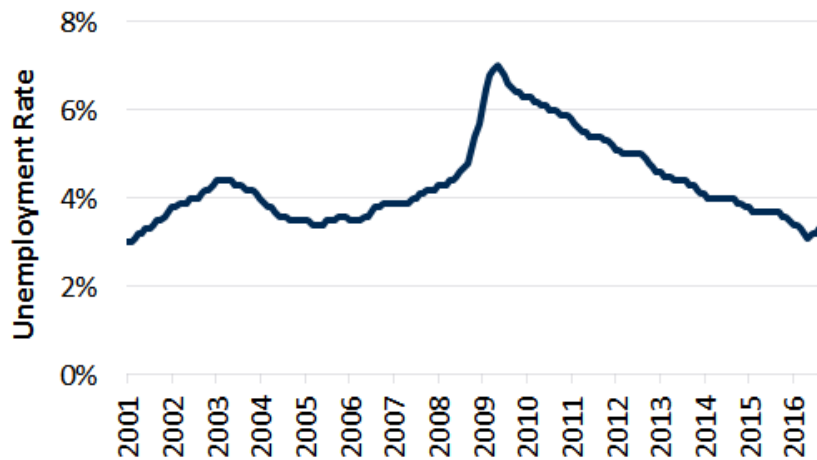
Industry	2015 Employment	
	(thousands)	(% of total)
Government and government enterprises	58.3	13.4%
Health care and social assistance	57.8	13.3%
Retail trade	46.7	10.7%
Accommodation and food services	35.4	8.1%
Manufacturing	35.0	8.1%
Construction	29.2	6.7%
Professional, scientific, and technical services	27.0	6.2%
Other services (except public administration)	22.3	5.1%
Educational services	18.6	4.3%
Administrative and support and waste management and remediation services	18.3	4.2%
Real estate and rental and leasing	15.3	3.5%
Finance and insurance	13.7	3.1%
Arts, entertainment, and recreation	11.7	2.7%
Wholesale trade	11.3	2.6%
Farming	9.9	2.3%
Transportation and warehousing	8.8	2.0%
Information	6.1	1.4%
Forestry, fishing, and related activities	3.8	0.9%
Management of companies and enterprises	2.5	0.6%
Utilities	1.7	0.4%
Mining, quarrying, and oil and gas extraction	1.3	0.3%
<b>Total</b>	<b>434.6</b>	

*Sources and Notes:*

Bureau of Economic Analysis (2016). Interactive Data Application. Posted at <http://www.bea.gov/itable>. Total Full-Time and Part-Time Employment by NAICS Industry.

Figure 4 shows changes in Vermont state unemployment over time.

**Figure 4: Vermont State Unemployment Rate, Seasonally Adjusted**



*Sources and Notes:*

Vermont Department of Labor (2016). Downloads: Labor Market Information. Posted at: <http://www.vtmi.info/detftp.htm#laus>

### 3. Findings of Previous Decommissioning Studies

We reviewed several existing studies of the costs and economic implications of nuclear decommissioning to gauge the potential magnitude of impacts in Vermont and to compare the allocation of decommissioning costs to economic sectors as demanded to apply the Regional Economic Models, Inc. Policy Insight (REMI) model as described in Section 4 below. These studies are summarized below.

#### A. 2014 VERMONT YANKEE DECOMMISSIONING REPORT<sup>7</sup>

In 2014, Entergy submitted a Post-Shutdown Decommissioning Activities Report, in accordance with the requirements of Title 10 of the Code of Federal Regulations (CFR) 50.82, “Termination of license,” paragraph (a)(4)(i), prepared by TLG Services. This report described the decommissioning activities for Vermont Yankee, discussed the environmental impacts of decommissioning, and provided a site-specific decommissioning cost estimate. The report analyzed the effects of Entergy’s proposed SAFSTOR decommissioning method, which would place the plant in SAFSTOR dormancy until 2068, and complete site restoration by 2075. Table 3 summarizes the costs of the proposed decommissioning approach. TLG estimated that total costs including license termination, spent fuel management, and site restoration would be \$1.24 billion in 2014 dollars.<sup>8</sup>

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<sup>7</sup> TLG Services (2014). Vermont Yankee Nuclear Power Station: Post Shutdown Decommissioning Activities Report. December 2, 2014. Posted at: <http://pbadupws.nrc.gov/docs/ML1435/ML14357A110.pdf>.

<sup>8</sup> See footnote 1 on page 2 for details.

**Table 3: TLG Report Timeline of Decommissioning Approach**

<b>Decommissioning Periods</b>	<b>License Termination</b>	<b>Spent Fuel Management</b>	<b>Site Restoration</b>	<b>Total</b>
Planning and Preparations	\$119,981	\$23,068	-	\$143,049
Dormancy w/ Wet Fuel Storage	\$45,746	\$217,244	-	\$262,990
Dormancy w/ Dry Fuel Storage	\$137,229	\$128,035	-	\$265,264
Dormancy w/ No Fuel Storage	\$54,016	-	-	\$54,016
Site Reactivation	\$43,277	-	\$578	\$43,855
Decommissioning Preparation	\$36,283	-	\$456	\$36,739
Large Component Removal	\$141,032	-	\$25	\$141,057
Plant Systems Removal and Building Remediation	\$208,167	-	\$4,118	\$212,285
License Termination	\$30,668	-	-	\$30,668
Site Restoration	\$823	-	\$51,968	\$52,791
<b>Total</b>	<b>\$817,219</b>	<b>\$368,347</b>	<b>\$57,145</b>	<b>\$1,242,711</b>

*Sources and Notes:*

TLG Services (2014). Vermont Yankee Nuclear Power Station: Post Shutdown Decommissioning Activities Report. December 2, 2014. Values are in thousands of 2014 dollars.

**B. SAN ONOFRE NUCLEAR GENERATING STATION DECOMMISSIONING<sup>9</sup>**

Beacon Economics prepared a study of the economic benefits of decommissioning the San Onofre Nuclear Generating Station (SONGS), which retired from operations in 2013. The SONGS facility contained two pressurized water reactors, each with a nameplate capacity of 1,127 MW. In contrast, Vermont Yankee was a single unit boiling water reactor with a nameplate capacity of 563.4 MW, or 25% as large as SONGS.<sup>10</sup> Southern California Edison (SCE) and the co-participants/owners of SONGS plan to decommission the facility within 20 years and return the site to the Department of the Navy. Beacon Economics employed the IMPLAN modeling system, estimating the decommissioning project would generate \$9 billion in economic output through 2026, of which \$4.1 billion would be in California. Table 4 illustrates how decommissioning project expenditures were assumed to vary by sector.

<sup>9</sup> See Beacon Economics, LLC (2015). Economic Impact Analysis of the SONGS Decommissioning Project: A Local, State, and National Analysis Years 2013-2026. Posted at: [https://www.songscommunity.com/docs/Full Economic Impact Analysis.pdf](https://www.songscommunity.com/docs/Full_Economic_Impact_Analysis.pdf).

<sup>10</sup> Source: SNL Energy, 2016.

**Table 4: SONGS Decommissioning Project Expenditures, 2013-2026**

NAICS Codes	Sector	Amount (Millions 2015 \$)	Percentage of Total Expenditures (% of total)
562	Waste Management and Remediation Services	1,004	30.7%
2211/2212/2213	Utilities	735	22.5%
238	Construction of Other New Nonresidential Structures	655	20.0%
5413	Architectural, Engineering, and Related Services	451	13.8%
5616	Investigation and Security Services	274	8.4%
5241	Insurance Carriers	40	1.2%
424120	Wholesale Trade	33	1.0%
5418	Advertising and Related Services	30	0.9%
54169	Environmental and Other Technical Consulting Services	20	0.6%
5324	Commercial and Industrial Machinery and Equipment Rental and Leasing	17	0.5%
531190	Real Estate	11	0.3%
334	Electronic Computer Manufacturing	4	0.1%
517	Telecommunications	2	0.0%
	<b>Total</b>	<b>3,273</b>	<b>100%</b>

*Sources and Notes:*

Beacon Economics, LLC (2015). Economic Impact Analysis of the SONGS Decommissioning Project: A Local, State, and National Analysis Years 2013-2026. Posted at: [https://www.songscommunity.com/docs/Full Economic Impact Analysis.pdf](https://www.songscommunity.com/docs/Full_Economic_Impact_Analysis.pdf)

### C. HEAPS REPORT<sup>11</sup>

In 2012, Richard Heaps prepared a report comparing the implications of three decommissioning approaches for Vermont Yankee on the Vermont and Windham County economies. His report was prepared as part of testimony before the Vermont Public Service Board (Docket No. 7862) on behalf of Entergy Nuclear Vermont Yankee, LLC, and Entergy Nuclear Operations, Inc. These three scenarios are consistent with scenarios in prior Vermont Yankee decommissioning studies prepared by TLG Services:

- **2032 Prompt Decommissioning:** The plant operates until 2032, at which point the non ISFSI portions of the site are decommissioned.
- **2032 Deferred Decommissioning:** The plant operates until 2032, at which point it enters the SAFSTOR process.
- **2013 SAFSTOR:** The plant ceases operations in 2012 and enters the SAFSTOR process in 2013.

<sup>11</sup> Richard Heaps (2012). The Economic Impact of the VY Station on Windham County and Vermont. June 27, 2012. Posted at: <http://psb.vermont.gov/sites/psb/files/docket/7862VYRelicense/Exhibit%20EN-RWH-1.PDF>.

The study found large differences between the 2013 SAFSTOR scenario and either of the 2032 decommissioning scenarios. However, these differences are primarily due to the 2032 scenario assuming Vermont Yankee continues to operate between 2013 and 2032, whereas the 2013 scenario assumes the plant ceases operations immediately. The 2032 Prompt Decommissioning and 2032 Deferred Decommissioning scenarios result in very similar economic effects with respect to wages, despite differences in when decommissioning activities occur. The Heaps study did not present estimates of employment or GDP differences between the 2032 decommissioning scenarios.

## 4. Methods of Analysis

This section summarizes the methods we used to analyze the effects of the Entergy and NorthStar decommissioning, restoration, and redevelopment approaches on the Vermont economy. Details can be found in the Appendix.

We use the Regional Economic Models, Inc. Policy Insight model (REMI) to measure the effects of both decommissioning approaches on the Vermont economy. REMI is a structural economic forecasting and policy analysis model.<sup>12</sup> The model dynamically estimates the effects of a policy intervention, in this case Vermont Yankee's decommissioning, on employment, wages, gross domestic product (GDP) and gross economic output. As defined by the Bureau of Economic Analysis, GDP by state is the state counterpart of national GDP, derived as the sum of the GDP originating in all industries in the state.<sup>13</sup> Gross output consists of sales, or receipts, and other operating income, plus commodity taxes and changes in inventories.<sup>14</sup> REMI integrates input-output, computable general equilibrium, econometric, and economic geography methodologies. REMI measures the combined direct and secondary effects of decommissioning on the state and regional economy. The direct effects cover all employees at the project site, as well as all expenditures directly associated with the project, while secondary effects cover supporting

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<sup>12</sup> See <http://www.remi.com/resources/technical/general>.

<sup>13</sup> See Broad Growth Across States in 2014: Explanatory Notes. Bureau of Economic Analysis. June 10, 2015. Posted at: [https://bea.gov/newsreleases/regional/gdp\\_state/gsp\\_newsrelease.htm](https://bea.gov/newsreleases/regional/gdp_state/gsp_newsrelease.htm).

<sup>14</sup> See Bureau of Economic Analysis Glossary: G. Posted at: [https://www.bea.gov/glossary/glossary\\_g.htm](https://www.bea.gov/glossary/glossary_g.htm).



employment created from goods and services produced as a result of the project, as well as the income effect.

REMI takes as inputs yearly sales and employment across 70 sectors of the economy. We assigned all expenditure data provided by the clients for both approaches across the 70 sectors. We based our assignments on our review of other decommissioning reports listed in Section 3 and the expenditure and labor category descriptions provided by the client. We also solicited input from the clients regarding the assignments. The resulting breakdown of expenditures across REMI categories are shown in Table 5 and Table 10. A crosswalk between the client-provided cost categories and our assignments is included in the Appendix. In addition, we used the JEDI model to assign expenditures for the solar PV array across REMI categories (see the Appendix for more details).

We measured all financial results in three ways: undiscounted (\$2016 dollars), net present value (NPV) assuming a 3% discount rate, and NPV assuming a 7% discount rate. Changes to employment were measured as total number of jobs, both full-time and part-time.

We input into REMI all labor and non-labor project expenditures in each of the 70 REMI categories as industry sales. REMI then allocates these expenditures into labor and non-labor.

## **5. Economic Activity under Entergy Approach**

Table 5 summarizes the Entergy approach expenditure by sector. Three sectors: (1) administrative and support services; (2) waste management and remediation services; and (3) management of companies and enterprises, account for over 76% of total spending. Two more sectors: (1) construction; and (2) professional and technical services account for another 14% of spending. The remaining 10% of expenditures is spread across seven additional industries.

**Table 5: Entergy Option Project Expenditures by Sector**

Sector	Amount <i>(Thousands Undiscounted 2016 \$)</i>	Percentage of Total Expenditures <i>(% of total)</i>
Administrative and support services	\$216,381	33.3%
Waste management and remediation services	\$169,750	26.1%
Management of companies and enterprises	\$111,861	17.2%
Construction	\$46,434	7.1%
Professional, scientific, and technical services	\$43,873	6.7%
Insurance carriers and related activities	\$24,525	3.8%
Utilities	\$22,749	3.5%
Machinery manufacturing	\$6,749	1.0%
Rental and leasing services; Lessors of nonfinancial intangible assets	\$5,672	0.9%
Retail trade	\$1,956	0.3%
Wholesale trade	\$451	0.1%
Broadcasting, except Internet	\$62	0.0%
<b>Total</b>	<b>\$650,463</b>	<b>100%</b>

*Sources and Notes:*

Project cost data provided by Entergy. Conversion of Entergy cost categories to REMI industries result of Brattle analysis. This table includes costs of solar installation and excludes all sectors in which no costs were allocated, as well as costs spent outside of Vermont.

**A. VERMONT IMPACTS OF THE ENTERGY APPROACH**

As shown in Table 6, the Entergy approach would increase GDP by \$662 million in undiscounted 2016 dollars over the period 2019 to 2060. The impact, discounted to 2016 totals \$292 million using a 3% discount rate and \$134 million using a 7% discount rate. These lower discounted values reflect the anticipated spending schedule between 2019 and 2060 as shown back in Figure 2. Gross output increases by almost \$1.2 billion over the time period (between \$219 and \$496 million discounted). State and federal tax revenues increase by about \$149 million (between \$30 and \$66 million discounted). Table 7 presents the estimated employment impacts. Over the period 2019 to 2060, the Entergy approach accounts for just over 12,000 jobs. This figure includes 6,951 direct jobs and 5,072 secondary jobs.

**Table 6: Effect on Vermont GDP, Gross Output, and Taxes, Entergy Approach**

	Undiscounted	Present Value	
	2019-2060 <i>(millions 2016 \$)</i>	3% discount rate	7% discount rate
<b>GDP</b>	\$662	\$292	\$134
<b>Gross Output</b>	\$1,161	\$496	\$219
<b>State Tax Revenues</b>	\$60	\$27	\$12
<b>Federal Tax Revenues</b>	\$89	\$39	\$18

*Sources and Notes:*

Regional Economic Models, Inc. output. All values are in millions of dollars.

**Table 7: Effect on Vermont Employment, Entergy Approach**

	Total FTEs 2019-2060
<b>Direct and Secondary Employment (<i>jobs</i>)</b>	12,023
Direct	6,951
Secondary	5,072

*Sources and Notes:*

Regional Economic Models, Inc. output. Direct and secondary employment derived using ratio from Labor-only method (see Appendix for details).

## **B. MASSACHUSETTS AND NEW HAMPSHIRE IMPACTS OF THE ENTERGY APPROACH**

Table 8 presents the economic impacts of the Entergy approach in Massachusetts and New Hampshire. GDP increases by between \$23 and \$53 million on a discounted basis in these states over the period 2019 to 2060. Gross output increases by between \$39 and \$90 million in present value over this period. State and federal tax revenues grow by between \$6 and \$14 million in present value over this period.

**Table 8: Effect on GDP, Gross Output, and Taxes in Massachusetts and New Hampshire, Entergy Approach**

	Undiscounted	Present Value	
	2019-2060 (millions 2016 \$)	3% discount rate	7% discount rate
<b>GDP</b>	\$122	\$53	\$23
<b>Gross Output</b>	\$211	\$90	\$39
<b>State Tax Revenues</b>	\$7	\$3	\$1
<b>Federal Tax Revenues</b>	\$26	\$11	\$5

*Sources and Notes:*

Regional Economic Models, Inc. output. All values are in millions of dollars.

Table 9 demonstrates employment effects. Employment increases by just over 1,200 jobs over the period. Of these jobs, 706 are direct jobs and 515 are secondary.

**Table 9: Effect on Employment in Massachusetts and New Hampshire, Entergy Approach**

	Total FTEs 2019-2060
<b>Direct and Secondary Employment (jobs)</b>	1,221
Direct	706
Secondary	515

*Sources and Notes:*

Regional Economic Models, Inc. output. Direct and secondary employment derived using ratio from Labor-only method (see Appendix for details).

## 6. Economic Activity under NorthStar Approach

Table 10 summarizes the NorthStar approach expenditure by sector. Three sectors: 1) professional- scientific and technical; 2) construction; and 3) administrative and support services, account for over 72% of total spending. Three more sectors: 1) utilities; 2) waste management and remediation; and 3) rental and leasing services account for another 20%. The remaining 8% of expenditures is spread across four additional industries.

**Table 10: NorthStar Approach Project Expenditures by Sector**

Sector	Amount <i>(Thousands Undiscounted 2016 \$)</i>	Percentage of Total Expenditures <i>(% of total)</i>
Professional, scientific, and technical services	\$160,061	27.3%
Construction	\$149,310	25.4%
Administrative and support services	\$117,064	19.9%
Utilities	\$42,124	7.2%
Waste management and remediation services	\$36,880	6.3%
Rental and leasing services; Lessors of nonfinancial intangible assets	\$35,200	6.0%
Insurance carriers and related activities	\$29,317	5.0%
Retail trade	\$9,946	1.7%
Wholesale trade	\$5,894	1.0%
Computer and electronic product manufacturing	\$1,200	0.2%
<b>Total</b>	\$586,995	100%

*Sources and Notes:*

Project cost data provided by NorthStar. Conversion of NorthStar cost categories to REMI industries result of Brattle analysis. This table includes costs of solar installation as well as operation and maintenance and excludes all sectors in which no costs were allocated.

## **A. VERMONT IMPACTS OF THE NORTHSTAR APPROACH**

Table 11 summarizes the economic impacts of the NorthStar approach with respect to GDP, gross output and taxes. This approach increases GDP by \$701 million in undiscounted 2016 dollars, and by between \$321 and \$479 million in present value (discounted dollars) over the period 2019 to 2060. Gross output increases by just over \$1.1 billion over the time period (between \$526 and \$781 million discounted). State and federal tax revenues increase by about \$158 million (between \$72 and \$107 million discounted). Table 12 summarizes the employment impacts. The NorthStar approach accounts for about 10,884 jobs over the period, of which 6,051 are direct jobs and 4,833 are secondary.

**Table 11: Effect on Vermont GDP, Gross Output, and Taxes, NorthStar Approach**

	Undiscounted	Present Value	
	2019-2060 (millions 2016 \$)	3% discount rate	7% discount rate
<b>GDP</b>	\$701	\$479	\$321
<b>Gross Output</b>	\$1,142	\$781	\$526
<b>State Tax Revenues</b>	\$64	\$43	\$29
<b>Federal Tax Revenues</b>	\$94	\$64	\$43

*Sources and Notes:*

Regional Economic Models, Inc. output. All values are in millions of dollars.

**Table 12: Effect on Vermont Employment, NorthStar Approach**

	Total FTEs 2019-2060
<b>Direct and Secondary Employment (jobs)</b>	10,884
Direct	6,051
Secondary	4,833

*Sources and Notes:*

Regional Economic Models, Inc. output. Direct and secondary employment derived using ratio from Labor-only method (see Appendix for details).

**B. MASSACHUSETTS AND NEW HAMPSHIRE IMPACTS OF THE NORTHSTAR APPROACH**

The NorthStar approach’s economic impacts in neighboring Massachusetts and New Hampshire over the period 2019 to 2060 are summarized in Table 13. GDP in these states increases by \$145 million in discounted 2016 dollars and between \$58 and \$92 million in present value. Gross output increases by \$242 million in undiscounted dollars and between \$95 and \$152 million in present value. State and federal tax revenues increase by \$39 million undiscounted and between \$15 million and \$25 million in present value.

**Table 13: Effect on GDP, Gross Output, and Taxes in Massachusetts and New Hampshire, NorthStar Approach**

	Undiscounted	Present Value	
	2019-2060 (millions 2016 \$)	3% discount rate	7% discount rate
<b>GDP</b>	\$145	\$92	\$58
<b>Gross Output</b>	\$242	\$152	\$95
<b>State Tax Revenues</b>	\$8	\$5	\$3
<b>Federal Tax Revenues</b>	\$31	\$20	\$12

*Sources and Notes:*

Regional Economic Models, Inc. output. All values are in millions of dollars.

Table 14 summarizes the NorthStar approach’s employment impact in Massachusetts and New Hampshire. The approach increases employment by 1,355. This figure includes 753 direct jobs and 602 secondary jobs.

**Table 14: Effect on Employment in Massachusetts and New Hampshire, NorthStar Approach**

	Total FTEs 2019-2060
<b>Direct and Secondary Employment (jobs)</b>	1,355
Direct	753
Secondary	602

*Sources and Notes:*

Regional Economic Models, Inc. output. Direct and secondary employment derived using ratio from Labor method (see Appendix for details).

## 7. Economic Impact of Entergy Approach Versus NorthStar Approach

In this section, we compare the decommissioning, site restoration and redevelopment approaches on the basis of cost and economic impacts. The estimated cost for the Entergy approach is \$650 million and for the NorthStar approach is \$587 million (undiscounted 2016 dollars). This comparison, however, is misleading because it does not capture the substantial time differences in spending between these approaches. A more meaningful cost comparison requires the costs to be adjusted for the time value of money using discounting. The discounted costs of the

approaches using two real discount rates used by the Office of Management and Budget, 3% and 7%, are summarized in Table 15. The lower value is sometimes referred to as the social rate of time preference. The higher value reflects historic returns to real estate and small business capital. There is no correct value. As is apparent, although the NorthStar approach involves modestly lower absolute costs when undiscounted, because its schedule is so accelerated relative to the Entergy approach, the discounted costs are considerably greater. The economic impacts must similarly be discounted in order to be meaningful. Below we compare the impacts of the approaches in Vermont and the neighboring states of Massachusetts and New Hampshire.

**Table 15: Summary of Total Costs**

		Undiscounted <i>(thousands 2016 \$)</i>	Present Value	
			3% discount rate <i>(thousands \$)</i>	7% discount rate <i>(thousands \$)</i>
<b>Entergy</b>	[1]	\$650,463	\$274,467	\$119,830
<b>NorthStar</b>	[2]	\$586,995	\$423,257	\$296,484
<b>Difference</b>	[3] = [2]-[1]	-\$63,468	\$148,789	\$176,654

### A. NET DIFFERENCES IN VERMONT

Table 16 summarizes the economic impact differences between NorthStar and Entergy over the period 2019 to 2060 on an undiscounted and discounted value basis. NorthStar generates between \$186 and \$187 million more in present value state GDP than Entergy and between \$286 and \$307 million more in present value gross output. Table 17 demonstrates the employment differences between approaches. This indicates that NorthStar accounts for 1,139 fewer jobs than Entergy in Vermont over the period 2019 to 2060. Note that these figures are presented without discounting because the absolute number of jobs is unaffected by time value. However, under the NorthStar approach jobs will arrive much sooner than the Entergy approach which may be considered of greater value, especially if they represent jobs in occupations with underemployment. The difference in jobs between the approaches is explained by the differences in spending by sector. The Entergy approach employs more workers in labor intensive industries than the NorthStar approach. Overall, employment impacts are imprecise because it is difficult to determine the extent they will be local and whether they will be filled by full or part time workers.



**Table 16: Net Difference between Entergy and NorthStar Approaches, Vermont**

	Entergy [1]	NorthStar [2]	Difference [3] [2]-[1]
<b>Undiscounted (millions 2016 \$)</b>			
GDP	\$662	\$701	\$39
Gross Output	\$1,161	\$1,142	-\$19
State Tax Revenues	\$60	\$64	\$4
Federal Tax Revenues	\$89	\$94	\$5
<b>3% Discount Rate (millions \$)</b>			
GDP	\$292	\$479	\$186
Gross Output	\$496	\$781	\$286
State Tax Revenues	\$27	\$43	\$17
Federal Tax Revenues	\$39	\$64	\$25
<b>7% Discount Rate (millions \$)</b>			
GDP	\$134	\$321	\$187
Gross Output	\$219	\$526	\$307
State Tax Revenues	\$12	\$29	\$17
Federal Tax Revenues	\$18	\$43	\$25

Sources and Notes:

Regional Economic Models, Inc. output differences.

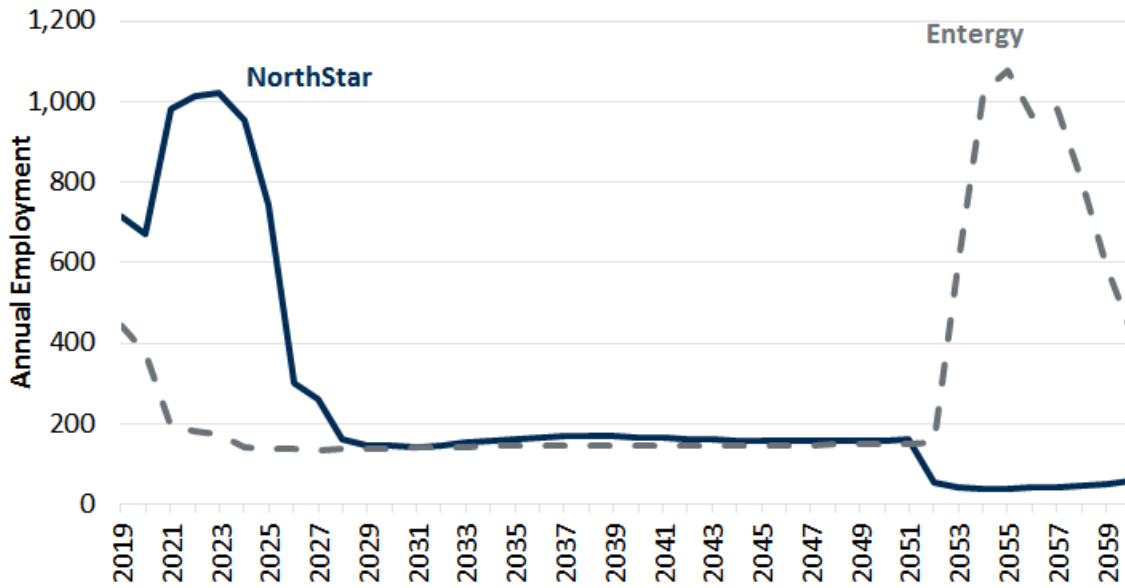
**Table 17: Net Difference between Entergy and NorthStar Approaches, Vermont Employment**

	Entergy [1]	NorthStar [2]	Difference [3] [2]-[1]
<b>Direct and Secondary Employment (jobs)</b>	12,023	10,884	-1,139
Direct	6,992	6,051	-941
Secondary	5,031	4,833	-198

Sources and Notes:

Regional Economic Models, Inc. output differences.

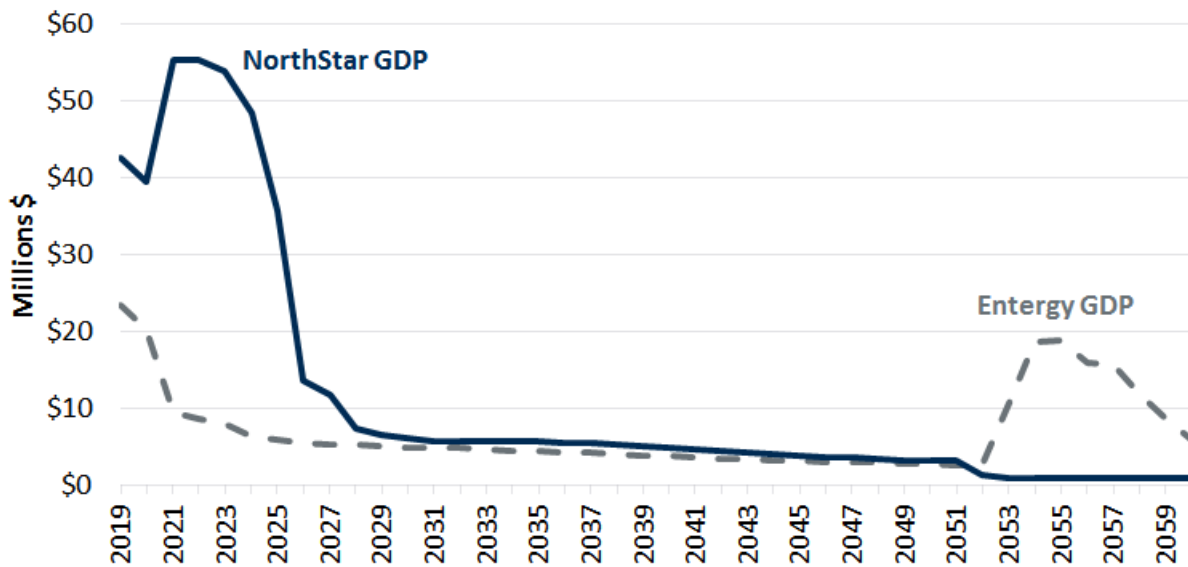
**Figure 5: Comparison of Vermont Employment Effects**



Sources and Notes:  
Regional Economic Models, Inc. output.

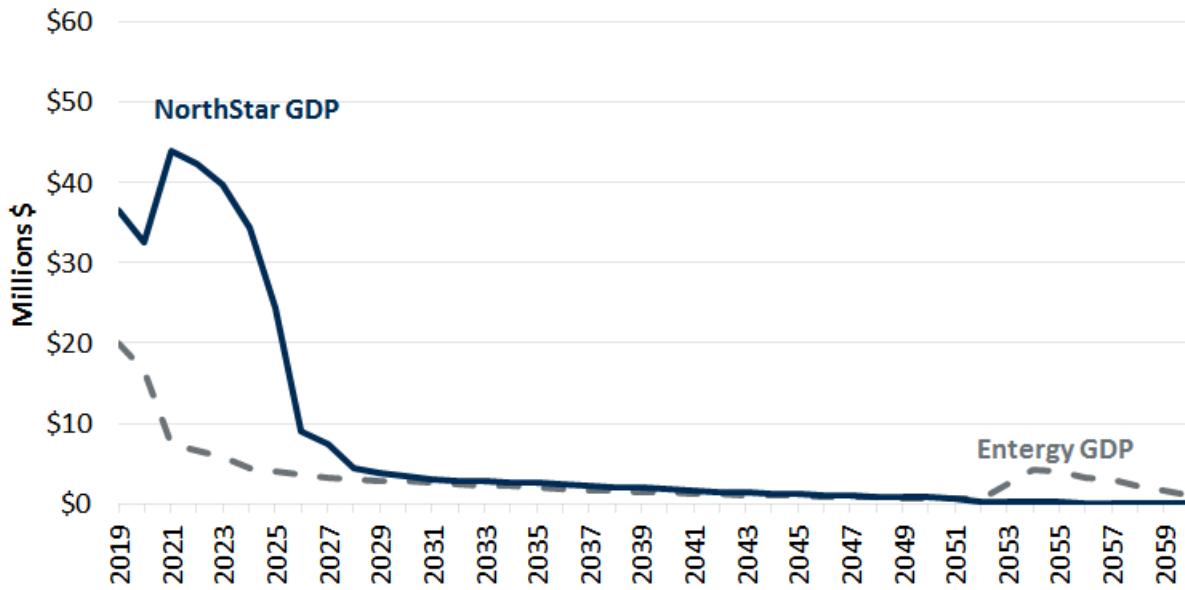
Figure 6 and Figure 7 present the differences in GDP over time between the approaches. These figures clearly show the important timing differences. The NorthStar GDP gains occur much earlier. This is reflected in the present value differences between the approaches.

**Figure 6: Comparison of Vermont Annual GDP Effects at 3% Discount Rate**



Sources and Notes:  
Regional Economic Models, Inc. output.

**Figure 7: Comparison of Vermont Annual GDP Effects at 7% Discount Rate**



Sources and Notes:  
Regional Economic Models, Inc. output.

Table 18 shows the changes in employment impacts by sector. The largest differences are in three sectors: 1) transportation and material moving; 2) building and ground cleaning and maintenance; and 3) sales and related, office and administrative support occupations.

Table 19 shows the changes in gross output by sector. The largest differences arise in two sectors: 1) construction and 2) professional services. This reflects the difference in methodologies anticipated by NorthStar and Entergy.

**Table 18: Total Net Employment Effects by Sector, Vermont**

Category	Entergy	NorthStar	Difference
	[1]	[2]	[3] [2]-[1]
Sales and related, office and administrative support occupations	2,900	2,678	-222
Construction and extraction occupations	1,312	1,501	189
Building and grounds cleaning and maintenance, personal care and service occupations	1,302	915	-387
Transportation and material moving occupations	1,300	667	-633
Management, business, and financial occupations	1,262	1,178	-85
Computer, mathematical, architecture, and engineering occupations	604	723	120
Production occupations	554	385	-168
Healthcare occupations	536	550	14
Protective service occupations	488	347	-141
Installation, maintenance, and repair occupations	471	446	-25
Other	1,294	1,493	199
<b>Total</b>	<b>12,023</b>	<b>10,884</b>	<b>-1,139</b>

*Sources and Notes:*

Regional Economic Models, Inc. output.

**Table 19: Effect on Gross Output and GDP by Sector, Vermont**

Sector	3% Discount Rate			7% Discount Rate		
	Entergy	NorthStar	Difference	Entergy	NorthStar	Difference
	[1]	[2]	[3] [2]-[1]	[4]	[5]	[6] [5]-[4]
Construction	\$52	\$172	\$120	\$22	\$132	\$110
Professional, Scientific, and Technical Services	\$35	\$142	\$107	\$15	\$97	\$82
Real Estate and Rental and Leasing	\$16	\$50	\$35	\$7	\$36	\$29
Utilities	\$15	\$45	\$30	\$8	\$27	\$19
Retail Trade	\$34	\$57	\$23	\$14	\$37	\$24
Health Care and Social Assistance	\$17	\$29	\$12	\$7	\$17	\$10
Finance and Insurance	\$22	\$30	\$9	\$11	\$19	\$8
Wholesale Trade	\$5	\$12	\$8	\$2	\$8	\$6
Manufacturing	\$6	\$13	\$7	\$2	\$9	\$7
Accommodation and Food Services	\$11	\$18	\$7	\$5	\$11	\$6
Other	\$241	\$141	-\$100	\$105	\$90	-\$15
<b>Total Gross Output Impact</b>	<b>\$496</b>	<b>\$781</b>	<b>\$286</b>	<b>\$219</b>	<b>\$526</b>	<b>\$307</b>
<b>Total GDP Impact</b>	<b>\$292</b>	<b>\$479</b>	<b>\$186</b>	<b>\$134</b>	<b>\$321</b>	<b>\$187</b>

*Sources and Notes:*

Regional Economic Models, Inc. output. Total output may not equal sum of sectors due to double counting of an output in one sector as an input to another. All values are in millions of dollars.

**B. NET DIFFERENCES IN MASSACHUSETTS AND NEW HAMPSHIRE**

Table 20 summarizes the economic impact differences between NorthStar and Entergy in Massachusetts and New Hampshire on an undiscounted and discounted value basis over the

period 2019 to 2060. The NorthStar approach generates between \$35 and \$39 million more GDP and between \$56 and \$63 million more in gross output than the Entergy approach. Tax revenue differences are between \$9 and \$10 million accounting for both federal and state.

Table 21 summarizes differences in employment. The NorthStar approach accounts for 134 more jobs in these states than the Entergy approach. As noted above, jobs are not discounted. The higher value for the NorthStar approach employment in this instance may be explained the location of available labor relative to Vermont and secondary employment impact.

**Table 20: Net Difference between Entergy and NorthStar Approaches, Massachusetts and New Hampshire**

	<b>Entergy</b> [1]	<b>NorthStar</b> [2]	<b>Difference</b> [3] [2]-[1]
<b>Undiscounted (millions 2016 \$)</b>			
GDP	\$122	\$145	\$23
Gross Output	\$211	\$242	\$31
State Tax Revenues	\$7	\$8	\$1
Federal Tax Revenues	\$26	\$31	\$5
<b>3% Discount Rate (millions \$)</b>			
GDP	\$53	\$92	\$39
Gross Output	\$90	\$152	\$63
State Tax Revenues	\$3	\$5	\$2
Federal Tax Revenues	\$11	\$20	\$8
<b>7% Discount Rate (millions \$)</b>			
GDP	\$23	\$58	\$35
Gross Output	\$39	\$95	\$56
State Tax Revenues	\$1	\$3	\$2
Federal Tax Revenues	\$5	\$12	\$7

*Sources and Notes:*

Regional Economic Models, Inc. output differences.

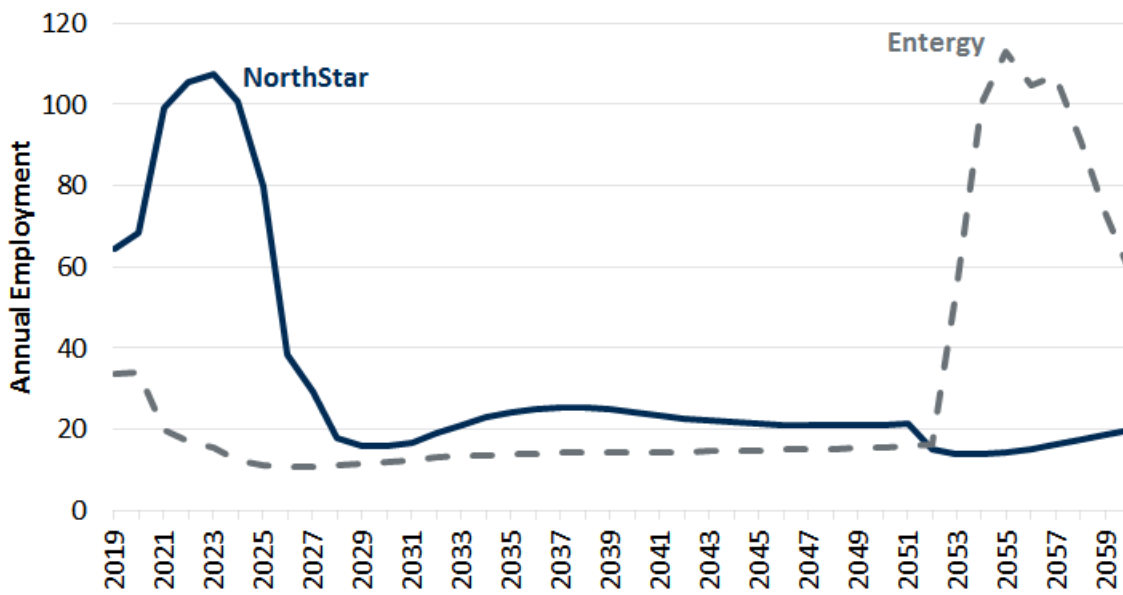
**Table 21: Net Difference between Entergy and NorthStar Approaches, Massachusetts and New Hampshire Employment**

	Entergy [1]	NorthStar [2]	Difference [3] [2]-[1]
<b>Direct and Secondary Employment (<i>jobs</i>)</b>	1,221	1,355	134
Direct	710	753	43
Secondary	511	602	91

Sources and Notes:

Regional Economic Models, Inc. output differences.

**Figure 8: Comparison of Massachusetts and New Hampshire Labor Effects**

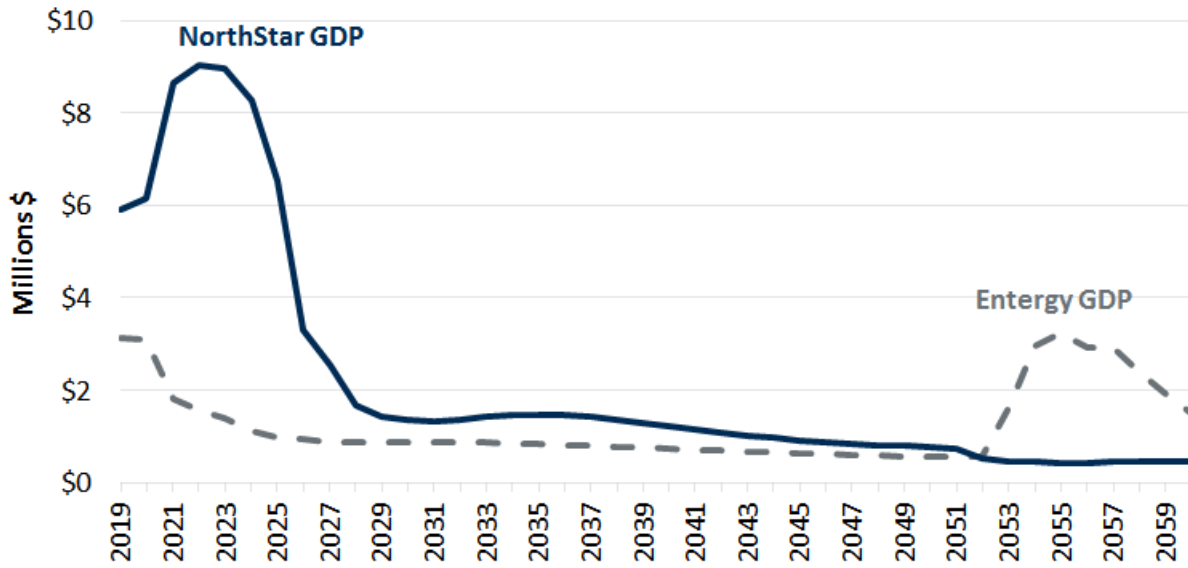


Source and Notes:

Regional Economic Models, Inc. output.

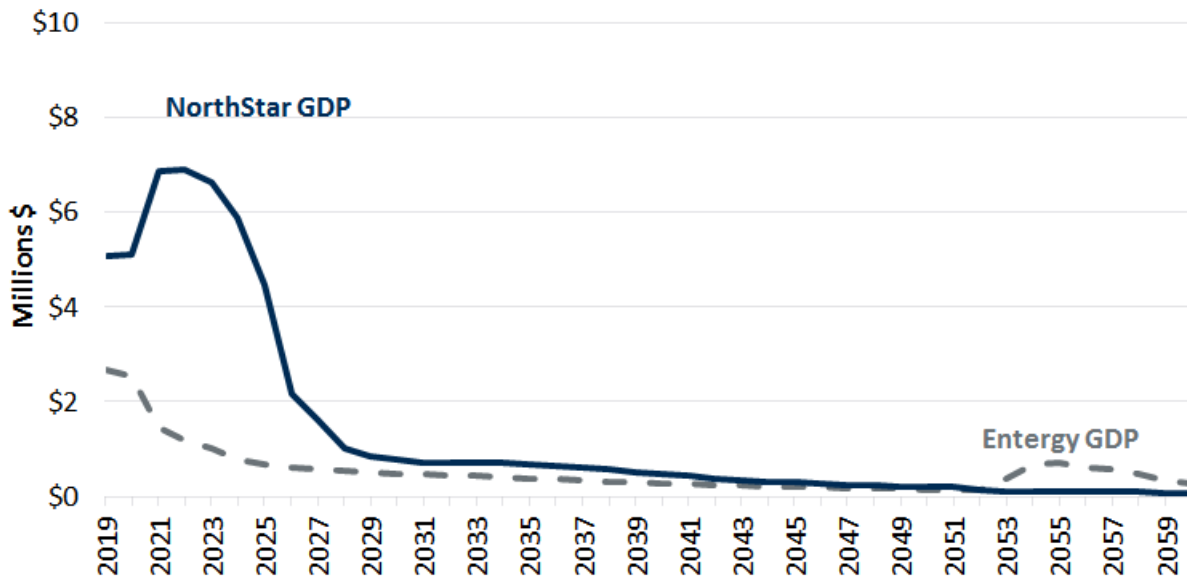
Figure 9 and Figure 10 demonstrate the GDP gains over time on a discounted basis. These figures again show the important timing differences between the two approaches.

**Figure 9: Comparison of Massachusetts and New Hampshire Annual GDP Effects at 3% Discount Rate**



Source and Notes:  
Regional Economic Models, Inc. output.

**Figure 10: Comparison of Massachusetts and New Hampshire Annual GDP Effects at 7% Discount Rate**



Source and Notes:  
Regional Economic Models, Inc. output.

Table 22 presents the differences in employment by sector between the approaches. The largest differences are in: 1) sales and related, office and administrative support occupations and 2) healthcare occupations. Table 23 presents the differences in gross output by sector. The most notable differences occur in: 1) real estate and rental and leasing and 2) professional services.

**Table 22: Total Net Employment Effects by Sector, Massachusetts and New Hampshire**

Category	Entergy [1]	NorthStar [2]	Difference [3] [2]-[1]
Sales and related, office and administrative support occupations	305	344	38
Management, business, and financial occupations	159	168	9
Healthcare occupations	118	138	20
Computer, mathematical, architecture, and engineering occupations	94	90	-4
Building and grounds cleaning and maintenance, personal care and service occupations	92	109	17
Food preparation and serving related occupations	85	104	19
Transportation and material moving occupations	67	72	6
Construction and extraction occupations	66	53	-13
Education, training, and library occupations	54	70	16
Installation, maintenance, and repair occupations	51	54	2
Other	131	153	22
<b>Total</b>	<b>1,221</b>	<b>1,355</b>	<b>134</b>

*Sources and Notes:*

Regional Economic Models, Inc. output.

**Table 23: Effect on Gross Output and GDP by Sector, Massachusetts and New Hampshire**

Sector	3% Discount Rate			7% Discount Rate		
	Entergy [1]	NorthStar [2]	Difference [3] [2]-[1]	Entergy [4]	NorthStar [5]	Difference [6] [5]-[4]
Real Estate and Rental and Leasing	\$12	\$20	\$9	\$5	\$13	\$8
Professional, Scientific, and Technical Services	\$13	\$21	\$8	\$5	\$13	\$7
Manufacturing	\$10	\$17	\$8	\$4	\$11	\$7
Health Care and Social Assistance	\$8	\$14	\$6	\$3	\$8	\$5
Finance and Insurance	\$7	\$12	\$5	\$3	\$8	\$4
Wholesale Trade	\$5	\$9	\$4	\$2	\$6	\$4
Construction	\$5	\$8	\$3	\$2	\$6	\$4
Information	\$7	\$10	\$3	\$3	\$6	\$3
Retail Trade	\$4	\$7	\$3	\$2	\$4	\$3
Accommodation and Food Services	\$2	\$4	\$2	\$1	\$3	\$2
Other	\$13	\$23	\$9	\$5	\$14	\$8
<b>Total Gross Output Impact</b>	<b>\$90</b>	<b>\$152</b>	<b>\$63</b>	<b>\$39</b>	<b>\$95</b>	<b>\$56</b>
<b>Total GDP Impact</b>	<b>\$53</b>	<b>\$92</b>	<b>\$39</b>	<b>\$23</b>	<b>\$58</b>	<b>\$35</b>

*Sources and Notes:*

Regional Economic Models, Inc. output. Total output may not equal sum of sectors due to double counting of an output in one sector as an input to another. All values are in millions of dollars.



## 8. Conclusion

The NorthStar approach generates up to \$187 million higher GDP, up to \$307 million higher gross output, and up to \$42 million greater tax revenues in Vermont than the Entergy approach. Although the NorthStar approach generates fewer jobs in Vermont, the NorthStar approach produces more jobs sooner. There are similar benefits to the surrounding states of Massachusetts and New Hampshire, but on a smaller scale. Although I cannot put a number on it, I expect the economic benefits will disproportionately accrue to Windham County, Vermont.

This analysis shows that on a present value basis the NorthStar approach is more expensive than the Entergy approach, even after accounting for the revenue-generating solar project, by between \$139 (= \$149 - \$10 million) and \$173 (= \$177 - \$4 million) million, but creates benefits to Vermont taxpayers in the form of higher GDP that outweigh these costs. The higher cost is the result of earlier decommissioning expenditures under this approach. Most of the spending occurs in the 2019 to 2026 period. In contrast, the bulk of spending under the Entergy approach occurs much later, 2053 to 2060. This delay reduces the present value of the Entergy approach as well as its costs.

On a present value basis, the increased cost of the NorthStar approach to the joint petitioners (\$139 to \$173 million) is less than the expected GDP gains to the economy of Vermont (approximately \$187 million). Adding the GDP gains to neighboring Massachusetts and New Hampshire, the total expected GDP gains exceed costs by an even greater amount.

## Appendix: Method Details

### A. ASSIGNING EXPENDITURES TO REMI CATEGORIES

We received project cost data from the client broken up into seven labor categories, four equipment and materials categories, and eleven non-labor categories, both for the Entergy and NorthStar approach. We allocated these costs and labor categories into REMI's 70-sector input categories. When making our initial assignments, we relied on several sources:

- **Client-provided Category Descriptions.** The client provided a description for the tasks associated with each of the labor categories and descriptions for each equipment and material category. We compared these descriptions to the REMI categories to inform our assignment of costs.
- **Beacon Economics SONGS Decommissioning Report.** This report provided project expenditures broken down by NAICS codes (see Table 4). We applied those corresponding REMI categories as a baseline for which categories should carry weights from our original data.
- **2014 TLG Vermont Yankee Decommissioning Report.** The TLG decommissioning report provides detailed cost breakdowns for each step in the decommissioning process. We took these cost breakdowns into consideration when assigning costs to REMI categories.

We reviewed our initial assignments with the client, who provided feedback based on their expertise and the expertise of their decommissioning experts. Table 24 and Table 25 show the final crosswalk between the provided categories and our assignments into REMI for each option.

**Table 24: Entergy Crosswalk Between Provided Categories and REMI Categories**

Industry	Labor						Equipment & Materials				Other (non-labor costs)					
	On-Site Plant Staff	Supplemental Staff	On-Site Plant Security	Consultant Labor	On-Site Craft Labor	On-Site DOC Labor	On-Site Contracted Labor	Small Tools, Consumables, Waste Packages	Reactor Vessel Tooling Support Equipment	Heavy Equipment	HP Equipment and Consumables	Insurance	Plant Energy	Emergency Planning Fees	Non-Labor Overhead	Communications Plan
Administrative and support services	38%	30%	100%													100%
Broadcasting, except Internet																100%
Construction	3%				19%	15%		30%		33%						
Insurance carriers and related activities												100%		100%		
Machinery manufacturing									50%							
Management of companies and enterprises	59%	11%														
Professional, scientific, and technical services	0%	59%		100%			100%									
Rental and leasing services; Lessors of nonfinancial intangible assets										34%						
Repair and maintenance																
Retail trade												20%				
Utilities													100%			
Waste management and remediation services					81%	85%		70%	50%	33%	80%					
<b>Total</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

Notes: Excludes REMI industry categories with no assigned weight, property taxes, and categories for expenditures incurred outside of the region.

**Table 25: NorthStar Crosswalk Between Provided Categories and REMI Categories**

Industry	Labor							Equipment & Materials				Other (non-labor costs)				
	On-Site Plant Staff	Supplemental Staff	On-Site Plant Security	Consultant Labor	On-Site Craft Labor	On-Site DOC Labor	On-Site Contracted Labor	Small Tools, Consumables, Waste Packages	Reactor Vessel Tooling Support Equipment	Heavy Equipment	HP Equipment and Consumables	Insurance	Plant Energy	Emergency Planning Fees	Non-Labor Overhead	Communications Plan
Administrative and support services	10%	10%	100%			10%										
Computer and electronic product manufacturing											10%					
Construction					80%	10%		40%	50%	30%	60%					
Insurance carriers and related activities												100%			100%	
Professional, scientific, and technical services	50%	90%		100%		70%	100%									
Rental and leasing services; Lessors of nonfinancial intangible assets										70%						
Retail trade								25%	20%		20%					
Telecommunications																100%
Utilities	40%													100%		
Waste management and remediation services					20%	10%		20%	20%		10%					
Wholesale trade								15%	10%							
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Notes: Excludes REMI industry categories with no assigned weight, property taxes, and categories for expenditures incurred outside of the region.

## **B. USE OF REMI**

Following the assignment of weights shown above, we utilize those weights to allocate costs by year to respective REMI industries for both the Entergy and NorthStar approaches. We input annual expenditure data for 2019 to 2060. We convert all costs into fixed 2015 dollars. We then multiply these by the real GDP growth rate assumed in REMI. After running the model forecast with these inputs, we compare the outcomes to a baseline simulation run on Vermont and Massachusetts/New Hampshire with no inputs. We convert the outputs back to fixed 2016 dollars.

The REMI model can be run in many ways. In the method we implemented, we input all client-provided labor and non-labor expenditures across each of the 70 REMI categories into industry sales. REMI then allocates these expenditures into labor and non-labor.

Alternatively, the user can specify only the number of employees (“Labor-Only Method”) in REMI. For this method, we follow the same process to assign labor expenditures to REMI categories and then divide those costs by the real annual wage rate assumed by REMI for that industry, resulting in direct employment numbers for each industry and year, which were used as our inputs to REMI. The model uses the number of employees to derive the associated intermediate output, which in theory would be the non-labor expenditures of the project. We ran this method to calculate the ratio of direct to secondary labor, which is then applied to the total labor output from REMI in our primary method to back out an estimated number for direct employment.

## **C. JEDI MODEL**

We used the National Renewable Energy Laboratory (NREL) PV Jobs and Economic Development Impact (JEDI) model to assign the costs of building and operating the solar PV array across REMI categories. This model provides local demand costs by NAICS category for installation, as well as operations and maintenance. We directly input the client-provided construction costs of \$12.2 million (\$2016 dollars) and use this projected total to find the projected JEDI costs margined by NAICS industry. We then crosswalked the NAICS categories to REMI categories. Finally, we included the categorized expenditures in our REMI analysis.

Additionally, we modelled revenues from the solar plant operation for all years following construction in the NorthStar approach. To do this, we pulled U.S Energy Information Administration Annual Energy Outlook 2016 data for future electricity generation prices in the New England region given as 2015 cents/kWh. This data, combined with an annual capacity factor for the solar plant provided by the client, let us calculate a rough estimate of future annual revenues from the plant. This outlook only forecasts out to 2040, and so we assumed the electricity generation price to remain constant at the 2040 value in 2015 dollars from 2041 to 2060.

Following the above methodology, we multiply these solar installation and operations expenditures and sales in 2015 dollars by the real GDP growth rate assumed in REMI each year as inputs for the model.

#### **D. OTHER MODELING ASSUMPTIONS**

The dynamics of the model takes into account whether or not the labor and equipment/materials used in the Vermont decommissioning will come from Vermont, Massachusetts/New Hampshire, or outside the region entirely based on relative prices and supply and demand. In our inputs, we exclude any out-of-state fees, as well as corporate administrative and general costs, since the headquarters of both Entergy and NorthStar are not in Vermont, New Hampshire, or Massachusetts. We also exclude property taxes.

To identify forecasted changes in tax revenues, we calculate both state and federal taxes in Vermont and combined in Massachusetts and New Hampshire as a percentage of GDP in 2015. We use the 2015 GDP from the REMI Baseline scenario. For state taxes, we downloaded data from the U.S Census Bureau's State Government Tax Collections 2015 Annual Survey.<sup>15</sup> For federal taxes, we use the total taxes as reported for each state in the Internal Revenue Service Data Book 2015.<sup>16</sup> We then apply the respective ratios to the changes in GDP to simulate changes in state and federal taxes.

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<sup>15</sup> See State Government Tax Collections. U.S. Census Bureau. Posted at: <https://www.census.gov/govs/statetax/>.

<sup>16</sup> See 2015 Internal Revenue Service Data Book. October 1, 2014 to September 30, 2015. Posted at: <https://www.irs.gov/pub/irs-soi/15databk.pdf>.

To adjust for inflation, we use inflation factors calculated from the average change in Consumer Price Index data as reported by the U.S. Bureau of Labor Statistics.<sup>17</sup>

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<sup>17</sup> See Consumer Price Index – All Urban Consumers 2006 to 2016. U.S. Census Bureau.

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