Macroeconomic Impacts of the Rhode Island Community Remote Net Metering Program

Prepared for the Rhode Island Division of Public Utilities and Carriers

March 10, 2021

Tim Woolf
Ben Havumaki
Steve Letendre, PhD
Caitlin Odom
Jamie Hall

Synapse Energy Economics, Inc.

485 Massachusetts Avenue, Suite 3
Cambridge, Massachusetts 02139

617.661.3248 | www.synapse-energy.com

CONTENTS

TABLE OF TABLES

TABLE OF FIGURES

EXECUTIVE SUMMARY

Background

Rhode Island Division of Public Utilities and Carriers (the Division) engaged Synapse Energy Economics, Inc. (Synapse) to prepare a report estimating the costs and benefits of the Community Remote Net Metering (CRNM) program using the Rhode Island benefit-cost test (RI Test).[1]

The RI Test, developed as part of Docket 4600, requires that benefit-cost analyses (BCA) of energy resources account for macroeconomic impacts of those resources.[2] The macroeconomic impacts of energy resources can be large and can have a significant effect on the BCA of those resources. Synapse therefore prepared this companion report to detail the methodology and assumptions used to calculate the macroeconomic impacts considered in the CRNM BCA report.

The Docket 4600 Work Group report and resulting Public Utilities Commission (PUC) orders provide little guidance regarding how to account for macroeconomic impacts. This report, therefore, provides background discussion of macroeconomic impacts and discusses the suitability of their use in BCAs.

Overview of Macroeconomic Impacts

There are several metrics that can be used to indicate macroeconomic activity, including:

- *Job creation*. This refers to all the jobs created by the economic activity. Job creation is best represented in terms of job-years. A job-year is equivalent to a full-time employment opportunity for one person for one year (e.g., five job-years could be five jobs for one year or one job for five years).
- *Personal Income*. Personal income refers to all income collectively received by all individuals or households in a country (or state). Personal income includes compensation from several sources including salaries, wages, and bonuses received from employment or self-employment.
- *Business Income*. Business income reflects earnings taken by businesses and is equivalent to income earned less costs. Note that business income is not equivalent to profits but is rather a broader metric that also includes depreciation of fixed assets and more.
- *State Tax Revenue*. State tax revenues increase in the form of property taxes, sales and gross receipts taxes, and individual income tax due to increased economic activity and employment within the state

---

1 Synapse Energy Economics. 2020. *Benefit-Cost Analysis of the Rhode Island Community Remote Net Metering Program*, prepared for the Rhode Island Division of Public Utilities and Carriers (Synapse CRNM BCA Report).

2 Public Utilities Commission's Guidance on Goals, Principles and Values for Matters Involving the Narragansett Electric Company d/b/a National Grid, October 27, 2017, Docket 4600.

- *State Gross Domestic Product* (GDP). State GDP is the total monetary or market value of all the finished goods and services produced within a state's borders in a specific time period.

Recent studies to estimate the macroeconomic impacts of energy resources in Rhode Island have tended to focus on GDP as the primary macroeconomic indicator of interest.

Prior to choosing a macroeconomic metric for use in making an energy resource decision, it is important to understand the relationship between each metric. For example, GDP includes the combined effects of personal income, business income, and state tax revenue.

There are also three different ways in which an investment will create economic activity, including:

- *Direct impacts* consist of the economic activity created from the direct investment in the project, including activity from the design and engineering, construction, operation, and maintenance of the project.
- *Indirect impacts* consist of the economic activity from the supply chain that is necessary to support the direct investment in the project.
- *Induced impacts* consist of the economic activity from employees in newly created direct and indirect jobs spending their paychecks locally on goods and services.

Macroeconomic Impacts in the Context of Benefit-Cost Analysis

Economic impact analyses (EIAs) have many similarities to BCAs and utilize many of the same inputs. EIAs and BCAs, however, typically serve different purposes and answer different questions, as indicated in Table 1.

Table 1. Overview of Differences between EIAs and BCAs

	Purpose	Method	Questions Answered
BCAs	To identify the costs, benefits, and net benefits of a proposed project	BCAs entail identifying all the relevant benefits and costs of a project and determining whether the benefits exceed the costs over the lifetime of the project.	Whether to invest in a proposed project. BCAs are typically conducted to determine whether to invest in one project over alternative projects, or to determine the lowest-cost way to achieve a desired outcome.
EIAs	To identify the effect on jobs and economic development of a proposed project	EIAs entail modeling how different money flows will affect business revenue, business profits, personal wages, jobs, and taxes, and determining the extent to which the decision will increase economic activity over the lifetime of the project.	Whether and to what extent a project will increase economic activity in the state or region of interest. EIAs are typically conducted when there is interest in the jobs and economic activity created by a proposed project.

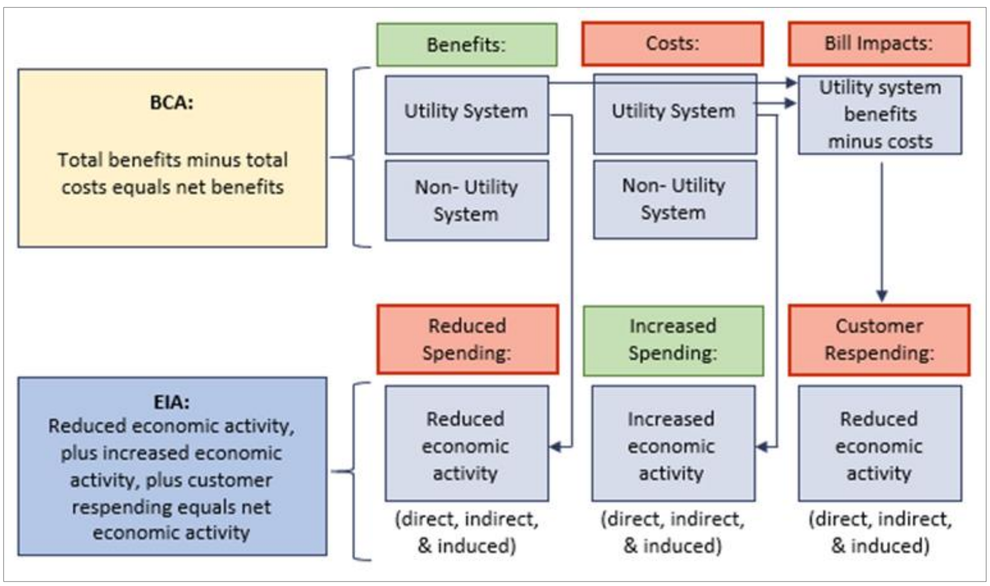
EIAs are commonly conducted independently of BCAs. Some studies combine the two by using the macroeconomic impacts from the EIA as one of the impacts in a BCA. Our literature search on this topic finds that there is relatively little discussion of the relationship between BCAs and EIAs. Nonetheless, most of the literature suggests that while EIAs and BCAs provide complementary information, the monetary EIA results should not be added to monetary BCA results.

There are several aspects of BCAs and EIAs that overlap. Therefore, adding the monetary results of EIAs onto the monetary results of BCAs will result in double-counting some of the impacts.

Figure 1 presents a comparison of the key elements of BCAs and EIAs. It indicates how some elements of the BCA determine some elements of the EIA, resulting in significant overlap:

- The utility system benefits, in terms of avoided costs, result in reduced spending that leads to reduced economic activity.
- The utility system costs, in terms of resource investments, result in increased spending that leads to increased economic activity.
- The customer bill impacts, which are the difference between the utility system benefits and costs, result in customer respending effects that also lead to economic activity. In the case of the CRNM program, the utility system costs exceed the benefits, which leads to increased customer bills, reduced disposable income, reduced customer spending, and reduced economic activity.

Figure 1. Comparison of Benefit-Cost Analyses and Economic Impact Analyses



Another way to frame the overlap between BCAs and EIAs is that the cost of the goods and services purchased (or not purchased) as a result of the utility investment are included in the BCA, and they are also included in the EIA in terms of the direct and indirect economic activity.

There is not, however, a one-to-one relationship between the BCA impacts and the EIA economic activity. In other words, a dollar spent on a utility investment in the BCA is not equivalent to a dollar of economic activity (GDP or otherwise) in the EIA.

In conclusion, some of the economic activity included in the EIA can be described as another representation of the impacts that are already accounted for in the BCA. Therefore, monetary values of macroeconomic impacts should not be added to the monetary impacts in a BCA. Instead, the macroeconomic impacts should be presented alongside the BCA impacts and considered separately.

The Role of Macroeconomic Impacts in Rhode Island

Accounting for macroeconomic impacts in utility decision-making is relatively new in Rhode Island. The PUC began requiring the consideration of macroeconomic impacts in utility cost-effectiveness analyses in 2017 within Docket 4600.[3]

Several studies have estimated the macroeconomic impacts of different energy resources proposed in Rhode Island since Docket 4600. These studies include the National Grid Energy Efficiency Plans (EE Plans), the Revolution Wind Energy Project, the Renewable Energy Growth Program, and the Gravel Pit solar project. However, to our knowledge the questions of how to account for macroeconomic impacts and how to incorporate them into BCAs of energy resources have not been fully vetted before the PUC.

A report prepared for National Grid to estimate the macroeconomic impacts of energy efficiency programs recognized that there is some double-counting of benefits in the BCA results.[4] This report recommends that double-counting can be avoided by estimating the "net incremental" macroeconomic benefits, by subtracting out the direct macroeconomic benefits created by customer respending of bill savings as a result of the energy resource being analyzed. The rationale for this adjustment is that bill savings are already accounted for in the BCA in the form of net benefits, and therefore they should not be included twice in the BCA.

In our view, this approach does not eliminate double-counting. It is true that bill savings are already captured in the BCA result, and therefore adding the macroeconomic impacts from them would be double-counting. However, it is also true that the BCA includes the costs of implementing the energy resource, which is what increases the macroeconomic activity associated with the resource. It is also true that the BCA includes the costs avoided by the energy resource, which is what reduces the macroeconomic activity associated with the resource. Since the three sources of macroeconomic impacts—increased spending on energy resources, reduced spending on energy resources, and customer respending effects—are already included in the BCA, then adding any of these macroeconomic impacts to the BCA would result in double-counting.

Therefore, we recommend that none of the monetary macroeconomic results be added to the monetary BCA results. Instead, the macroeconomic impacts should be presented alongside the BCA impacts and considered separately.

Nonetheless, in this report we estimate the "net incremental" macroeconomic impacts using the methodology described above because this is the methodology that National Grid used in the 2020 EE Plan.

Macroeconomic Impacts of the CRNM Program

The CRNM program allows electric customers to take advantage of distributed renewable generation without needing to site the resource at the point of the load or make any upfront investment. Through the program, residential customers can subscribe to a community solar project from which they receive electricity bill savings.

3 Public Utilities Commission's Guidance on Goals, Principles and Values for Matters Involving the Narragansett Electric Company d/b/a National Grid, October 27, 2017, Docket 4600.

4 Brattle Group. 2019. *Review of RI Test and Proposed Methodology,* prepared for National Grid (Brattle RI Test Study).

As documented in the Synapse CRNM BCA Report, this program is expected to cost $185 million and create benefits of $108 million present value dollars, before including macroeconomic impacts.[5] This results in a benefit-cost ratio of 0.59 and net costs of $76 million present-value dollars.

Our analysis finds that the CRNM Program will create the following macroeconomic benefits over the 25-year contract period:

- Increased jobs of 556 job-years
- An increase in personal income of $38 million, business income by $18 million, and state taxes by nearly $7 million
- An increase state GDP by $84 million

The direct GDP benefits represent nearly 83 percent of the total GDP benefits, the indirect impacts represent nearly 8 percent, and the induced impacts represent nearly 10 percent of total benefits.

Macroeconomic Impacts of Other Remote Community Solar Programs

The Synapse CRNM BCA report assesses the costs and benefits of several different community remote solar programs for the purposes of comparing them to the CRNM program. Table 2 compares the different features of the six programs analyzed in the Synapse CRNM BCA report. These programs are described in more detail in the Synapse CRNM BCA Report.

Table 2. Features of Community Remote Solar Programs

Feature	CRNM	Modified CRNM #1	Modified CRNM #2	Modified CRNM #3	Modified CRNM #4	CRDG
RNM credit based on	C-06 rate	C-06 rate	C-06 rate	C-06 rate	C-06 rate	competitive bids
RNM credit over time	increases	increases	increases	fixed	increases	fixed
RECs assigned to	developers	developers	Nat. Grid	Nat. Grid	Nat. Grid	Nat. Grid
Capacity assigned to	developers	Nat. Grid	Nat. Grid	Nat. Grid	Nat. Grid	Nat. Grid
LMI customers	very few	20%	20%	20%	20%	very few
Contract period	25 years	25 years	25 years	25 years	20 years	20 years

Table 3 summarizes the results of our macroeconomic analysis across all remote community solar programs analyzed.

[5] Unless otherwise noted, all dollar values presented in this report are in terms of 2019 present value dollars, cumulative over the 25-year study period.

Table 3. Summary of Macroeconomic Impacts across All Programs

Impact	CRNM	Modified CRNM #1	Modified CRNM #2	Modified CRNM #3	Modified CRNM #4	CRDG
Jobs (job-years)	556	595	699	637	516	500
Personal Income (mil PV$)	38	41	47	42	35	33
Business Income (mil PV$)	18	20	23	21	17	16
State Taxes (mil PV$)	7	7	9	8	6	6
GDP (mil PV$)	84	88	102	85	74	64

1. INTRODUCTION

Rhode Island Division of Public Utilities and Carriers (the Division) engaged Synapse Energy Economics, Inc. (Synapse) to prepare a report estimating the costs and benefits of the Community Remote Net Metering (CRNM) program using the Rhode Island benefit-cost test (RI Test).[6]

The RI Test, developed as part of Docket 4600, requires that benefit-cost analyses (BCAs) of energy resources account for the macroeconomic impacts of those resources.[7] The macroeconomic impacts of energy resources can be quite large and can have a significant effect on the BCA of those resources. Synapse therefore prepared this companion report to detail the methodology and assumptions used to calculate the macroeconomic impacts considered in the CRNM BCA report.

Since the Docket 4600 Work Group report and resulting Public Utilities Commission (PUC) orders provide little guidance regarding how to account for macroeconomic impacts, this report also provides a review of macroeconomic impacts and discusses the appropriateness of their use in BCAs.

We begin Chapter 2 with a description of the Rhode Island community solar programs. Chapter 3 provides an overview of how to analyze macroeconomic impacts, including a discussion of the relationship between BCAs and macroeconomic analyses. Chapter 4 describes how macroeconomic analyses have been used recently in making energy resource decisions in Rhode Island. Chapter 5 presents our results.

[6] Synapse Energy Economics. 2020. *Benefit-Cost Analysis of the Rhode Island Community Remote Net Metering Program*, prepared for the Rhode Island Division of Public Utilities and Carriers, (Synapse CRNM BCA Report).

[7] Public Utilities Commission's Guidance on Goals, Principles and Values for Matters Involving the Narragansett Electric Company d/b/a National Grid, October 27, 2017, Docket 4600.

2. RHODE ISLAND COMMUNITY SOLAR PROGRAMS

Rhode Island has several programs that support various types of solar application in the state. These programs target a range of use cases from behind-the-meter residential applications to larger front-of-the-meter/grid-tied systems. This report focuses on two of these programs: the CRNM Program and the Community Remote Distributed Generation (CRDG) Program.

2.1. Community Remote Net Metering

The CRNM program allows electric customers to take advantage of distributed renewable generation without needing to site the resource where the energy is used or to make any upfront investment. Through the program, residential customers can subscribe to a community solar project from which they receive electricity bill savings.

The key elements of the program include the following:

- A renewable net metering (RNM) credit is used to compensate renewable project developers and provide bill savings for subscribers.
- The RNM credit is defined as the sum of the standard offer charge, the transmission charge, distribution charge, and transition charge of National Grid's small commercial customer electric rate (the C-06 rate). This rate determines the value of the RNM credits for all subscribers to the CRNM program.
- The RNM credit will change over time as the small commercial customer rate changes over time.
- The CRNM subscription charge is set to equal 90 percent of the RNM credit and is used to compensate the renewable project developers. The remaining 10 percent of the RNM credit is used to provide bill savings for subscribers.
- Project developers are assigned rights to the renewable energy credits (REC) created by the remote renewable projects.
- Project developers are assigned rights to the generation capacity created by the remote renewable projects.
- CRNM subscribers sign up for a 25-year contract.

Six solar projects have been accepted into the CRNM program and will provide the full 30 MW allowed into the pilot. According to National Grid, 28.4 MW of solar have been reserved and another 1.6 MW remain available to potential subscribers as of June 2020.[8] More information on the CRNM program can be found in the Synapse CRNM BCA Report.

---

8 National Grid. March 2, 2020. "RI – Net Metering." Available at: https://ngus.force.com/s/article/Net-Metering-in-Rhode-Island.

2.2. Modified Community Net Metering Programs

The Synapse CRNM BCA Report assesses the costs and benefits of several different community remote solar programs for the purposes of comparing them to the CRNM program. Table 4 presents the different features of the six programs analyzed in the Synapse CRNM BCA Report. These programs are described in more detail in the Synapse CRNM BCA Report.

Table 4. Features of Community Remote Solar Programs

Feature	CRNM	Modified CRNM #1	Modified CRNM #2	Modified CRNM #3	Modified CRNM #4
RNM credit based on	C-06 rate	C-06 rate	C-06 rate	C-06 rate	C-06 rate
RNM credit over time	increases	increases	increases	fixed	increases
RECs assigned to	developers	developers	Nat. Grid	Nat. Grid	Nat. Grid
Capacity assigned to	developers	Nat. Grid	Nat. Grid	Nat. Grid	Nat. Grid
LMI customers	very few	20%	20%	20%	20%
Contract period	25 years	25 years	25 years	25 years	20 years

2.3. Community Remote Distributed Generation

The CRDG program has many features similar to the CRNM program. They both promote remote community solar facilities that are financed by National Grid electric customers who voluntarily subscribe to the program. Because of these similarities, we compare the costs and benefits of the CRNM program to those of the CRDG program.

The CRDG program differs from the CRNM program in the following ways:

- The RECs created by the solar projects are assigned to National Grid.
- The generation capacity rights of the solar projects are assigned to National Grid.
- The subscribers sign up for a 20-year contract, instead of the 25-year contract in the CRNM program. Consequently, the BCA and the macroeconomic analysis use a 20-year study period.
- The RNM credit is based on the proposals provided by renewable project developers in a competitive solicitation. This results in a lower RNM credit and lower costs for the program.
- The RNM credit is held fixed throughout the 20-year contract for each subscriber. This also results in a lower RNM credit and lower costs for the program.

2.4. Benefit-Cost Analysis of the Community Solar Programs

Table 5 presents a summary of the BCA results for the Rhode Island community remote solar programs, as estimated in the Synapse CRNM BCA Report. Note that these results to not include any values for macroeconomic impacts.[9] We present the results this way in order to clearly indicate the cost-

9 In the Synapse CRNM BCA Report, we refer to this case as the Separate Impacts Case.

effectiveness results before any macroeconomic impacts are added. This is necessary because the BCA results are an input to this EIA.

Table 5. Benefit-Cost Analysis of Rhode Island Community Solar Programs

Analysis	Impact	CRNM	Modified CRNM #1	Modified CRNM #2	Modified CRNM #3	Modified CRNM #4	CRDG
Benefit-Cost Analysis	Costs (mil PV$)	185	185	185	125	145	93
	Benefits (mil PV$)	105	116	134	134	112	112
	Net Benefits (mil PV$)	-76	-69	-51	9	-33	18
	Benefit-Cost Ratio	0.59	0.63	0.73	1.07	0.77	1.20

3. Overview of Macroeconomic Impacts

Macroeconomic impacts occur when an industry or government investment or program directly affects the flow of money between customer, businesses, and government agencies. An EIA is often conducted to assess how an economy is likely to change as a result of these flows of money.

Energy efficiency and renewable energy programs provide incentives to encourage adoption of resources that shift economic activity away from traditional energy sources. Increasingly, policymakers are interested in understanding the macroeconomic impacts of these programs. In some cases, macroeconomic impacts may be used to justify new programs or expand existing programs.

In this chapter, we provide an overview of the methods used to conduct an EIA, the macroeconomic indicators that are often reported in an EIA, the key macroeconomic effects modeled in an EIA, and the role of EIA results in a BCA.

3.1. Macroeconomic Indicators

Several indicators may be used to describe the macroeconomic changes that result from a new policy or program. This section defines each of these indicators and discusses how they should be interpreted.

Number of Jobs

For policymakers, one of the most important indicators of macroeconomic impacts is jobs. Commonly used language about job impacts can be misleading if it lacks a time dimension. For example, a claim that a program creates 100 new jobs is imprecise. This could be interpreted to mean that there are 100 new jobs created that persist in perpetuity. The more precise term, "job-years," includes a time dimension and is often how the job impacts of a new program and policy are reported from an EIA. One job-year is equal to one person working full time (40 hours per week) for a year, or two people working full time for a half of a year, etc.[10] Job-years allow an EIA to more accurately represent variation in the duration of jobs that are created from a new policy or program.

Job-years as an indicator of macroeconomic impacts does not tell us anything about the type of jobs that are created. The number of job-years is determined by investment and wages. If a job associated with an industry has low wages, there will be more job-years produced by a given investment, whereas a job with higher wages will have fewer job-years associated with the same investment. Ensuring wages are industry-based and an accurate representation of wage levels will ensure more accurate results.

Personal Income

Personal income includes wages or salaries, social security and other government benefits, dividends and interest earned, business ownership, or other sources of income.[11] Other macroeconomic indicators

---

[10] U.S. Environmental Protection Agency. 2018. *Quantifying the Multiple Benefits of Energy Efficiency and Renewable Energy, A Guide to State and Local Governments*, Part 2, Chapter 5, 2018 Edition.

[11] U.S. Department of Commerce, Bureau of Economic Analysis. Accessed September 8, 2020. "Personal Income." Available at: https://www.bea.gov/data/income-saving/personal-income#:~:text=What%20is%20Personal%20Income%3F,Learn%20More.

include revenues to businesses, whereas personal income focuses on the additional income retained by individuals—whether they are on the payroll or owners of the businesses.

Business Income

Business income reflects earnings taken by businesses, not individuals. This is equivalent to income earned as a result of a company's operations less costs.[12] Note that business income is not equivalent to profits, but is rather a broader metric that also includes depreciation of fixed assets and transfer payments.[13]

State Taxes

When economic activity in a state increases, it may result in an uptick in state tax revenues. States draw revenues from many sources, including property taxes, payroll and income taxes, and sales taxes. State tax revenues may be construed as one measure of the societal benefit provided by an economically stimulating program or policy.

Gross Domestic Product

Gross domestic product (GDP) represents the market value of the goods and services produced within a region over a specified period of time (e.g., annual or quarter).[14] GDP is often assessed at the national or state level but can also be reported for a specified region. Since there may be many intermediate steps required to produce these finished goods and services, GDP accounting excludes the value of certain intermediate inputs to calculate just the value that has been added through production occurring within the region of interest.[15]

GDP may be estimated using either an expenditure approach or an income approach. The expenditure approach involves summing all of the money spent on goods and services. In contrast, the income approach is calculated by adding up all the incomes generated through the production process. The value added at each stage of production inside the region of interest is equal to the incomes generated by production. Note that "income" in this context includes both personal and business income.

GDP is frequently used as the indicator of the economic health of a region. However, GDP is a very broad measure and does not directly translate to individual welfare. Since a region's GDP is a blunt measure of overall activity, the metric is likely to reflect many different kinds of transactions, ranging from the purchase of luxury goods to money spent on disaster relief or even spending on medical bills associated with rising sickness resulting from exposure to poor air quality. Some of these GDP contributors are

---

[12] Investopedia. Last accessed November 25, 2020. "What is Busines Income." Available at https://www.investopedia.com/terms/b/businessincome.asp.

[13] A transfer payment is a one-way payment of money for which no money, good, or service is received in exchange. Transfer payments commonly refer to efforts by local, state, and federal governments to redistribute money to those in need.

[14] U.S. Department of Commerce, Bureau of Economic Analysis. 2015. *Measuring the Economy: A Primer on GDP and the National Income and Product Accounts*. 2. Available at: https://www.bea.gov/sites/default/files/methodologies/nipa_primer.pdf.

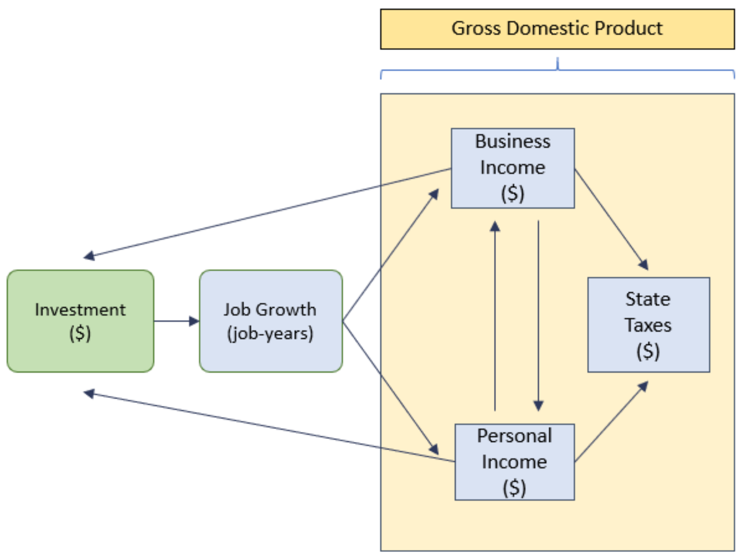
[15] IMPLAN. Accessed September 19, 2020. "Measures of GDP: Value Added and Final Demand." Available at: https://implanhelp.zendesk.com/hc/en-us/articles/115002815494-Measures-of-GDP-Value-Added-and-Final-Demand.

associated with wellbeing. On the other hand, GDP growth may come at cost to human health, environment, and even social cohesion. As a result, some have argued that GDP is not a useful indicator for human welfare.[16,17] Instead, measures of job and personal income growth may be better indicators of the state of human welfare in a given region.

GDP provides a total, top-down view of the economy at a point in time. As discussed above, there are many correlates of GDP, including jobs, income, and taxes. Changes in regional GDP are expected to bring directionally identical changes in these other categories. This is unsurprising—workers and wages are the lifeblood of the economy, and output and employment are integrally connected. There are also causal links between these different components over time.

GDP is the sum of business income, personal income, state taxes, and other effects such as rental income, net interest, business transfer payments, and surplus of government enterprises. Figure 2 shows how the key macroeconomic indicators relate to each other.

Figure 2. Indicators of Economic Development: Inter-Relationships



As indicated, these macroeconomic indicators are highly inter-related. In particular:

- Investment leads to job growth.
- Job growth increases business income.
- Job growth increases personal income.
- Business income growth increases state taxes.
- Personal income growth increases state taxes.
- Increased business income leads to more investment.
- Increased personal income leads to more investment.

[16] Kapoor, Amit, Bibek Debroy. 2019. "GDP Is Not a Measure of Human Well-Being." *Harvard Business Review*, October 4. Available at: https://hbr.org/2019/10/gdp-is-not-a-measure-of-human-well-being.

[17] Aitken, Andrew. 2019. "Measuring Welfare Beyond GDP." *National Institute Economic Review,* 2019; Vol 249(1):R3-R16. DOI:10.1177/002795011924900110. Available at https://journals.sagepub.com/doi/full/10.1177/002795011924900110.

3.2. Direct, Indirect, and Induced Effects

An EIA may consider many varieties of changes in spending occurring within an economy. For activities that stimulate new investments in infrastructure, an EIA will capture the spending flows associated with construction, operation and maintenance (O&M), the respending of wages earned by workers as a result of the changes under study, and any additional respending of savings that may result from the policy or program in question.

Investments in construction often generate short-term jobs as firms expand hiring to staff projects.[18,19] In addition to these *direct effects*, the associated growth in demand for construction materials may result in additional employment further up the supply chain. This supply-related hiring is an *indirect effect* of the construction project. Finally, newly hired workers generate additional economic impact through respending their wages—an *induced effect* of the construction project's direct and indirect effects. Should the construction project result in additional savings, the respending and reinvestment of these savings may generate additional economic stimulus, yet another induced impact of the original construction investment.[20] An example of this would be utility customers who experience bill savings from a cost-effective utility program.

Examples of direct, indirect, and induced impacts for a new solar photovoltaic construction project are provided below:

- Direct impacts consist of the jobs for design and engineer, construction, and O&M. Jobs that are considered direct impacts all come from the direct investment in the infrastructure project. For example, consider investment in a 1 MW solar project. Direct impacts would be the jobs created from the design, construction, and operation of that single solar facility.
- Indirect impacts account for jobs created and the economic activity from the supply chain. In the 1 MW solar project example, indirect impacts would include jobs created for increased solar panel production to meet the new demand created by the project.
- Induced impacts result from employees in newly created direct and indirect jobs spending their paychecks locally on goods and services. An example of an induced job from the example solar project would be additional employment at a coffee shop from increased spending by local solar construction workers.

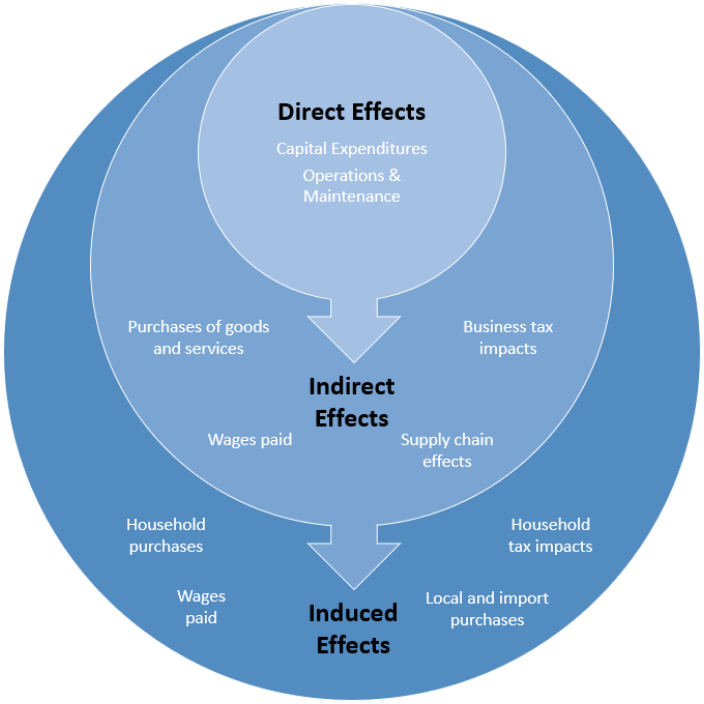
Figure 3 presents a summary of the relationships between direct, indirect, and induced effects.

[18] Increased spending may also result in the already employed putting in more hours. This alternative to expanded hiring is typically treated identically in EIA model outputs—as additional job-years. Notably, an individual workers could represent greater than one job-year over the course of a year.

[19] Unlike construction jobs, jobs supporting the O&M of a project are expected to last for the duration of the project's lifetime. This means that investment in O&M results in jobs that are sustained for the duration of the project lifetime, allowing for a sustained impact on net job-years created from an infrastructure project.

[20] Perspective plays a critical role in classifying impacts as direct, indirect, or induced. For example, while the respending of wages is an induced effect of direct spending on construction that results in hiring additional employees, the respending of wages also has its own trifecta of direct, indirect, and induced impacts.

Figure 3. Direct, Indirect, and Induced Effects



Source: Adapted from IMPLAN.

3.3. Net Impacts

Industry growth does not always result in overall economic growth for a region. It is possible that the jobs gained in the industry that is the recipient of the new investment are less than the losses in the sector for which investment declines. Thus, it is important to calculate macroeconomic impacts, rather than gross impacts. Net impacts will account for jobs that are displaced in other sectors by the investment.

For example, solar may result in more O&M jobs per MW than traditional fossil generators but may have fewer construction jobs. Finding the net macroeconomic impact from solar investments accounts for the reduced economic activity of other generation sources that are displaced. Similarly, net macroeconomic impacts must account for the direct, indirect, and induced impacts from declining investments in the sector from which resources are redirected.

3.4. Methods and Models

Estimating the local-level economic impacts from changes in an economy involves projecting likely changes in the flow of goods, services, and income, and then estimating the resulting economic impacts measured by the key economic indicators discussed above.[21]

[21] U.S. Environmental Protection Agency, *Estimating the Economic Benefits of Energy Efficiency and Renewable Energ*y, Part 2, Chapter 5, 2018.

Estimates of local macroeconomic impacts start by defining the geographic boundary of the study, which is typically a state. The next step is to establish a baseline from which to compare changes in economic activity. The baseline should reflect current conditions.

There are a variety of methods and models used in EIA with varying degrees of complexity, ranging from simple and inexpensive rules-of-thumb factors to more detailed and costly econometric models. Regardless of the method used, an EIA estimates the net economic development impacts by comparing the economic outcomes given the baseline scenario to the economic outcomes associated with the changes in the economy of interest. The net increases or decreases in economic development indicators are thus attributed to the factors that result in the changes to the local economy.

Table 6 describes the most common approaches for estimating macroeconomic impacts.

Table 6. Economic Development Impacts - Methods and Models

Method	Description	Typical Use
Rules-of-thumb factors	Generic rules-of-thumb factors for EIAs are simplified factors that represent relationships between key policy or program characteristics (e.g., financial spending, energy savings) and employment or output.	High-level screening analysis
Input-output models	Input-output models, also known as multiplier analysis models, can also be used to conduct analyses within a limited budget and timeframe, but provide more rigorous results than those derived from rules of thumb.	Short-term analysis of investments with limited scope and impact
Econometric models	Econometric models use mathematical and statistical techniques to analyze economic conditions both in the present and in the future to forecast how investments might affect income, employment, gross state product, and other common output metrics.	Short- and long-term analysis of investments with an economy-wide impact
Computable general equilibrium models (CGE)	CGE models use equations derived from economic theory to trace the flow of goods and services throughout an economy and solve for the levels of supply, demand, and prices across a specified set of markets.	Long-term analysis of Investments with an economy-wide impact
Hybrid models	Hybrid models typically combine aspects of CGE modeling with those of econometric models and may be based more heavily on one or the other.	Short- and long-term analysis of investments with a limited or economy-wide impact

Notes: Adapted from Table 5-1: Types of Methods and Models and Their Typical Uses, U.S. Environmental Protection Agency Estimating the Economic Benefits of Energy Efficiency and Renewable Energy, Part 2, Chapter 5. See this reference for a detailed discussion of the strengths and limitations of each approach.

Input-output modeling is one of the most frequently used methods to conduct EIAs given its relative low cost and flexibility. The two most common input-output models used to estimate the economic development impacts are:

- *REMI (Regional Economic Models Inc.) Model.* REMI is a dynamic forecasting and policy analysis tool. The model forecasts the future of a regional economy, and it predicts the effects on that same economy when the user implements a change. REMI models have been used throughout the world for a wide range of topic areas, including economic development, the environment, energy, transportation, and taxation, forecasting, and planning.
- *IMPLAN (Economic Impact Analysis for Planning, IMPLAN Group, LLC).* IMPLAN is an industry-standard input-output model that accounts for both the direct and indirect

economic impact of an industry. IMPLAN was developed by the U.S. Forest Service in the 1970s to deliver accurate and timely estimates of economic impacts of forest resources.

3.5. The Role of Macroeconomic Impacts in BCAs

Inter-Relationships between BCAs and EIAs

EIAs have many similarities to BCAs and utilize many of the same inputs. However, EIAs and BCAs typically serve different purposes and answer different questions, as indicated in Table 7.

Table 7. Overview of Differences between EIAs and BCAs

	Purpose	Method	Questions Answered
BCAs	To identify the costs, benefits, and net benefits of a proposed project	BCAs entail identifying all the relevant benefits and costs of a project and determining whether the benefits exceed the costs over the lifetime of the project.	Whether to invest in a proposed project. BCAs are typically conducted to determine whether to invest in one project over alternative projects, or to determine the lowest-cost way to achieve a desired outcome.
EIAs	To identify the effect on jobs and economic development of a proposed project	EIAs entail modeling how different money flows will affect business revenue, business profits, personal wages, jobs, and taxes, and determining the extent to which the decision will increase economic activity over the lifetime of the project.	Whether and to what extent a project will increase economic activity in the state or region of interest. EIAs are typically conducted when there is interest in the jobs and economic activity created by a proposed project.

There is not much literature to draw from for guidance on the use of EIA results in BCAs. The literature we reviewed generally suggests that EIAs and BCAs are complementary in nature but not additive.

The U.S. Transportation Research Board (TRB) offers a relatively definitive statement about the relationship between an EIA and a BCA. The TRB's web guide states the following:

> When conducting BCA and EIA for the same project, it is important to keep the following points in mind:
>
> - Keep the analyses separate. Although both practices use some of the same initial information (such as travel time savings), results should be developed and presented separately to avoid any confusion.
> - Never add final economic impacts to BCA benefits.[22]

Joseph et al. (2020a) use a criteria-based evaluation of a BCA and an EIA for use in environmental assessments. They find that a BCA has numerous strengths relative to an EIA but that both methods are

[22] U.S. Transportation Research Board. Last accessed November 25, 2020. "BCA vs. Economic Impact Analysis." http://bca.transportationeconomics.org/home/bca-vs-economic-impact-analysis.

useful.[23] They conclude that a BCA and an EIA are complementary and provide decision-makers with more complete information when presented together.[24]

In a second article by Joseph et al. (2000b) the authors use a case study of a proposed Canadian oil project to assess the contributions of cost-benefit analysis to an environmental assessment to compare against the results of an EIA. In this article, the authors conclude that:

> The case study demonstrates that economic impact analysis can help inform decision-makers of projects' economic impacts, but the cost-benefit analysis should be used to help inform decision-makers with respect to the contribution of projects to the public interest.[25]

Weisbrod et al. (2016) arrive at the same conclusion. The researchers explore the differences between an EIA and a BCA using a case study of bus rapid transit in Sydney, Australia. They conclude that:

> This paper provides the rationale for using an extended analysis EIA as a complement to the welfare-based CBA [cost-benefit analysis]. The approach is illustrated by a case study of a bus rapid transit proposal in Sydney. It shows how these approaches are complementary, answer different questions, and can be used together to provide a more holistic evaluation of the value of a public transport infrastructure change.[26]

Weisbrod et al. (2016) compare BCAs with EIAs along three dimensions: time, spatial, and impact element.

- On the time dimension, a BCA looks at the net present value of a discounted stream of costs and benefits. In contrast, an EIA predicts the expected change in a regional economy at future points in time. The EIA does not entail discounting of future values.
- On the spatial dimension, a BCA will adopt a specific viewpoint (utility or societal) but it typically has no explicitly stated spatial boundary. An EIA, however, has a very well-defined spatial boundary by tracing money flows through a defined economic system (state, regional, or national).
- On the impact dimension, a BCA covers all social welfare benefits and costs, and in the case of transportation facilities includes both users and non-users.[27] In contrast, an EIA covers macroeconomic impacts resulting from the flow of money in the economy of a designated study area.

---

[23] Chris Joseph, Thomas Gunton, Duncan Knowler, Sean Broadbent. 2020a. "The Role of Cost-benefit Analysis and Economic Impact Analysis in Environmental Assessment: The Case for Reform," *Impact Assessment and Project Appraisal,* DOI: 10.1080/14615517.2020.1767954, page 1.

[24] *Id*, page 7.

[25] Chris Joseph, Thomas I. Gunton, James Hoffele. 2020b. "Assessing the public interest in environmental assessment: lessons from cost-benefit analysis of an energy megaproject." *Impact Assessment and Project Appraisal*, Vol 38:5, 397-411, DOI: 10.1080/14615517.2020.1780371. page 397.

[26] Glen Weisbrod, Corinne Mulley, David Hensher. 2016. "Recognizing the complementary contributions of cost benefit analysis and economic impact analysis to an understanding of the worth of public transport investment: A case study of bus rapid transit in Sydney, Australia." *Research in Transportation Economics,* Vol 59: pages 450 - 461. page 40.

[27] In the case of energy resource investments or projects, the BCA may be confined to just the utility, participants, or society depending on the perspective adopted.

Exploring these types of economic analyses along these dimensions serves to highlight the key distinctions and supports the researchers claims that these are complementary analyses and both provide useful information for decision-makers.

A study of a medium-sized international sports event was used to empirically illustrate the difference between a standard EIA and a BCA. The EIA found that the Pan-American Junior Athletic Championships would yield a net increase in economic activity in the City of Windsor of 5.6 million CAD.[28] In contrast, the BCA of the event yielded net benefits of -2.6 million CAD. This case study demonstrates the potential that a BCA and an EIA can provide conflicting information to decision-makers about new investments or projects.

Macroeconomic Impacts in Energy Efficiency Cost-Effectiveness Analysis

We have found few examples of states that include macroeconomic impacts in BCAs of energy efficiency resources. Furthermore, there is no standard metric for capturing the macroeconomic impacts within a BCA of demand-side resources.

In the limited cases where macroeconomic impacts have been integrated into an energy efficiency BCA, GDP has been the default metric. A recent study of Wisconsin's energy efficiency and renewable energy programs conducted for the Public Service Commission of Wisconsin added the monetary GDP impacts to the monetary BCA results.[29] When the GDP impacts are included in the BCA results, the energy efficiency programs' BCA ratio increases from 3.6 to 5.8.[30]

The use of EIA results as inputs into BCAs has led to concerns about the potential for double-counting of benefits. The American Council for an Energy-Efficient Economy's (ACEEE) 2019 *State Policy Toolkit: Guidance on Measuring the Economic Development Benefits of Energy Efficiency* warns of the potential of double-counting.

ACEEE makes an important distinction in the lifecycle of efficiency programs between the implementation or construction phase and the savings phase. The first phase is limited in duration and results in economic development impacts when workers are hired to produce and install energy efficiency equipment.[31] The savings phase begins once the efficiency measures have been installed and customers begin to realize bill savings. The macroeconomic impacts from this phase result when consumers re-spend these savings. The ACEEE toolkit describes a concern with double-counting in the savings phase:

> Perhaps the easiest mistake would be to include the savings-phase benefits in a test that already values customer savings. If a cost test includes the value of customer

[28] Taks, Marijke; Kesenne, Stefan; Chalip, Laurence; Green, Christine B. 2011. "Economic Impact Analysis Versus Cost Benefit Analysis: The Case of a Medium-Sized Sport Event." *International Journal of Sport Finance*, Vol 6 (3), 187-203. https://scholar.uwindsor.ca/humankineticspub/20.

[29] Cadmus. 2020. *Focus on Energy 2015–2018 Quadrennium Economic Impact Analysis*. A report prepared for the Public Service Commission of Wisconsin. Available at https://focusonenergy.com/sites/default/files/WI%20Focus%202015-18%20Quad_Econ%20Impacts_final.pdf.

[30] Cadmus, 2020.

[31] American Council for an Energy-Efficient Economy (ACEEE). 2019. *State Policy Toolkit: Guidance on Measuring the Economic Development Benefits of Energy Efficiency*. Available at https://www.aceee.org/sites/default/files/Jobs%20Toolkit%203-8-19.pdf.

savings, it has identified the dollar value of the savings to the economy. If we consider the savings as essentially an increase in disposable income for energy customers, the fact that they spend it on activities that create jobs and increase GDP is simply another way of describing that benefit. In most instances, the only new impacts that should be included are the impacts from the implementation phase.[32]

ACEEE does not indicate in its policy toolkit that monetary values of economic impacts should not be added to the monetary BCA results, but rather raises concerns about the potential for double-counting of benefits.

Analysis and Recommendation

We conclude that BCAs and EIAs both provide useful information for decision-makers, but that there is significant overlap between the two analyses. This overlap suggests that adding the monetary results from an EIA onto the monetary results of a BCA would lead to a significant amount of double-counting of some impacts. Figure 4 helps explain how we reach this conclusion.

Figure 4. Comparison of Benefit-Cost Analyses and Economic Impact Analyses

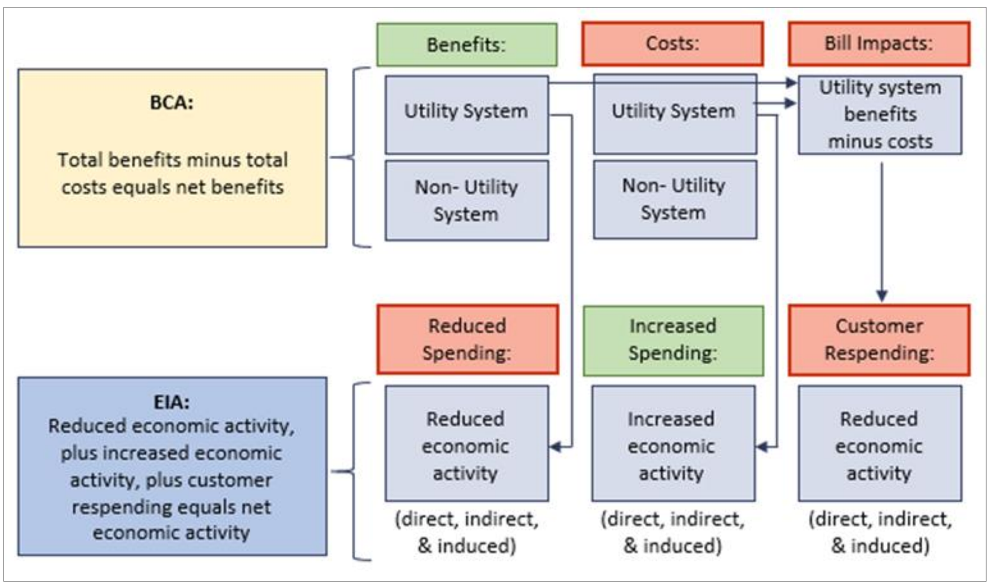


Figure 4 indicates how some elements of the BCA determine some elements of the EIA:

- The utility system benefits, in terms of avoided costs, result in reduced spending that leads to reduced economic activity.
- The utility system costs, in terms of resource investments, result in increased spending that leads to increased economic activity.
- The customer bill impacts, which are the difference between the utility system benefits and costs, result in customer respending effects that also lead to economic activity. In

32 ACEEE, 2019.

the case of the CRNM program, the utility system costs exceed the benefits, which leads to increased customer bills, reduced disposable income, reduced customer spending, and reduced economic activity.

Another way to frame the overlap between BCAs and EIAs is that the cost of the goods and services purchased (or not purchased) as a result of the utility investment are included in the BCA, and are also included in the EIA in terms of the direct and indirect economic activity.

There is not, however, a one-to-one relationship between the BCA impacts and the EIA economic activity. In other words, a dollar spent on a utility investment in the BCA is not equivalent to a dollar of economic activity (GDP or otherwise) in the EIA. This combination of significant overlap plus the lack of a one-to-one relationship between BCA and EAI impacts makes it very difficult to adjust the EIA results to eliminate double-counting.

In conclusion, some of the economic activity included in the EIA can be described as another representation of the impacts already accounted for in the BCA. Therefore, monetary values of macroeconomic impacts should not be added to the monetary impacts in a BCA. Instead, the macroeconomic impacts should be presented alongside the BCA impacts and considered as complementary benefits.

4. The Role of Macroeconomic Impacts in Rhode Island

4.1. Docket 4600 and Macroeconomic Impacts

In 2017 the PUC established the RI Test as part of Docket 4600, which requires that BCAs of energy resources account for macroeconomic impacts of those resources.[33]

The macroeconomic impacts are described as: "impacts on state product or employment, effects of land use change on property tax revenue." The candidate methodologies for accounting for these impacts include: "qualitative assessment or economic modeling (e.g. input / output life-cycle analysis, property tax base studies)."[34] Beyond this, the Docket 4600 materials do not provide guidance on how to account for macroeconomic impacts.

In Docket 4600, the PUC was clear that decisions regarding energy investments should not necessarily be limited to the monetary values included in the RI Test and that there may be instances where it is appropriate to consider additional impacts, including state energy goals. In particular:

> The PUC holds that the Framework should be relied upon, but also that it should not be the exclusive measure of whether a specific proposal should be approved. Rather, the Framework should serve as a starting point in making a business case for a proposal. For example, there may be outside factors that need to be considered by the PUC regardless of whether a specific proposal was determined to be cost-effectiveness or not. This may include statutory mandates or qualitative considerations.[35]
>
> [I]f persuasive evidence is presented where a proposal that does not pass the screening is nonetheless found to be beneficial to the system and/or furthers state energy goals, it may be approved. Conversely, if a proposal passes the cost-effectiveness test, it will not automatically be approved, and can be rejected if persuasive evidence is presented that the proposal is costly to the system and/or hinders state energy goals.[36]

This language from the PUC allows for macroeconomic impacts to be considered separately from the monetary values included in the BCA if there are uncertainties or other challenges with adding the EIA results onto the BCA results. Section 4.2 below, summarizes recent filings to the PUC that include macroeconomic impacts.

---

[33] Public Utilities Commission's Guidance on Goals, Principles and Values for Matters Involving the Narragansett Electric Company d/b/a National Grid, October 27, 2017, Docket 4600.

[34] Docket 4600 Facilitation (Mediation)/Consulting Team, Docket 4600: Stakeholder Working Group Process Report to the Rhode Island Public Utilities Commission, April 5, 2017, Appendix B.

[35] Public Utilities Commission's Guidance on Goals, Principles and Values for Matters Involving the Narragansett Electric Company d/b/a National Grid, October 27, 2017, Docket 4600, page 23.

[36] Public Utilities Commission's Guidance on Goals, Principles and Values for Matters Involving the Narragansett Electric Company d/b/a National Grid, October 27, 2017, Docket 4600, page 24.

4.2. Macroeconomic Impacts in Recent PUC Filings

Energy Efficiency

In its 2020 Energy Efficiency Plan (EE Plan), National Grid used an estimate of state GDP as the indicator of economic development benefits of its energy efficiency programs. That plan utilized a study prepared for National Grid to estimate the monetary values of economic development benefits in terms of state GDP.[37] Table 8 presents a summary of the results of that analysis and the impact it had on the BCA of those energy efficiency programs. As indicated, the economic development benefits have a dramatic effect on the BCA results, increasing the benefit-cost ratio from 2.8 to 4.6.

Table 8. Economic Development Impacts on the National Grid 2020 EE Plan

	Without Economic Development Benefits	With Economic Development Benefits	Difference
Costs (mil PV$)	130	130	0
Benefits (mil PV$)	366	603	237
Net Benefits (mil PV$)	236	473	237
Benefit-Cost Ratio	2.8	4.6	1.8

Source: National Grid 2020 EE Plan, Attachment 5, Tables E-5, E-5A and E-6.

The 2020 EE Plan was agreed to by the settling parties and approved by the PUC.[38] However, it is our understanding that questions regarding (a) which macroeconomic indicator is most appropriate, (b) how to account for that indicator in the BCA, and (c) how to address concerns about double-counting have not been discussed or vetted before the PUC. This is partly because recent EE Plans have been filed in the form of settlements, and partly because the energy efficiency programs were cost-effective in the absence of the macroeconomic impacts, so these questions had little bearing on the outcome of the EE Plans.

The report prepared for National Grid to estimate the macroeconomic impacts of energy efficiency programs recognized that there is some double-counting of benefits in the BCA results.[39] This report recommends that double-counting can be avoided by estimating the "net incremental" macroeconomic benefits, by subtracting out the direct macroeconomic benefits created by customer respending of bill savings as a result of the energy resource being analyzed. The rationale for this adjustment is that bill savings are already accounted for in the BCA, in the form of net benefits, and therefore they should not be included twice in the BCA.

In our view, this approach does not eliminate double-counting. It is true that bill savings are already captured in the BCA result, and therefore adding the macroeconomic impacts from them would be double-counting. However, it is also true that the BCA includes the costs of implementing the energy resource, which is what increases the macroeconomic activity associated with the resource. It is also

[37] Brattle Group, 2019.

[38] The Narragansett Electric Co. d/b/a National Grid - 2020 Energy Efficiency Plan (Docket No. 4979).

[39] Brattle Group, 2019.

true that the BCA includes the costs avoided by the energy resource, which is what reduces the macroeconomic activity associated with the resource. Since the three sources of macroeconomic impacts—increased spending on energy resources, reduced spending on energy resources, and customer respending effects—are already included in the BCA, then adding any of these macroeconomic impacts to the BCA would result in double-counting. Further, the logic used to subtract direct impacts should apply to indirect impacts as well. If the goal is to completely eliminate double-counting, then both the direct and indirect impacts should be excluded from the EIA results.

Therefore, as noted above, we recommend that none of the monetary macroeconomic results be added to the monetary BCA results. Instead, the macroeconomic benefits should be considered alongside the BCA benefits, as a different type of impact. (See Section 3.5.)

Gravel Pit Solar Project

In February 2020, National Grid submitted a petition to the PUC for approval of a power purchase agreement with the Gravel Pit solar project, in compliance with the *Rhode Island Clean Energy Security Act*.[40] As a part of this petition, National Grid included a BCA of the Gravel Pit project, finding benefits of $157 million, costs of $56 million, and net benefits of $101 million, for a benefit-cost ratio of 2.8.

The BCA in this petition included an economic development benefit of $121,371 based on a commitment from the developer to invest at least $300,000 for training the renewable developer workforce. National Grid did not explain, to our knowledge, why it did not conduct a conventional EIA to assess the economic development benefits of the Gravel Pit project. This project was found to be cost-effective, even without including economic development benefits.

In its order approving National Grid's Gravel Pit petition, the PUC noted that the project could "reasonably be found to provide other direct economic benefits to Rhode Island," referring to the $300,000 in workforce training offered by the developers.[41]

Revolution Wind Project

In February 2019, National Grid submitted a petition to the PUC for approval of a power purchase agreement with the Revolution Wind offshore wind project, in compliance with the *Rhode Island Clean Energy Security Act*.[42] This petition was supported in part by a study assessing the economic development benefits of the Revolution Wind project.[43]

The Navigant economic development study claimed that "Value Added is the best indicator of economic development benefits to the local Rhode Island economy." The study noted that the "sum total of value

[40] RI General Laws 39-31-5 and 39-31-6.

[41] Rhode Island Public Utility Commission, The National Grid Review of Power Purchase Agreement, Docket No. 5011, Report and Order, March 30, 2020, pages 8-9.

[42] RI General Laws 39-31-5 and 39-31-6.

[43] Navigant Consulting. 2018. *Advisory Opinion of the Economic Development Benefits of the Revolution Wind Project*, prepared for Revolution Wind. Submitted in RIPUC Docket 4929, National Grid Schedule NG-6.

added of all enterprises and self-employed in a given state comprises that state's GDP,"[44] implying that value added is another term for state GDP.

The Navigant economic development study found:

> [F]or the total capital costs of $1.4 billion, $305 million will be spent in Rhode Island, resulting in 2,583 total job-years and $251.3 million Value Added during the construction phase. During the plant's 25 years of operation, $7.4 million will be spent annually in Rhode Island, resulting in 128 total annual jobs and $14.3 million Value Added per year.[45]

The Navigant economic development study did not include a BCA of the Revolution Wind project. It focused only the economic development benefits.

It its petition to the PUC, National Grid added the results of the economic development study to its BCA of the Revolution Wind project.[46] The implications of adding the economic development benefits into the Revolution Wind BCA are summarized in Table 9. As indicated, this project was cost-effective even without the economic development benefits. Those benefits simply increased the benefit-cost ratio from 1.5 to 1.8, making it more cost-effective.

Table 9. Economic Development Impacts on the Revolution Wind BCA

	Without Economic Development Benefits	With Economic Development Benefits	Difference
Costs (mil PV$)	1,334	1,334	0
Benefits (mil PV$)	2024	2,429	405
Net Benefits (mil PV$)	690	1,095	405
Benefit-Cost Ratio	1.5	1.8	0.3

Source: National Grid Review of Purchased Power Agreements, Testimony submitted in RIPUC Docket 4929, National Grid Schedule NG-7.

In its order approving the Revolution Wind purchased power agreement, the PUC noted several deficiencies in the economic development study, including (a) the lack of consideration of economic development resulting from electricity customer bill impacts; (b) the lack of consideration of the reduced economic development as a result of the avoided costs of the wind project; and (c) the lack of consideration of the timing of when the economic development impacts will occur relative to the costs and benefits of the BCA.[47] Consequently, the PUC found that there was "no evidence presented to

[44] *Id.*, page 6.

[45] *Id.*, page 8.

[46] National Grid, Review of Purchased Power Agreements, Testimony submitted in RIPUC Docket 4929, National Grid Schedule NG-7.

[47] Rhode Island Public Utility Commission, The National Grid Review of Power Purchase Agreement, Docket No. 4929, Report and Order, June 7, 2019, pages 11-12.

quantify the impact such that the PUC could find the costs to the Rhode Island economy will definitively exceed the benefits."[48]

There was no discussion in this docket, to our knowledge, of any sort of double-counting that might occur between the economic development study and the BCA.

Renewable Energy Growth Program

In 2017, the Rhode Island Rhode Island Office of Energy Resources and the Rhode Island Distributed Generation Board commissioned Brattle Group (Brattle) to conduct an analysis of the economic, jobs, and environmental impacts of the Renewable Energy Growth (REG) program. The analysis examined program years 2015 and 2016 as well as the impacts of the program in total from 2015 to 2019.

Brattle compiled data on program costs and benefits to estimate the changes in spending and the associated impacts on the Rhode Island economy. Program costs included the tariff paid to the renewable projects and National Grid's program administration costs. The benefits of the program included avoided energy, capacity, and REC costs. The study also accounted for state taxes paid by REG program facilities, which ultimately benefit Rhode Island residents.

Brattle used IMPLAN to estimate the state GDP and job impacts from the current and forecasted investments in renewable energy projects through the REG programs. Brattle estimated that by the end of the REG program in 2019 the state would see 160 MW of renewable energy capacity with total investment to $390 million.[49] The EIA found that this level of investment would contribute an estimated $236 million on a present value basis to Rhode Island's GDP through 2040 and on average 88 jobs will be added in each year. Most of the job growth occurs early in the program with close to 500 per year from 2016–2019 as part of the construction phase.[50] Longer term, the study projected that, on net, there would be nearly zero jobs per year from 2020 through 2040.[51] This is due to the fact that the growth in O&M jobs are largely offset by the jobs lost due to reduced spending because of slightly higher electricity prices.

The economic development impacts were presented for both the construction phase and the tariff phase. Economic development impacts were presented in the form of job-years, labor income, GDP, and economic output.[52] Each of these were further broken out into direct, indirect, and induced impacts.

To the best of our knowledge, the economic development results for the REG program produced by Brattle were not integrated into a BCA. Consequently, there was no discussion of the potential for double-counting between the EIA and a BCA.

---

48 *Id*., page 12.

49 Brattle Group. 2017. *Renewable Energy Growth Program Analysis: Economic, Jobs and Environmental Impacts for Program Years 2015 and 2016 and the Overall Program Years 2015 to 2019*. A report prepared for Rhode Island Office of Energy Resources and Rhode Island Distributed Generation Board. Available at https://brattlefiles.blob.core.windows.net/files/7349_renewable_energy_growth_program_analysis.pdf.

50 *Ibid*.

51 *Ibid*.

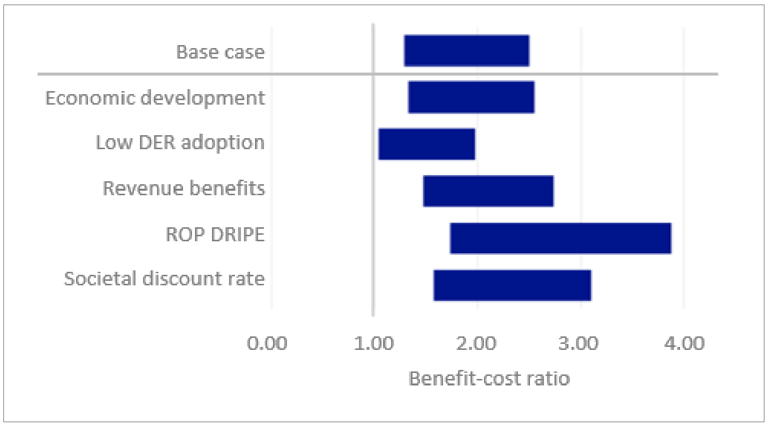
52 "Economic output is a measure of economic activity, and here represents a state level GDP reflecting the market value of all goods and services produced in one year by labor and property supplied by residents of the state." Id., page 7.

Advanced Metering and Grid Modernization

National Grid is currently conducting business case analysis of its proposed advanced metering functionality (AMF) and grid modernization proposals. The Company is not, to our knowledge, including economic development benefits in its business case analyses for these investments.

National Grid appears to conduct some sensitivities for its AMF business case that include economic development benefits. In a recent presentation to the PUC, National Grid presented the range of benefit-cost ratios that result from its economic development sensitivities. This range indicates that, even without the economic development benefits, the benefit-cost ratios for the AMF proposal are likely to exceed 1.0.

Figure 5. National Grid AMF Proposal: Sensitivities on Economic Development Benefits



Source: Reproduced from National Grid, AMF Business Case, General Preview, slide deck presented to the Rhode Island Public Utility Commission Technical Session, September 24, 2020.

4.3. Summary

Since Docket 4600 established the requirement to consider macroeconomic impacts in energy resource BCA, there have been several studies and proposals intended to comply with this requirement. In every instance to date, however, the macroeconomic impacts have been applied only in cases where the investment in question was cost-effective regardless of the macroeconomic benefits. There have been no instances where the macroeconomic benefits are significant enough to turn an investment that is not cost-effective into one that is cost-effective. In other words, the PUC has not yet been faced with the situation like the CRNM project, where the macroeconomic benefits flip the results of the BCA.

Further, and perhaps because of this, the PUC has not vetted or resolved some of the key questions regarding how to account for macroeconomic impacts in a BCA. These include: (a) what is the best indicator of macroeconomic benefits; (b) how should these indicators be addressed in a BCA; and (c) how to prevent double-counting between a BCA and an EIA.

5. Macroeconomic Impacts of Rhode Island Community Solar Programs

5.1. Modeling Approach

For this project, Synapse used a combination of the IMPLAN model and complementary data from the Jobs and Economic Development Impact (JEDI) models, the Bureau of Labor Statistics (BLS), and other sources, in conjunction with a spreadsheet-based approach to estimate the jobs, personal income, business income, and tax effects of the five alternative renewable energy programs.

Working with state-level economic data, IMPLAN is used to estimate the GDP, job, and income effects of some of the spending changes that are expected to occur under each of the alternative programs. While IMPLAN can be used to assess supply chain effects associated with manufacturing of PV and other concomitant changes in the generation portfolio (*i.e.,* reduction in demand for gas generation capacity or reduction in demand for transmission capacity), it is not an appropriate tool for computing all of the impacts of every one of the myriad spending change that will results from each of the programs. Table 10 presents every spending change analyzed through the modeling process, and for each, indicates how IMPLAN was used.

Table 10. Effects Modeled and the Role of IMPLAN

Flow	How IMPLAN was used
Utility-Scale Solar Construction	To estimate supply-chain impacts; to estimate induced impacts of construction hiring
Transmission Construction	To estimate supply-chain impacts; to estimate induced impacts of construction hiring
Distribution Upgrades	To estimate supply-chain impacts; to estimate induced impacts of construction hiring
Planning Studies	To estimate all effects
Legal Services	To estimate all effects
Interconnection	To estimate all effects
Utility-Scale Solar O&M	To estimate induced impacts of hiring O&M workers
Natural Gas CT O&M	To estimate supply-chain impacts; to estimate induced impacts of O&M hiring
Natural Gas CC O&M	To estimate supply-chain impacts; to estimate induced impacts of O&M hiring
Asset Management	To estimate induced impacts of hiring asset management workers
Subscriber Acquisition	To estimate all impacts of spending on the marketing and advertising industry and the induced impacts of hiring more workers
Site Lease Costs	To estimate all effects
Insurance Costs	To estimate all effects
Taxes Respending	To estimate all effects
Residential Respending	To estimate all effects
Commercial Respending	To estimate all effects
Industrial Respending	To estimate all effects

As Table 10 illustrates, several of the spending changes cannot be completely accounted for in the IMPLAN model. These include the spending changes associated with solar, natural gas, transmission, distribution, asset management, and subscriber acquisition. In each of these cases, there are no IMPLAN industries or commodities that correspond closely enough to the activity in question. Consider the case of utility-scale solar construction. Here, we are assessing the economic impacts of the actual construction project. While IMPLAN may be used to gauge the effects of the production of essential materials—panels, steel, electronics, etc. (supply chain effects)—we determined that no single IMPLAN-defined industry or combination of industries or commodities closely enough approximates a utility-scale solar project.[53] As such, IMPLAN was used to calculate the indirect project impacts along with the induced impacts, but there is a gap in accounting for the direct project effects.

Calculating Direct Effects Outside IMPLAN

Synapse handled direct effects for activities that are not completely covered by IMPLAN through the following process:

1. We first determined the share of spending going to labor vs. materials—usually based on data from the JEDI model.[54]
2. We input the materials share of spending (corresponding to indirect effects) into IMPLAN.
3. We then used the labor share of spending to calculate direct impacts as follows:
    a. The direct labor income associated with the project is calculated by multiplying the labor share by the total project spend.
    b. The average wage for those employed in the direct roles (e.g., on a solar construction site) is determined, and this wage is used to calculate the total number of jobs created by dividing the total direct labor income by this average wage.[55]
    c. The direct GDP impact is calculated as follows:
        i. A ratio of GDP-to-income is determined for the sector in which the activity is occurring, or for a proximate sector.
        ii. The wages to value-added ratio is multiplied by labor income associated with the direct effect to estimate the total direct GDP impact.
4. As a final step, for all direct impacts calculated using the above approach, Synapse calculated the induced impact of workers respending wages (labor share) using IMPLAN macroeconomic factors.

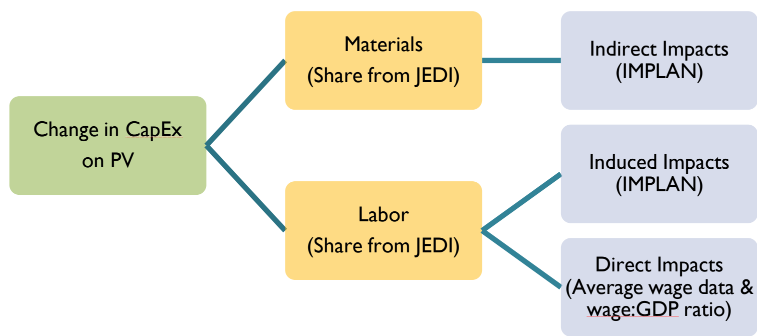
[53] Industries are the production mechanism for one or more commodity. Commodities are goods or services that can be produced by one or more industry.

[54] National Renewable Energy Laboratory (NREL). Accessed October 5, 2020. "JEDI: Jobs & Economic Development Impact Models." Available at: https://www.nrel.gov/analysis/jedi/models.html.

[55] Wage estimates are usually based on data from BLS, the JEDI model, industry reports, or industry expert interviews.

Figure 6 illustrates how we used IMPLAN in conjunction with the complementary techniques described above to estimate the economic impacts of increased spending on solar PV construction.

Figure 6. Schematic of Modeling Economic Impacts of a Spending Change on Solar Capital Expenditures (CapEx)



5.2. Components of GDP

For each of the scenarios analyzed, we also estimated incremental state tax revenues and incremental business income. The state tax results that we report come directly as an output of IMPLAN. (IMPLAN also outputs other tax outcomes, including total federal taxes, and total taxes on production and imports.)

However, business income must be estimated using the GDP, personal income, and taxes on production and imports values provided by IMPLAN through the following equation:

GDP = Personal Income + Taxes on Production and Imports + Other Property Income (OPI)

Note that it is not possible to estimate business income directly. Instead, we back out OPI from this equation as a close proxy for business income. While OPI includes other elements in addition to business earnings, it provides an approximate measure of business profits (and indeed was previously termed "profits" in IMPLAN).[56,57]

Since the personal income results presented in this report are pre-tax, there is some overlap between the tax and income results that are provided.

[56] To estimate the state tax and business income impacts associated with the direct effects estimated outside of the IMPLAN model, state tax and business income shares for the associated indirect effects that were estimated inside the IMPLAN model were applied. For example, to estimate the state taxes and business income associated with the direct effects of PV construction, the state tax and business income factors output by IMPLAN for the indirect portion of PV construction (supply chain portion) were applied to the direct GDP results to impute tax and business income results.

[57] See https://implanhelp.zendesk.com/hc/en-us/articles/360016072114-Understanding-Other-Property-Income-OPI-.

5.3. Modeling Inputs and Assumptions

In this section, we list the key inputs and assumptions used in Synapse's economic modeling of the community remote solar programs.

- Inflation rate: The EIA assumes an inflation rate of 2.06 percent per year, consistent with the CRNM BCA Report analysis. All values are provided in 2019 real dollar terms.
- Discount rate: Consistent with the BCA, a discount rate of 0.84 percent is applied to future year spending changes.
- Profits: While the CRNM program is expected to generate substantial profits for the solar developers and other invested parties, it is assumed that profits will yield no respending effect inside Rhode Island.
- Respending: Changes in utility bills resulting from increases or decreases in overall system costs are expected to impact residential respending and commercial and industrial reinvestment (often referred to as respending). It is assumed that total utility system cost changes are apportioned to each of the classes in equal measure. It is further assumed that 94 percent of the total change in residential bills translates to a change in residential respending, while 50 percent of the total change in commercial and industrial bills translates to change in reinvestment.
- Avoided utility system costs: It is assumed that utility-scale solar avoids transmission investments, but not generation capacity investments.
- PV O&M: We assume that 60 percent of PV O&M costs are spent on labor. This is a standard assumption that Synapse uses in macroeconomic studies, and is informed by NREL's JEDI model results.[58,59] As discussed in Section 5.1, Synapse applied a GDP-to-wage ratio to estimate the direct GDP benefits of PV O&M direct labor spending; this ratio was constructed from Massachusetts data and adapted to RI based on the ratios from adjacent industries since the IMPLAN state data for RI did not include industry data for the pertinent IMPLAN industry – "Electric Power Generation – Solar."
- Program costs: Since a detailed developer cost breakdown is available only for the CRNM program,[60] encompassing a range of different spending categories (see Table 10), it is assumed that in the modified programs, solar development costs are similarly distributed in the same proportion across the same set of categories. For the modified programs, the specific costs for these items from the CRNM program are scaled down by the ratio of total cumulative subscription fees paid in each modified program relative to the total cumulative subscription fees paid in the CRNM program.

---

[58] NREL. JEDI: Jobs & Economic Development Impact Models.

[59] The CRNM project developers provided us with confidential data indicating a different portion of PV O&M costs are spent on labor. We chose to use the Synapse standard assumption because that is consistent with what we have seen in other studies and is informed by the JEDI model results.

[60] Confidential information provided by the CRNM project developers.

- Local labor: For the direct labor impacts estimated outside of IMPLAN using the materials/labor share factor and average wage data (see Figure 6), it is assumed that all workers employed for the direct impact are residents of Rhode Island.

Finally, it is important to note that while the key macroeconomic factors used in this analysis are contemporary, this study evaluates impacts over periods of 20 and 25 years. In that time, changes in the economic and demographic structure are all but assured. Policies are also likely to evolve during that timeframe so projections of out-year impacts necessarily include greater uncertainty. While this uncertainty is somewhat mitigated by the compound effect of the discount rate, which dampens the potential for variability in later period results, this potential nonetheless should be recognized.

5.4. Adjustments for Double-Counting

In 2018, National Grid engaged Brattle to conduct a review of the methodology it used to calculate the economic development benefits of its prior energy efficiency programs.[61] Brattle identified two primary concerns. The first concern was that the current methodology overstated the job and GDP benefits by not netting out the reduction in economic activity from sectors that experience a decline in spending due to energy efficiency investments.

Second, consistent with ACEEE's concern about double-counting described above, Brattle concluded that the economic impact associated with re-spending of savings calculated in the EIA should not be included as a benefit in the BCA. Brattle argued that because the savings from energy efficiency are a benefit in the BCA, including the direct economic development impacts from the EIA into the BCA would result in double-counting. Brattle recommends that double-counting can be avoided by estimating the "net incremental" macroeconomic benefits, by subtracting out the direct macroeconomic benefits created by customer respending of bill savings as a result of the energy resource being analyzed.

As described in Section 4.2, we believe this approach does not fully eliminate double-counting. Nonetheless, we estimate the "net incremental" macroeconomic impacts, using the methodology from the Brattle RI Test Report. We use this approach because it has been used by National Grid in its 2020 EE Plan.

5.5. Results

As described in Section 2, we developed macroeconomic impacts for six community remote solar programs. This includes the CRNM Program, four modified versions of the CRNM Program, and the CRDG Program. This section provides the results for each program. The resulting GDP impacts for each program is incorporated into the Base Case BCA in the separate CRNM BCA Report.

Results for CRNM

The CRNM program is expected to increase state GDP by approximately $84 million dollars over the 25-year study period. GDP impacts are presented by impact type and spending category in Table 11.

---

[61] Brattle Group, 2019.

Table 11. GDP Impacts by Spending Category and Impact Type (millions of 2019$, present value)

	Direct	Indirect	Induced	Total
Increased Spending on Solar	99	22	25	146
Solar construction	56	9	18	84
Solar O&M	35	0	3	38
Solar other	7	13	4	24
Reduced Spending on Non-Solar	-5	-1	-2	-8
Natural gas construction	0	0	0	0
Natural gas O&M	0	0	0	0
Transmission construction	-6	-2	-2	-10
Distribution construction	2	0	1	3
Respending: Customers	-33	-12	-13	-58
Residential	-15	-5	-5	-25
Commercial	-11	-4	-5	-19
Industrial	-7	-3	-3	-14
Taxes	3	0	1	4
Gross Impacts	64	9	11	84
Net Impacts	97	9	11	117

Figure 7. GDP Impacts by Spending Category and Impact Type

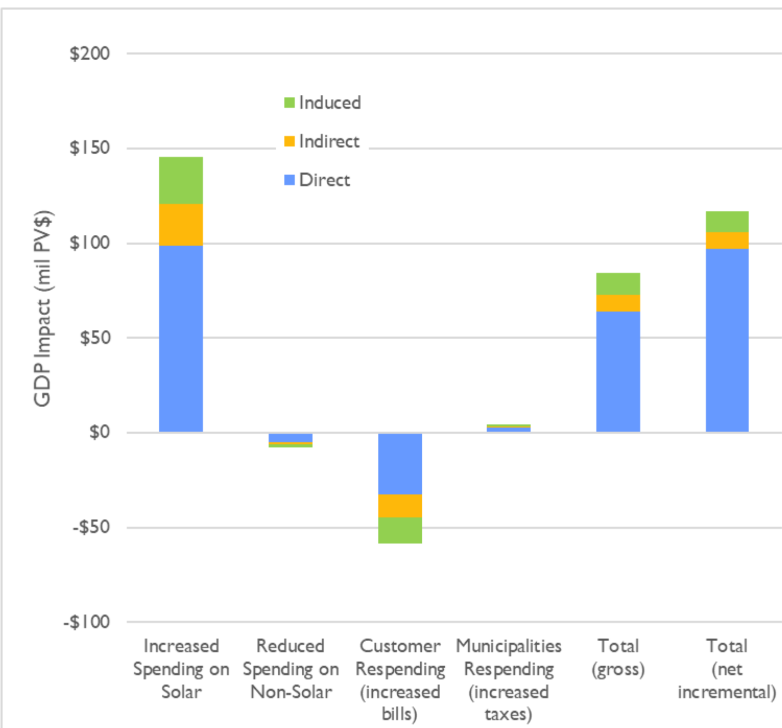


Figure 7 provides a graphical summary of the results presented in Table 11. As indicated, the direct impacts are the largest of the three types. The reduced spending on non-solar projects is relatively small, partly because this does not include avoided capacity costs and partly because the avoided costs are not as large as the solar investment costs. The customer respending effect is negative in this case, because for the CRNM program the utility system costs exceed the utility system benefits.

Table 12 provides an overview of macroeconomic impacts for the CRNM program. The table includes GDP, jobs, and personal income impacts, along with state tax and business income effects.

Table 12. Summary of CRNM Economic Impacts

Analysis	Impact	Result
Economic Impact Analysis	Jobs (job-years)	556
	Personal Income (mil PV$)	38
	Business Income (mil PV$)	18
	State Taxes (mil PV$)	7
	Gross Domestic Product (mil PV$)	84

Results for Modified CRNM Program #1

Table 13 and Table 14 provide an overview of macroeconomic impacts for the Modified CRNM Program #1. These impacts include changes to GDP, jobs, and personal income, along with state tax and business income effects.

Table 13. GDP Impacts by Spending Category and Impact Type (millions of 2019$, present value)

	Direct	Indirect	Induced	Total
Increased Spending on Solar	99	22	25	146
Reduced Spending on Non-Solar	-5	-1	-2	-8
Respending: Customers	-31	-11	-12	-54
Taxes	3	0	1	4
Gross Impacts	66	10	12	88
Net Impacts	97	10	12	119

Table 14. Summary of Modified CRNM #1 Economic Impacts

Analysis	Impact	Result
Economic Impact Analysis	Jobs (job-years)	595
	Personal Income (mil PV$)	41
	Business Income (mil PV$)	20
	State Taxes (mil PV$)	7
	Gross Domestic Product (mil PV$)	88

Results for Modified CRNM Program #2

Table 15 and Table 16 provide an overview of macroeconomic impacts for the Modified CRNM Program #2. These impacts include changes to GDP, jobs, and personal income, along with state tax and business income effects.

Table 15. GDP Impacts by Spending Category and Impact Type (millions of 2019$, present value)

	Direct	Indirect	Induced	Total
Increased Spending on Solar	103	22	25	150
Reduced Spending on Non-Solar	-5	-1	-2	-8
Respending: Customers	-25	-9	-10	-45
Taxes	3	0	1	4
Gross Impacts	76	12	14	102
Net Impacts	101	12	14	127

Table 16. Summary of Modified CRNM #2 Economic Impacts

Analysis	Impact	Result
Economic Impact Analysis	Jobs (job-years)	699
	Personal Income (mil PV$)	47
	Business Income (mil PV$)	23
	State Taxes (mil PV$)	9
	Gross Domestic Product (mil PV$)	102

Results for Modified CRNM Program #3

Table 17 and Table 18 provide an overview of macroeconomic impacts for the Modified CRNM Program #3. These impacts include changes to GDP, jobs, and personal income, along with state tax and business income effects.

Table 17. GDP Impacts by Spending Category and Impact Type (millions of 2019$, present value)

	Direct	Indirect	Induced	Total
Increased Spending on Solar	70	16	18	103
Reduced Spending on Non-Solar	-5	-2	-2	-9
Respending: Customers	-7	-3	-3	-12
Taxes	2	0	1	3
Gross Impacts	59	12	14	85
Net Impacts	66	12	14	92

Table 18. Summary of Modified CRNM #3 Economic Impacts

Analysis	Impact	Result
Economic Impact Analysis	Jobs (job-years)	637
	Personal Income (mil PV$)	42
	Business Income (mil PV$)	21
	State Taxes (mil PV$)	8
	Gross Domestic Product (mil PV$)	85

Results for Modified CRNM Program #4

Table 19 and Table 20 provide an overview of macroeconomic impacts for the Modified CRNM Program #4. These impacts include changes to GDP, jobs, and personal income, along with state tax and business income effects.

Table 19. GDP Impacts by Spending Category and Impact Type (millions of 2019$, present value)

	Direct	Indirect	Induced	Total
Increased Spending on Solar	76	17	20	112
Reduced Spending on Non-Solar	-5	-1	-2	-8
Respending: Customers	-19	-7	-8	-34
Taxes	2	0	1	3
Gross Impacts	54	8	11	74
Net Impacts	73	8	11	93

Table 20. Summary of Modified CRNM #4 Economic Impacts

Analysis	Impact	Result
Economic Impact Analysis	Jobs (job-years)	516
	Personal Income (mil PV$)	35
	Business Income (mil PV$)	17
	State Taxes (mil PV$)	6
	Gross Domestic Product (mil PV$)	74

Results for CRDG

Table 21 and Table 22 provide an overview of macroeconomic impacts for the CRDG program. These impacts include changes to GDP, jobs, and personal income, along with state tax and business income effects.

Table 21. GDP Impacts by Spending Category and Impact Type (millions of 2019$, present value)

	Direct	Indirect	Induced	Total
Increased Spending on Solar	49	12	13	74
Reduced Spending on Non-Solar	-5	-1	-2	-8
Respending: Customers	-2	-1	-1	-3
Taxes	1	0	1	2
Gross Impacts	43	10	11	64
Net Impacts	45	10	11	66

Table 22. Summary of CRDG Economic Impacts

Analysis	Impact	Result
Economic Impact Analysis	Jobs (job-years)	500
	Personal Income (mil PV$)	33
	Business Income (mil PV$)	16
	State Taxes (mil PV$)	6
	Gross Domestic Product (mil PV$)	64

Results Across All Programs

Table 23 summarizes the results of the EIA across all the community remote solar programs. These impacts include changes to GDP, jobs, and personal income, along with state tax and business income effects.

Table 23. Comparison of Economic Impact Analysis Results across All Community Remote Solar Programs

Analysis	Impact	CRNM	Modified CRNM #1	Modified CRNM #2	Modified CRNM #3	Modified CRNM #4	CRDG
Economic Impact Analysis	Jobs (job-years)	556	595	699	637	516	500
	Personal Income (mil PV$)	38	41	47	42	35	33
	Business Income (mil PV$)	18	20	23	21	17	16
	State Taxes (mil PV$)	7	7	9	8	6	6
	GDP (mil PV$)	84	88	102	85	74	64