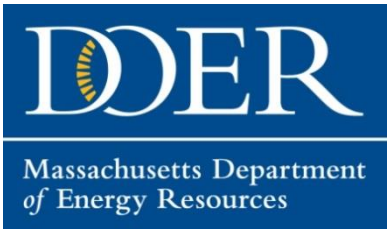
Task 4 Report: Comparative Regional Economic Impacts of Solar Ownership/Financing Alternatives

Prepared for the

Massachusetts Department of Energy Resources



By

Cadmus, Meister Consultants Group, and Sustainable Energy Advantage, LLC

In association with

La Capra Associates, Inc.

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About the Massachusetts Department of Energy Resources (DOER)

DOER's mission is to create a cleaner energy future for the Commonwealth, economically and environmentally, including:

- Achieving all cost-effective energy efficiencies;
- Maximizing development of cleaner energy resources;
- Creating and leading implementation of energy strategies to ensure reliable supplies and improve relative costs; and
- Support clean tech companies and spurring clean energy employment.

DOER is an agency of the Massachusetts Executive Office of Energy and Environmental Affairs (EEA).

About this Report

The Consulting Team completed the Comparative Regional Economic Impacts of Solar Ownership/ Financing Alternatives (Task 4) Report in support of the DOER's Solar Policy Program and post 400-MW policy analysis under a competitive contract awarded to Cadmus.

As part of the effort, Cadmus, La Capra Associates, Meister Consultants Group, and Sustainable Energy Advantage developed five companion reports:

Task 1: Evaluation of Current Solar Costs and Needed Incentive Levels across Sectors
Task 2: Comparative Evaluation of Carve-out Policy with Other Policy Alternatives
Task 3a: Evaluation of the 400 MW Solar Carve-out Program's Success in Meeting Objectives
Task 3b: Analysis of Economic Costs and Benefits of Solar Program
Task 4: Comparative Regional Economic Impacts of Solar Ownership/ Financing Alternatives

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1 Introduction

The local economic impacts of solar photovoltaic (PV) system installations may vary depending on aspects of the system's installation, ownership, and financing. To aid the crafting of solar incentives to align with the Commonwealth's policy objectives, the Massachusetts Department of Energy Resources (DOER) is interested in gaining an understanding of the differences in economic impacts and benefits that may result from different PV ownership and financing structures. DOER commissioned a consulting team consisting of Cadmus (Prime Contractor), Sustainable Energy Advantage, LLC (Project Manager), Meister Consultants Group, and La Capra Associates (the Consulting Team) to evaluate regional economic impacts of solar ownership and financing alternatives.

1.1 Purpose and Scope

This fifth and final report, completed in support of DOER's solar policy programs, compares two hypothetical scenarios:

- A residential scale (5 kW) solar photovoltaic (PV) system owned by the homeowner and financed through a local community bank (direct ownership), versus
- The same project owned, installed, and maintained by a third-party with nationally based investors and with a power purchase agreement with the homeowner (third-party ownership).

After consulting with DOER, the Consulting Team defined the term "local" to mean within the state of Massachusetts.

For this analysis, the Consulting Team identified differences in the opportunity costs and risks borne by participants, annual cash flows to the applicable financial entities, and net benefits to system and property owners. In addition, the Consulting Team also estimated the proportion of cash flow and net benefits generally maintained within the local (Massachusetts) economy, as well as those that flow to national and international regions.

In order to assess the local economic impacts for each hypothetical scenario, characteristics beyond those defined by DOER were assigned to both homeowners and third-party owners. These attributes were assigned within the context of the "local" versus "national" comparison desired. To aid in defining these attributes, the Consulting Team conducted interviews with industry professionals.

1.2 Limitations of This Analysis

The profiles developed for the homeowner and third-party owner scenarios are not intended to represent real persons or companies nor the variability in real local economic impacts across the industry. The profiles were developed to compare the impacts of a hypothetical direct ownership scenario, in which the use of local resources is preferred, to a third-party ownership scenario, in which the third-party is agnostic to the use of local resources.

1.3 Organization of This Report

The report is organized as follows:

- Section 2 describes the approach used in developing this report.
- Section 3 discusses the results of the analysis.
- Section 4 provides conclusions derived from the results.
- Appendix A provides detailed annual cash flows for each scenario.
- Appendix B details model inputs used in the analysis.

2 Approach

This analysis relies on two models developed by the National Renewable Energy Laboratory (NREL) and available on NREL's website. The Cost of Renewable Energy Spreadsheet Tool (CREST) model was used to model cash flows for each of the two scenarios. The Jobs and Economic Development Impact (JEDI) model was used to construct projections of regional economic impacts, including the number of jobs and economic impacts to a local area related to a solar PV installation. For purposes of this analysis the term "local" is defined as the area within the state of Massachusetts.

Table 1. Application of CREST and JEDI Models

Analysis	CREST	JEDI
Opportunity Costs and Risk	✓	
Cash Flow Analysis	✓	✓
Net Benefits	✓	
Regional Economic Impact		✓
Net State and Federal Incentives	✓	✓

2.1 Framing Analysis

The Consulting Team defined the attributes of hypothetical direct ownership and third-party ownership scenarios through a framing analysis. The framing analysis defined the parties involved in each of the two scenarios to be analyzed. To enable a direct comparison the following common attributes were established for each scenario.

- Construction occurred in 2013.
- The installed cost in each scenario is $22,712.
- The installations are located within the National Grid Massachusetts Electrical Company service territory.
- No Commonwealth Solar, or equivalent, rebate is available.
- No sale taxes are assessed on the equipment for the PV system.
- The PV installation is exempt from property taxes.

The installed cost of $22,712 is reported in *Evaluation of Current Solar Costs and Needed Incentive Levels across Sectors* (Task 1 Report),[1] which was completed for this project. The assumption that no rebates are available follows the modeling completed under the Task 1 report and DOER's request to not consider rebates in the analyses. State law exempts qualified renewable energy projects from sales and property taxes on residential property.

After consultation with DOER, a $300 price for solar renewable energy credits (SRECs) was used in the models. While selection of the $300 SREC value is arbitrary, it was used because it lies between the market's highest and lowest historical prices and results in payback periods of five to seven years. In the direct ownership scenario analysis, it is assumed that the homeowner does not pay federal or state income taxes on the SREC revenues.

[1] Available at www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/solar/rps-solar-carve-out/post-400-mw-solar-policy-development.html.

2.1.1 Direct Ownership Scenario

Under the direct ownership scenario, the homeowner contracts with a local installer to design and install a 5 kW PV system. Following interviews with industry professionals, the following attributes were selected to represent the homeowner.

- Has sufficient federal tax liability to fully utilize the full 30% federal renewable energy tax credit, and
- Has sufficient state tax liability to obtain the full Massachusetts personal tax credit ($1,000).

DOER defined the direct ownership scenario to include the homeowner who receives a loan from a local community bank. For consistency, the Consulting Team chose a loan profile that was used in Task 1 of the project.

- A home equity or personal loan to the homeowner, equal to 40% of the installed costs of the PV system at a rate of 4%,[2] and
- A loan term of 15 years.

Further, it is assumed the local installer installs the PV system with:

- A labor force that resides within Massachusetts,
- A majority of the equipment (75%) is purchased from distributors located within Massachusetts,
- The inverter used is manufactured within Massachusetts, and
- All other equipment is assumed to be manufactured outside Massachusetts.

Lastly, it is assumed that all (100%) of sales and overhead costs are expended locally. This profile is intended to represent a homeowner and local installer with local purchasing preferences. The assumption that a majority of equipment purchased from local distributors is supported by results of interviews with industry professionals. The Consulting Team believes that local installers are the primary customers of local distributors.

The manufacturer of residential PV inverters is based in Massachusetts. All other equipment is assumed to be manufactured outside the state.

2.1.2 Third-Party Ownership Scenario

Under the third-party ownership scenario, the homeowner executes a Power Purchase Agreement (PPA) with a national residential solar developer. In the Task 1 Report, it was assumed that the homeowner pays the third party for PV-generated electricity at a rate that is 5% less than the rate the homeowner pays for electricity off the grid. This 5% discount is constant through the life of the PV installation. This approach is also used in this analysis.

DOER defined the third-party ownership scenario to include a nationally based company as the third-party owner. The company receives a loan to cover part of the project cost from a non-local bank. For consistency, the Consulting Team chose the loan profile that was used in Task 1 of the project.

- A loan equal to 40% of the project cost at a rate of 6%, and
- A loan term of five years.

[2] A recent survey commissioned by DOER found that for a majority of residential lenders PV systems were funded through home equity loans with a standard rate of 4 to 5%. (Rooftop Solar Challenge: Outreach to Local Massachusetts Financial Institutions, ICF International, February 2013. Available at www.mass.gov/eea/docs/doer/renewables/solar/doer-solar-financing-report-final.pdf.

In addition, a number of other attributes were assigned. These attributes are based in part on interviews with industry professionals.

- A majority of the equipment (75%) is purchased directly from manufacturers or from national distribution centers outside the state,
- A local contractor is hired to install the PV system,
- The inverter used is manufactured within Massachusetts, and
- The national company maintains a local operations office.

2.2 Use of CREST and JEDI Models

2.2.1 JEDI

The Jobs and Economic Development Impact (JEDI) model, developed by the NREL, was used to estimate the economic impacts of constructing and operating the solar PV systems at the state level. Model results were also used to help with the cash flow analysis and assessment of state and federal incentive levels. The JEDI model provides direct (project development and onsite labor), indirect (supply-chain labor and local revenue), and induced estimates of economic impacts. JEDI is available free of charge from NREL.[3] A detailed description of the inputs used in the model is available in Appendix B.

2.2.2 CREST

Under Task 1 of this project, the Consulting Team developed levelized cost of energy (LCOE) projections using the solar version of National Renewable Energy Laboratory's (NREL) *Cost of Renewable Energy Spreadsheet Tool* (CREST). The CREST model and supporting documentation, which were developed by Sustainable Energy Advantage, LLC, are available from the NREL website.[4] The model is designed to calculate the cost of energy, or minimum revenue per unit of production needed, for the modeled renewable energy project to meet its equity investors' assumed minimum required after-tax rate of return. For this analysis, the Consulting Team ran CREST to model financial flows with SRECs assumed to be sold at a price of $300.

2.2.3 Cost and Investment Profile

The costs of the PV installations under each scenario, and the shares of the parties putting forward funding to pay for an installation, are shown in Table 2. These values are results from the Task 1 Report for an installation in calendar year 2013.

[3] More information on JEDI is available at www.nrel.gov/analysis/jedi/about_jedi.html
[4] More information on CREST is available at https://financere.nrel.gov/finance/content/crest-model

Table 2. Investment Profile

Input	Value
Installed Cost	$22,712
Capacity (kW-DC)	5.0
Direct Ownership Scenario	
State Tax Credit	$1,000
Federal Tax Credit	$6,280.00
Bank Loan	$6,173.00
Equity	$9,259.00
Total	**$22,712.00**
Third-Party Ownership Scenario	
Federal Tax Credit	$6,280.00
Bank Loan	$6,814.00
Equity	$9,618.00
Total	**$22,712.00**

2.2.4 SRECs, RECs and Bonus Depreciation

State and federal incentives play a key role in the economics of a solar PV system. The incentives considered in this analysis are listed in Table 3. Under the direct ownership scenario, it was assumed that no taxes are paid on energy savings and SREC revenues. Under the third-party ownership scenario, a federal income tax rate of 35% and a state tax rate of 8% were used. It was also assumed that the project qualified for a 50% bonus depreciation tax treatment available for systems installed in 2013.

Table 3. Direct Ownership Scenario: State and Federal Incentives

	Incentive	Value	Notes
Massachusetts	Personal Income Tax Credit (Direct Ownership Scenario Only)	$1,000	Maximum allowable credit
	SRECs	$300	Through Year 10
	RECs	$25	Years 11 Through 25
Federal	Residential Renewable Energy Tax Credit / Investment Tax Credit	$6,280	30% of applicable project costs

3 Results

3.1 Opportunity Costs and Risk Analysis

Under the direct ownership scenario, opportunity costs to a homeowner are equal to the returns an alternative investment might realize in excess of the returns obtained through investment in a solar PV system. In this analysis, the hypothetical homeowner realizes a rate of return from the solar investment close to 15%. An alternative investment with higher rate of return, and acceptable risk, may be difficult to find. Under the third-party ownership scenario, there are no opportunity costs to the homeowner as no investment of capital is needed to begin the in the project.

The risks borne by a homeowner differ substantially between the direct and the third-party ownership scenarios. Table 4 describes three categories of risk a homeowner will face, with two examples for each category. Under the direct ownership scenario, the homeowner faces all six examples of risk. By contrast, under the third-party scenario, the homeowner faces only two of the six categories of risk, because the third-party owner takes on most of the risk.

Table 4. Comparison of Risk Exposure to Homeowners Under Ownership Scenarios

Risk Category / Risk	Example	Direct Ownership Scenario	Third-Party Ownership Scenario
Solar PV Performance [A]			
Equipment failure	Inverter failure	✓	
Lower than expected generation	PV generates only 50% of the expected energy in a year	✓	
Change In Law [B]			
Net metering	Net metering services substantially altered	✓	✓
SRECs	SREC program substantially altered	✓	
Energy & SREC Market			
Grid supplied electricity	Electricity prices drop substantially, thus lower savings on PV energy	✓	✓
SRECs	SREC market oversupplied and prices fall	✓	

[A] After expiration of service agreement, which typically lasts five years.
[B] Some third-party agreements may have provisions to renegotiate a contract under a change in law.

3.2 Cash Flow Analysis

Annual cash flow analyses for the direct ownership and third-party ownership scenarios were created using the CREST model's results developed for the Task 1 Report.

3.2.1 Construction Phase

Cash flows are shown in Figure 1 (direct ownership) and Figure 2 (third -party ownership) for the construction phase of the project, prior to PV operation. Key results for the two scenarios on a per-project basis include:

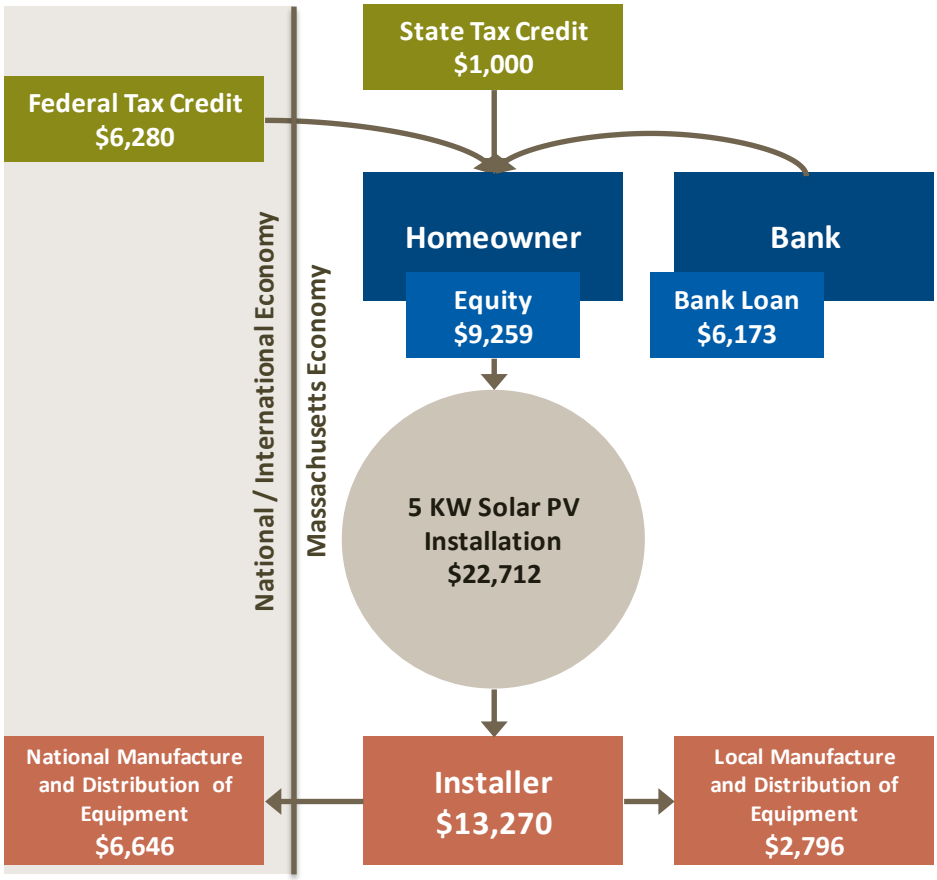
- Investments from local sources constitute 72% of the total investment under the direct ownership scenario, versus all (100%) of the investment coming from non-local sources under the third-party scenario.

- 71% of the cash flows during construction under the direct ownership scenario remain in the local economy compared to 41% for the third-party ownership scenario.

There are two key reasons for the difference in the local proportion of cash flows.

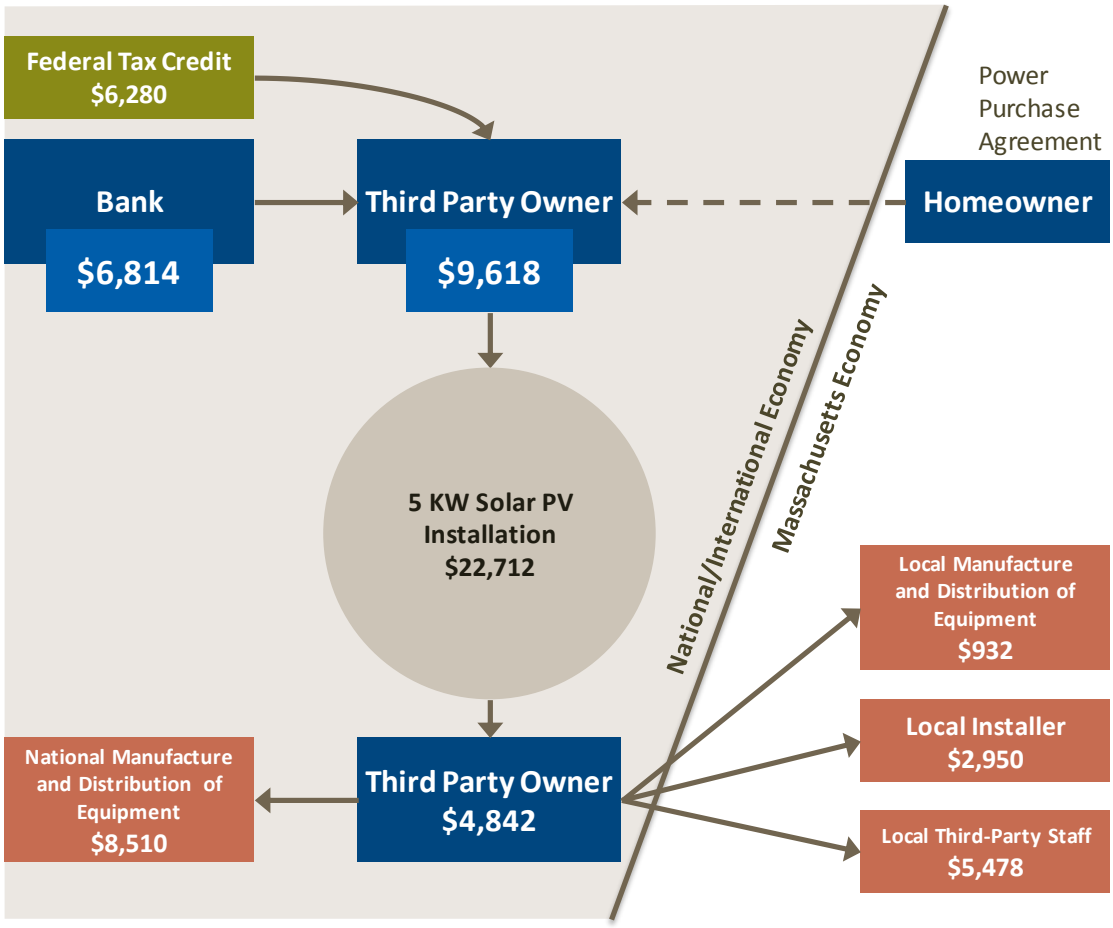
- A majority (75%) of the PV equipment is purchased locally under the direct ownership scenario compared to a minority (25%) under the third-party scenario.[5]
- All of the non-installation-related costs (e.g., sales, management, back office, etc.) are expended locally by the local installer under the direct ownership scenario, while only roughly half of these costs are expended locally under the third-party scenario.

Figure 1. Direct Ownership - Construction Phase Cash Flows



[5] See Section 2 of this report for a discussion on attributes assumed under each scenario.

Figure 2. Third-Party Ownership – Construction Phase Cash Flows



3.2.2 Operations Phase

Local and non-local cash flows over the 25-year life of the project are provided in Appendix B. Under the direct ownership scenario, the homeowner, after paying for maintenance and making loan repayments,[6] receives $27,454 in benefits from energy savings,[7] and SREC and REC sales during the operations phase of the project. Loan payments to the bank total $8,328. These revenues and benefits are maintained locally.

The combined benefits for the third-party owner and homeowner in the alternate scenario total $22,291. Assuming one-half of the third-party owner's revenues remain with the local office, the local portion of this benefit is $11,770.[8] In addition, the state receives $1,108 in tax revenue. Federal tax payments of $4,462 flow out of the local economy. Another $5,625 flows to the non-local third-party operations. The non-local bank repayment totals $8,088. Overall, local revenues and energy savings total $12,878 during the operations phase of the project.

[6] Assumptions for operations and maintenance costs, including inverter replacement, follow those used in the Task 1 Report. These assumptions are described in Appendix A of the Task 1 Report.

[7] Note: the net cash flows reported in this section are undiscounted.

[8] See Section 2 for the basis for the assumption.

A key assumption in the analysis is that the homeowner does not pay state and federal income taxes on the revenue from SRECs. Should the homeowner pay federal income taxes on SREC sales, the proportion of revenues maintained locally will be lower.

3.3 Net Benefits

While there is a substantial upfront investment required, the net benefit over the PV installation lifetime is much higher for the homeowner under the direct ownership scenario than under the third-party scenario. As shown in Table 5, the net present value (NPV) to homeowners under the direct ownership scenario is more than ten times that of the third-party ownership scenario.

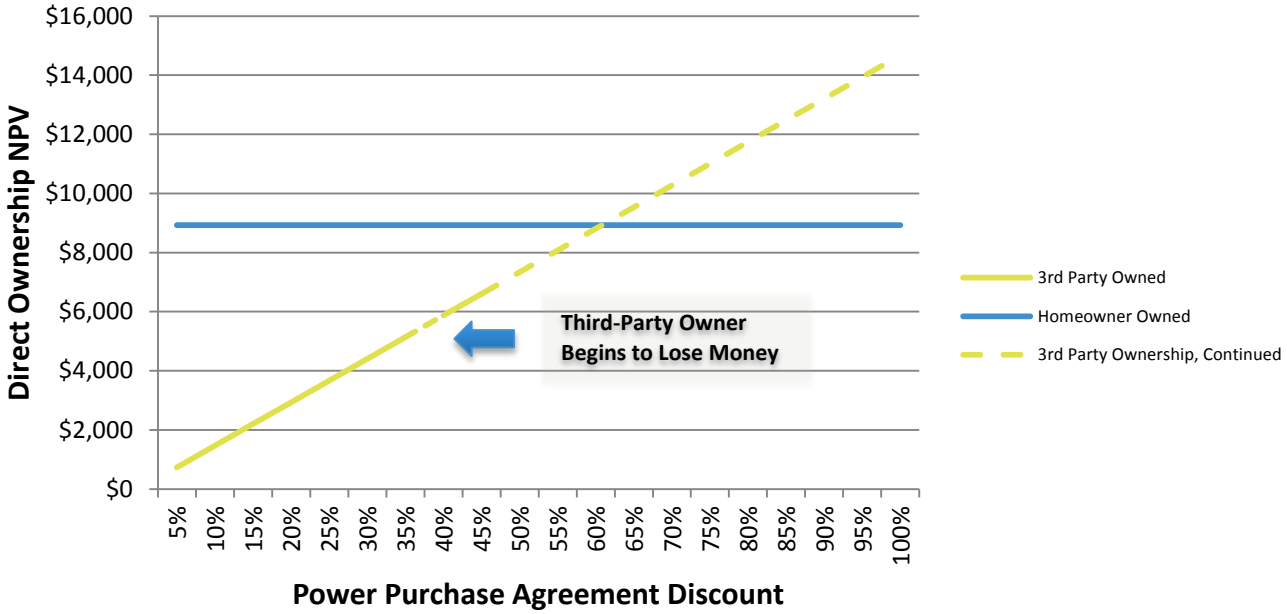
Table 5. Project Lifetime Net Benefits

	Total	NPV
Direct Ownership		
Homeowner	$18,194	$8,927
Third-Party Ownership		
Homeowner	$1,248	$734
Third-Party Owner	$11,425	$4,894

In the third-party scenario, the homeowner pays the third party for electricity generated by the PV installation. The rate for PV electricity is set 5% less than the homeowner pays for electricity off the grid over the life of the PV installation. Should the discount be higher than 5%, the homeowner will see a higher NPV.

Figure 3 shows the NPV for the homeowner versus the discount off the price of electricity from the grid. At a discount of roughly 35%, the third-party owner of the system will begin to lose money. This represents a practical upper bound on the NPV for the homeowner. Even with a 35% discount, the NPV for the homeowner is substantially less than under the direct ownership scenario. A key factor in this difference is that while third-party owner revenues are taxed, energy savings and SREC revenues for the homeowner are not.

Figure 3. Direct Ownership NPV as a Function of Power Purchase Agreement Discount



3.4 Regional Economic Impact

To estimate the net economic impacts realized under the direct and third-party ownership scenarios, the Consulting Team utilized the Jobs and Economic Development Impact (JEDI) model. Employment and economic results are reported in four categories:

1. Project development, includes the design and installation of the solar PV system.
2. Module and supply chain impacts, includes the impacts associated with manufacturing and distribution of the equipment.
3. Professional and other services, includes sales, marketing, back office, overhead.
4. Induced impacts, includes jobs and economic activity not directly related to the project.

The analysis in this section considers the installation of 1,000 systems (5 kW). A detailed review of the inputs used in the model is provided in Appendix B of this report.

The majority of positive regional economic impacts derived from a solar project occur during the construction phase.[9] Table 6 shows the model results for the quantity of Massachusetts-based jobs attributable to construction and economic output associated with this phase. Jobs and economic impacts realized under the direct ownership scenario are over 50% higher than under the third-party ownership scenario. The difference is due to the installer's preference for sourcing equipment locally and basing all staff and operations locally.[10]

[9] This analysis considers economic impacts due to construction and maintenance. For a consideration of other possible costs and benefits, such as impacts to the electrical grid, see *Task 3B Report: Analysis of Economic Costs and Benefits of Solar Program*.

[10] See Section 2 of this report for scenario development and rationale.

Table 6. Massachusetts Economic Impact for Construction (1,000 PV Systems)

	Direct Ownership			Third-Party Ownership		
	Jobs	Earnings	Output	Jobs	Earnings	Output
		$1,000 in 2013			*$1,000 in 2013*	
Project Development and Onsite Labor Impacts						
Construction and Installation Labor	45.5	2,950		45.5	2,950	
Construction and Installation Related Services	38.4	2,323		20.9	1,276	
Subtotal	***83.9***	***5,273***	***8,300***	***66.3***	***4,226***	***5,880***
Module and Supply Chain Impacts						
Manufacturing Impacts	5.5	516	1,929	1.8	172	643
Trade (Wholesale and Retail)	13.8	1,053	2,922	5.9	441	1,224
Professional and Other Services						
Professional Services	12.1	736	2,146	6.7	409	1,190
Other Services	19.7	1,752	5,172	9.8	876	2,586
Other Sectors	22.6	424	1,384	13.9	367	1,032
Subtotal	***73.6***	***4,481***	***13,555***	***38.2***	***2,265***	***6,675***
Induced Impacts	53.6	2,772	8,392	31.7	1,636	4,953

Jobs numbers related to maintaining the PV installations are lower than during the construction phase. As shown in Table 7, the model estimates that just over two full-time local jobs will be supported under the direct ownership scenario. The number for the third-party ownership scenario is half that of the direct ownership scenario. The difference is due to staff location and local versus non-local equipment sourcing as discussed above.

Table 7. Massachusetts Economic Impact for Operations and Maintenance (1,000 PV Systems)

Onsite Labor Impacts	Direct Ownership			Third-Party Ownership		
	Jobs	Earnings	Output	Jobs	Earnings	Output
		$1,000 in 2013			*$1,000 in 2013*	
PV Project Labor Only	0.8	46.4	46.4	0.8	$46	$46
Local Revenue and Supply Chain Impacts	0.6	44.7	138.3	0.1	$10	$29
Induced Impacts	0.8	42.5	128.8	0.2	$8	$24

3.5 Net State and Federal Incentives

Table 8 below shows the total and NPV of net state and federal benefits obtained over the lifetime of the projects. Net benefits are defined here as the incentives received less taxes paid. The NPV of combined state and federal incentives for the direct ownership scenario total $21,017, which is $2,854 more than under the third-party ownership scenario. Two reasons contribute to the difference: the availability of a state tax rebate for direct ownership but not for third-party owners, and the payment of taxes by the third-party owners. Tax payments after the first few years of operation begin to offset the tax benefits, and the state and federal governments in effect begin to recover some of the incentives provided.

Table 8. Net State and Federal Incentives (5 kW project)

		Massachusetts	Federal	Combined
Direct Ownership	Total	$19,692	$6,280	$25,972
	NPV	$14,979	$6,038	$21,017
Third-Party Ownership	Total	$17,584	$1,818	$19,402
	NPV	$13,641	$4,523	$18,163

As shown in Table 9, the NPV of combined state and federal incentives when normalized to capacity (kW) is $4,203 per kW under the direct ownership scenario. The dollar per kW for the third-party scenario is lower ($3,633) due to the payment of taxes on revenues. Thus, it takes more net state and federal incentives to install a PV system under the direct ownership scenario than under the third-party scenario.

However, lower state and federal incentives are needed to support economic output and jobs supported. For example, the NPV of state and federal incentives per local job maintained is $100 under the direct ownership scenario and $133 under the third-party scenario.

Table 9. Normalized Net Incentives (5 kW project)

	Direct Ownership (Net Present Value)			Third-Party-Owned (Net Present Value)		
	MA	Federal	Combined	MA	Federal	Combined
Per kW installed ($/kW)	$2,996	$1,208	$4,203	$2,728	$905	$3,633
Per $1,000 of local economic output	$495.21	$199.64	$694.84	$779.12	$258.33	$1,037.45
Per local job supported	$71	$29	$100	$100	$33	$133

4 Conclusions

DOER commissioned this analysis to understand how the local economic impacts of solar photovoltaic (PV) system installations may vary depending on aspects of the system's installation, ownership, and financing. After comparing a hypothetical homeowner-owned project using local resources to a hypothetical third-party-owned project managed by a nationally based company, the Consulting Team offers the following conclusions.

- Direct ownership results in a substantially higher economic benefit for the homeowner.
- However, the homeowner takes on economic risks and management tasks such as contracting for SREC sales. To aid homeowners, DOER should consider policies for the SREC-II program that reduce risk and simplify participation in the program.
- Local economic impacts are optimized when equipment is purchased locally and all non-installation-related work such as sales and management is performed locally. To optimize local economic impacts from the SREC-II program, DOER, where feasible, should consider policies that support local sourcing of equipment and services.[11]
- A locally based company that offers a third-party ownership opportunity to homeowners and purchases equipment locally would have a higher local economic impact than the nationally based company modeled in this analysis. DOER should consider the impacts of policies to any local companies offering third-party ownership opportunities to avoid disincentives to their business.

[11] However, if local sourcing increases the cost of a PV installation, the homeowner will see a lower return on their investment.

Appendix A: Annual Net Cash Flows

(For hypothetical 5 kW system)

Year	Direct Ownership				Third-Party Ownership			
	Homeowner	Local Bank	State (Taxes & SREC/REC)	Federal (Taxes)	Third-Party Owner	Non-Local Bank	State (Taxes & SREC/REC)	Federal (Taxes)
0	($9,259)	($6,173)	($1,000)	($6,280)	($9,618)	($6,814)	$0	($6,280)
1	$1,710	$555	($1,711)		$4,562	$1,618	($2,494)	($3,151)
2	$1,674	$555	($1,702)		$1,025	$1,618	($1,789)	($347)
3	$1,680	$555	($1,694)		$531	$1,618	($1,681)	$53
4	$1,659	$555	($1,686)		$206	$1,618	($1,612)	$298
5	$1,651	$555	($1,677)		$165	$1,618	($1,597)	$324
6	$1,653	$555	($1,669)		$1,535		($1,539)	$522
7	$1,641	$555	($1,660)		$1,319		($1,490)	$687
8	$1,667	$555	($1,652)		$1,332		($1,480)	$694
9	$1,670	$555	($1,644)		$1,334		($1,471)	$695
10	$1,684	$555	($1,636)		$1,341		($1,462)	$699
11	$218	$555	($135)		$450		($81)	$219
12	$236	$555	($135)		$460		($79)	$224
13	$254	$555	($134)		$471		($77)	$230
14	$272	$555	($133)		$481		($75)	$235
15	$284	$555	($133)		$487		($73)	$239
16	$857		($132)		$490		($70)	$250
17	$871		($131)		$491		($67)	$259
18	$891		($131)		$502		($65)	$265
19	$912		($130)		$514		($63)	$272
20	$926		($129)		$522		($61)	$276
21	$946		($129)		$531		($58)	$283
22	$975		($128)		$546		($55)	$294
23	$1,005		($127)		$562		($52)	$303
24	$1,044		($127)		$584		($49)	$315
25	$1,076		($126)		$602		($46)	$324
Sum	**$18,195**	**$2,155**	**($19,692)**	**($6,280)**	**$11,425**	**$1,274**	**($17,584)**	**($1,818)**
Net Present Value	**$8,927**	**($0)**	**($14,979)**	**($6,038)**	**$5,127****	**$372**	**($13,641)**	**($4,523)**

** To allow for a direct comparison of scenarios, the federal tax credit was moved to year zero. This results in a higher NPV than used in other sections of this report, which rely on an analysis that has the tax credit claimed in year one.

Appendix B: JEDI Model Inputs

(for hypothetical installation of 1,000 PV systems (5 kW)

Direct Ownership Model

Table 10. Detailed Solar PV Project Costs, Direct Ownership Model (1,000 PV Systems)

Installation Costs	Cost	Purchased Locally (%)	Manufactured Locally (Y or N)
Materials & Equipment			
Mounting (rails, clamps, fittings, etc.), Modules, Electrical (wire, connectors, breakers, etc.)	$7,142,500	75%	N
Inverter	$2,300,000	75%	Y
Subtotal	***$9,442,500****		
Labor			
Installation	$2,950,000*	100%	
Subtotal	***$2,950,000***		
Subtotal	***$12,392,500***		
Other Costs			
Permitting	$635,905*	100%	
Other Costs	$1,271,811*	100%	
Business Overhead	$8,411,438*	100%	
Subtotal	***$10,319,154***		
Subtotal	***$22,711,654***		
Sales Tax (Materials & Equipment Purchases)	$0**	100%	
Total	**$22,711,654**		

* Default values calculated by JEDI as a proportion of total cost.

** No sales tax is assessed on qualifying solar equipment in Massachusetts. (M.G.L. 64H.6(dd))

Table 11. Annual Operating and Maintenance Costs, Direct Ownership Model (1,000 PV Systems)

Installation Costs	Cost	Purchased Locally (%)	Manufactured Locally (Y or N)
Labor			
Technicians	$50,000	100%	
Subtotal	***$50,000****		
Materials and Services			
Materials & Equipment	$50,000	75%	Y
Services	$0	100%	
Subtotal	***$50,000****		
Sales Tax (Materials & Equipment Purchases)	$0	100%	
Average Annual Payment (Interest and Principal)	$775,224	100%	
Property Taxes	$0	100%	
Total	**$875,224**		

* Based on Task 1 Report value of $20 per kW per year for O&M costs. One-half of this cost has been assigned to labor, and one-half to equipment.

Table 12. Debt and Tax Parameters, Direct Ownership Model

Financial Parameters		
Debt Financing		
Percentage financed	40%*	100%
Years financed (term)	15*	
Interest rate	4%*	
Tax Parameters		
Local Property Tax (percent of taxable value)	0%	
Assessed Value (percent of construction cost)	0%	
Taxable Value (percent of assessed value)	0%	
Taxable Value	$0	
Property Tax Exemption (percent of local taxes)	100% **	
Local Property Taxes	$0	100%
Local Sales Tax Rate	6.25%	100%
Sales Tax Exemption (percent of local taxes)	100% ***	

* From Task 1 Report scenario for residential the direct ownership scenario.
**Twenty year exemption from property taxes in Massachusetts (M.G.L. ch. 59 § 5 (45, 45A))
*** No sales tax is assessed on qualifying solar equipment in Massachusetts. (M.G.L. 64H.6(dd))

Table 13. Payroll Parameters, Direct Ownership Model

Payroll Parameters	Wage per hour	Employer Payroll Overhead
Construction and Installation Labor		
Construction Workers / Installers	$21.42*	45.6%*
Operations and Maintenance Labor		
Technicians	$21.42*	45.6%*

* JEDI model default values.

Third-Party Ownership Model

Table 14. Detailed Solar PV Project Costs, Third-Party Ownership Model (1,000 PV Systems)

Installation Costs	Cost	Purchased Locally (%)	Manufactured Locally (Y or N)
Materials & Equipment			
Mounting (rails, clamps, fittings, etc.), Modules, Electrical (wire, connectors, breakers, etc.)	$7,142,500*	25%	N
Inverter	$2,300,000*	25%	Y
Subtotal	*$9,442,500*		
Labor			
Installation	$2,950,000*	100%	
Subtotal	*$2,950,000*		
Subtotal	*$12,392,500*		
Other Costs			
Permitting	$635,905*	100%	
Other Costs	$1,271,811*	50%	
Business Overhead	$8,411,438*	50%	
Subtotal	*$10,319,154*		
Subtotal	*$22,711,654*		
Sales Tax (Materials & Equipment Purchases)	$0**	100%	
Total	**$22,711,654**		

* Default values calculated by JEDI as a proportion of total cost.

** No excise tax is assessed on qualifying solar equipment in Massachusetts. (MGL ch. 63, § 38H))

Table 15. Annual Operating and Maintenance Costs, Third-Party Ownership Model (1,000 PV Systems)

Installation Costs	Cost	Purchased Locally (%)	Manufactured Locally (Y or N)
Labor			
Technicians	$50,000*	100%	
Subtotal	*$50,000*		
Materials and Services			
Materials & Equipment	$50,000*	25%	N
Services	$0	100%	
Subtotal	*$50,000*		
Sales Tax (Materials & Equipment Purchases)	$0**	100%	
Average Annual Payment (Interest and Principal)	$1,526,223	0%	
Property Taxes	$0**	100%	
Total	**$1,626,223**		

* Based on Task 1 Report value of $20 per kW per year for O&M costs. One-half of this cost has been assigned to labor, and one-half to equipment.

** No excise tax on sales and tangible property is assessed on qualifying solar equipment in Massachusetts. (MGL ch. 63, § 38H))

Table 16. Debt and Tax Parameters, Third-Party Ownership Model

Financial Parameters	
Percentage financed	30%*
Years financed (term)	5*
Interest rate	6%*
Local Property Tax (percent of taxable value)	0%
Assessed Value (percent of construction cost)	0%
Taxable Value (percent of assessed value)	0%
Taxable Value	$0
Property Tax Exemption (percent of local taxes)	100%**
Local Property Taxes	$0
Local Sales Tax Rate	6.25%
Sales Tax Exemption (percent of local taxes)	100%***

* From Task 1 Report scenario for residential the third-party ownership scenario.
**Excise tax exemption on tangible solar proerty (M.G.L. ch. 59 § 5 (45, 45A))
*** No sales tax is assessed on qualifying solar equipment in Massachusetts. MGL ch. 63, § 38H))

Table 17. Payroll Parameters, Third-Party Ownership Model

Payroll Parameters	Wage per hour	Employer Payroll Overhead
Construction and Installation Labor		
Construction Workers / Installers	$21.42*	45.6%*
O&M Labor		
Technicians	$21.42*	45.6%*

* JEDI model default values.