Solar Equity: Evaluation of Economic Rent from the Massachusetts RPS Solar Carve-Out II Program

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1. Background

Massachusetts is one of the leading states in solar energy, and its success is mainly due to programs that the state has put forth to incentivize and accelerate solar projects. One of these programs is the RPS Solar Carve-Out II program (familiarly known as the SREC II program) that was preceded by the RPS Solar Carve-Out program and succeeded by Solar Massachusetts Renewable Target program (SMART). SREC II was active from 2013 to 2019, and was created to continue the early rapid solar market growth in Massachusetts as well as reduce ratepayer costs. Additionally, it was intended to encourage policy-preferred solar market sectors, such as rooftops, parking canopies, community shared solar, and solar supporting low income and municipal customers. The SREC II program supported more than 1,700 MW of solar capacity in Massachusetts, distributed across more than 75,000 solar installations.

While the solar program has brought impactful benefits to Massachusetts in jobs, business creation, and greenhouse gas reductions, there are components that have not been well considered nor analyzed. They include concurrent costs to ratepayers, the magnitude and distribution of the financial benefits of the economic rents associated with the solar development. These rents take the form of financial rates of return to owners/investors, energy cost discounts offered to solar net metering off-takers, and lease or other payments to municipalities or site owners. Economic rents from solar projects are important when evaluating solar equity, as they provide significant opportunities for wealth generation and potential redistribution of economic equity between producers and consumers in a decentralized energy market.

Under an internal seed grant from the UMass Institute for Social Science Research, the Clean Energy Extension is estimating the magnitude of economic rent generated by the SREC II solar market. The analysis considers how this rent varies as well as how is distributed across recipient classes, solar project types and ownership/financing arrangements. Our preliminary findings support our hypothesis that the economic rents generated in the SREC II program accrue most substantially to third-party, nationally-based solar companies and affiliated project equity investors, particularly in the commercial and community shared solar sectors, and more local distribution of economic rents accrue in the portion of the residential solar market where projects

are directly owned by homeowners. The project findings will be used to evaluate the distribution of solar rents across the general wealth distribution in the U.S., and opportunities for solar markets and state and federal policy to encourage greater equity from a decentralized energy future.

2. Data Sources

Our analysis utilizes publicly available data from the Massachusetts Department of Energy Resources (DOER). DOER maintains a database of projects qualified for each of its Renewable Portfolio Standard (RPS) programs including SREC II. This SREC II database provides entries for each of the roughly 75,000 qualified projects, with useful data on Facility Type, Nameplate Capacity (kW), Market Sector, Market Subsector, SREC Factor, RPS Effective Date, and Total Installation Costs. The DOER database does not include information on project ownership or financing.

We also utilized and adapted a pro-forma cash flow spreadsheet model from DOER which we used as the basis for our determination of economic rents remaining from project costs, financing, tax flows, and revenues. We developed 12 cash flow scenarios for 6 project types and each with direct (by project host or off-takers) or third-party ownership. Each of these scenarios was then applied for each of the six full years of the program (2014-2019), creating 72 separate cash flow runs. For each run, the net present value over a 30-year project life of the economic rent was calculated for each of seven recipient categories. All of our project economic financing and incentive value assumptions are provided in Section 4 and are preliminary. The assumptions will be subject to further review with a Massachusetts solar market consultant as part of the ISSR Seed Grant.

3. Methodology

We decided to focus on SREC II program because of its recent completion and its design which differentiates project design and incentives by market sector. We began by mapping the 75,905 SREC II DOER project data for Market Sector, Market Subsector, and Facility Type into the seven Project Types used for this analysis as shown in Table 1. Using an Excel pivot table, we then determined for each Project Type and for each program year, the total capacity installed (MW), the average installed cost ($/W), and the average SREC Factor weighted by installation capacity (the SREC Factor discounts the SREC II incentive value), as shown in Tables 2 a, b, and c, respectively.

Table 1. Categorization of All Projects into Seven Categories
Using the Market Sector, Market Subsector, and Facility Type

MA DOER SREC II Project Designations			Project Types for Econ. Rent Analysis
Market Sectors	**Market Subsectors**	**Facility Types**	
Market Sector A	<=25 kW DC	Residential	**Residential**
	Solar Canopy	Multi-family Residential	
Market Sector B	Building Mounted		
Market Sector C	Ground Mounted		
Market Sector A	Affordable Housing	all types	**Low Income**
Market Sector A	<=25 kW DC	Agricultural; Commercial/Office; Federal; Hospital/Health Care; Industrial; Mixed use (commercial & residential); Restaurant/Food Service; Retail; School (K-12)	**Commercial**
	Solar Canopy	Commercial/Office; Hospital/Health Care; Industrial; Retail; School (K-12);	
Market Sector B	Building Mounted	Agricultural; Commercial/Office; Hospital/Health Care; Industrial; Mixed use (commercial & residential); Restaurant/Food Service; Retail; School (K-12)	
	Ground Mounted		
Market Sector C	Brownfield	Commercial/Office; Industrial	
	Ground Mounted	Agricultural; Commercial/Office; Hospital/Health Care; Industrial; Mixed use (commercial & residential); Restaurant/Food Service	
	Landfill	Industrial; Mixed use (commercial & residential)	
Managed Growth		Agricultural; Commercial/Office; Industrial; School (K-12)	
Market Sector A	<=25 kW DC	Community Solar	**Community Shared Solar**
	Community Shared Solar	all types	
Market Sector B	Building Mounted	Community Solar	
Market Sector C	Ground Mounted	Community Solar	
Market Sector A	Affordable Housing	all types	**Low Income**
Market Sector A	<=25 kW DC	College/University; Religious	**Non-Profit**
	Solar Canopy	College/University	
Market Sector B	Building Mounted	College/University; Religious	
	Ground Mounted		
Market Sector C	Ground Mounted	College/University	
Managed Growth	Managed Growth	College/University	
Market Sector A	<=25 kW DC	Municipal - K-12 School; Municipal/Government/Public; State	**Public/Govt**
	Emergency Power Facility	Municipal/Government/Public	
	Solar Canopy	Municipal - K-12 School; Municipal/Government/Public; State - College/University	
Market Sector B	Building Mounted	Municipal - K-12 School; Municipal/Government/Public; State; State - College/University	
	Ground Mounted	Municipal - K-12 School; Municipal/Government/Public; State; State - College/University	
Market Sector C	Brownfield	Municipal - K-12 School; Municipal/Government/Public	
	Ground Mounted	Municipal - K-12 School; Municipal/Government/Public; State	
	Landfill	Municipal/Government/Public; State - College/University	
Managed Growth	Managed Growth; Other	Municipal/Government/Public	
Market Sector A	<=25 kW DC; Solar Canopy	Other	**Other (discarded from analysis)**
Market Sector B	Building Mounted; Ground Mounted		
Market Sector C	Brownfield; Ground Mounted; Landfill		

Table 2a. Total Capacity Installed (MW) per Project Type per Year

Project Type	Year						Total
	2014	2015	2016	2017	2018	2019	
Commercial	12,246	50,342	76,998	126,747	79,692	4,551	**350,575**
CSS	34	2,499	31,625	145,623	110,825	19,763	**310,369**
LI	101	11,614	19,757	56,829	42,165	10,734	**141,200**
Non-Profit	2,769	1,099	1,339	10,877	3,877	95	**20,055**
Other	1,339	10,378	18,111	54,449	17,887	739	**102,903**
Public/Govt	936	49,376	56,731	118,399	27,967	97	**253,506**
Residential	37,545	140,022	189,399	90,099	91,643	527	**549,242**
Total	**54,970**	**265,329**	**393,960**	**603,023**	**374,056**	**36,506**	**1,727,850**

Table 2b. Average Installed Cost ($/W) per Project per Year

Project Type	Year						Total
	2014	2015	2016	2017	2018	2019	
Commercial	2.45	2.32	2.89	2.62	2.58	2.37	**2.62**
CSS	4.36	3.13	2.38	2.49	2.41	2.85	**2.48**
LI	5.17	2.69	2.77	2.29	2.11	2.30	**2.34**
NP/Other	2.87	2.67	2.68	2.64	2.69	3.31	**2.67**
Public/Govt	5.98	2.41	2.65	2.46	2.47	5.56	**2.51**
Residential	4.77	4.78	4.45	3.96	3.80	2.41	**4.37**
Total	**4.77**	**4.78**	**4.45**	**3.96**	**3.80**	**2.41**	**4.37**

Project Type	Year						Total
	2014	2015	2016	2017	2018	2019	
Commercial	0.90	1.00	1.00	1.00	0.88	0.65	**0.93**
CSS	0.91	0.89	0.87	0.84	0.66	0.61	**0.81**
LI	1.00	1.00	1.00	0.99	0.77	0.70	**0.90**
NP/Other	0.89	0.83	0.82	0.79	0.74	0.84	**0.79**
Public/Govt	0.89	0.76	0.75	0.80	0.61	0.55	**0.76**
Residential	1.00	1.00	1.00	0.83	0.80	0.60	**0.94**
Total	**0.97**	**0.93**	**0.93**	**0.88**	**0.77**	**0.67**	**0.87**

The pro-forma cash flows of each of the six project types, on a per MW installed basis, were prepared under a direct ownership and third-party ownership arrangement and for each of the six program years. The analysis used the installed cost and SREC Factor data determined from the SREC II qualified project database, along with a range of differentiating assumptions on terms of project financing, taxes, and electricity and SREC II and REC prices. Cash flows for 30 years were considered, and cash flows accruing as economic rent (net revenues, off-taker electricity discounts, lease and municipal payments in lieu of taxes) were parsed, depending on ownership and project type, and attributed to one or more of the seven recipient classes considered and shown in Table 3. The net present value (NPV) of these rents were calculated and reported as the primary results of the analysis.

Table 3. Economic Rent Recipients

Economic Rent Recipients
Solar Finaciers
Commercial
Residential
Low Income
Public/Govt
Non-Profit

With these NPVs of economic rents per MW, we multiplied them for each project type by the installed capacity of that project type of each year, and with an assumed portion of that capacity being directly owned and third-party owned. These results provide for the magnitude and distribution of economic rents across recipients, and are presented as our main findings.

4. Market Assumptions

To calculate preliminary economic rents per project type and their distribution, certain market assumptions were made to estimate price and financial conditions. There are three major categories of assumptions: SREC and REC price projections, financial assumptions, and ownership assumptions.

4.1 SREC II and REC prices

Solar Renewable Energy Certificate II (SREC II) and Renewable Energy Certificate (REC) prices received by solar owners depend on market supply and demand in that year, and whether certificates are being transacted in the spot market or under a long-term contract. SREC II projects are eligible to receive SREC II for their first 10 years, followed by RECs for the remainder of their generation. The RPS regulations bound maximum prices through the alternative compliance payment rate, and for the SREC II market bound the minimum price through a clearinghouse auction mechanism. We assumed prices for SREC II based on published broker prices that were available for the first few years of the program, and assumed that declining price trend would continue – with prices falling a bit above the auction floor price. Ten years after a project is installed, the annual incentive becomes an RPS Class I REC with an assumed steady price of $25. Table 4 provides the SREC II and REC prices assumed in the analyses.

Table 4. SREC II and REC prices assumptions.

Year	SREC II	Class I REC
	$/certificate	$/certificate
2014	356	25
2015	285	25
2016	273	25
2017	271	25
2018	308	25
2019	266	25
2020	255	25
2021	244	25
2022	233	25
2023	222	25
2024	211	25
2025	209	25
2026	198	25
2027	183	25
2028	168	25
2029		25
2030 and on		25

4.2 Financial Assumptions

To develop cash flow analyses for the project types, we made significant financial assumptions on the nature and terms of project financing as shown in Table 5. The assumptions are differentiated by project type and ownership arrangement, though they remain constant across the years of the program. For the calculation of the NPV of economic rent to the recipients, discount rates appropriate to these recipient classes were assumed as shown in Table 6. (At this point, we maintain the discount rate constant across recipient classes to enhance our ability to interpret our preliminary results by constraining the variables.)

Table 5. Cash Flow Model Financial Assumptions per Projects Type and Ownership Arrangements

Project Type	Ownership	Tax Status of Owner	State Solar Residential Income Tax Credit	Electricity Retail Rate (2014) per kWh	Electricity Retail Annual Escalation Rate	Electric or Net-Metering Off-Taker Discount	PILOT / other Payment Agreement annually	Percent Project Cost Financed w/ Cash	Loan Annual Interest Rate	Loan Term years	Federal Tax Rate	State Tax Rate
Commercial	Third Party	Taxable (Corporation)	$0	$0.18	5.0%	15%	$0	60%	6.0%	5	35%	10%
Commercial	Direct	Taxable (Corporation)	$0	$0.18	5.0%	0%	$0	0%	5.0%	10	35%	10%
CSS	Third Party	Taxable (Corporation)	$0	$0.18	5.0%	15%	$0	60%	6.0%	5	35%	10%
CSS	Direct	Taxable (Residential)	$0	$0.18	5.0%	0%	$0	0%	5.0%	10	20%	5%
LI	Third Party	Taxable (Corporation)	$0	$0.18	5.0%	15%	$0	60%	6.0%	5	35%	10%
LI	Direct	Non-Taxable	$0	$0.18	5.0%	0%	$0	0%	5.0%	10	0%	0%
NP/Other	Third Party	Taxable (Corporation)	$0	$0.18	5.0%	15%	$0	60%	6.0%	5	35%	10%
NP/Other	Direct	Non-Taxable	$0	$0.18	5.0%	0%	$0	0%	5.0%	10	0%	0%
Public/Govt	Third Party	Taxable (Corporation)	$0	$0.18	5.0%	15%	$10,000	60%	6.0%	5	35%	10%
Public/Govt	Direct	Non-Taxable	$0	$0.18	5.0%	0%	$0	0%	5.0%	10	0%	0%
Residential	Third Party	Taxable (Corporation)	$0	$0.18	5.0%	15%	$0	60%	6.0%	5	35%	10%
Residential	Direct	Taxable (Residential)	$1,000	$0.18	5.0%	0%	$0	0%	5.0%	10	20%	5%

Table 6. Discount Rates per Economic Rent Recipient

Economic Rent Recipient	Discount Rate for NPV
Commercial	5%
Low Income	5%
Non-Profit	5%
Public/Govt	5%
Residents	5%
Solar Financiers	5%

4.3 Ownership Assumptions

Given the significant difference in the recipients and distribution of economic rent based on who owns that solar project, our last set of assumptions provide for the percent of projects under each project type and for each program year that is direct-owned by the host site or off-takers sharing ownership of an off-site project, or third party-owned by solar developers or investors unaffiliated with the ownership of the host site. We used prior knowledge as well as judgement to base our assumptions, and these assumptions will be subject to further research and market intelligence later. Table 7 outlines the ownership assumptions for each project type and for each year.

Table 7. Assumptions about Ownership Trends Over Time by Project Type

Project Type	Year											
	2014		2015		2016		2017		2018		2019	
	Third-Party Owned	Direct Owned	Third-Party Owned	Direct Owned	Third-Party Owned	Direct Owned	Third-Party Owned	Direct Owned	Third-Party Owned	Direct Owned	Third-Party Owned	Direct Owned
Commercial	70%	30%	70%	30%	70%	30%	70%	30%	70%	30%	70%	30%
CSS	95%	5%	95%	5%	95%	5%	95%	5%	95%	5%	95%	5%
LOI	95%	5%	95%	5%	95%	5%	95%	5%	95%	5%	95%	5%
NP/Other	90%	10%	90%	10%	90%	10%	90%	10%	90%	10%	90%	10%
Public/Govt	95%	5%	95%	5%	95%	5%	95%	5%	95%	5%	95%	5%
Residential	70%	30%	65%	35%	60%	40%	55%	45%	50%	50%	45%	55%

Additionally, we have made assumptions about the distribution of economic rent within a project and ownership type. These 24 scenarios are laid out in Tables 8 and 9.

Table 8. Offtakers for Third Party Ownership per Project Type

Offtakers for Third Party Ownership						
	Com	CSS	LoI	NPO	P&G	Res
Commercial	100%	25%				
Low Income			60%			
Non-Profit				100%		
Public/Govt		25%			100%	
Residents		50%	40%			100%
Solar Financiers						

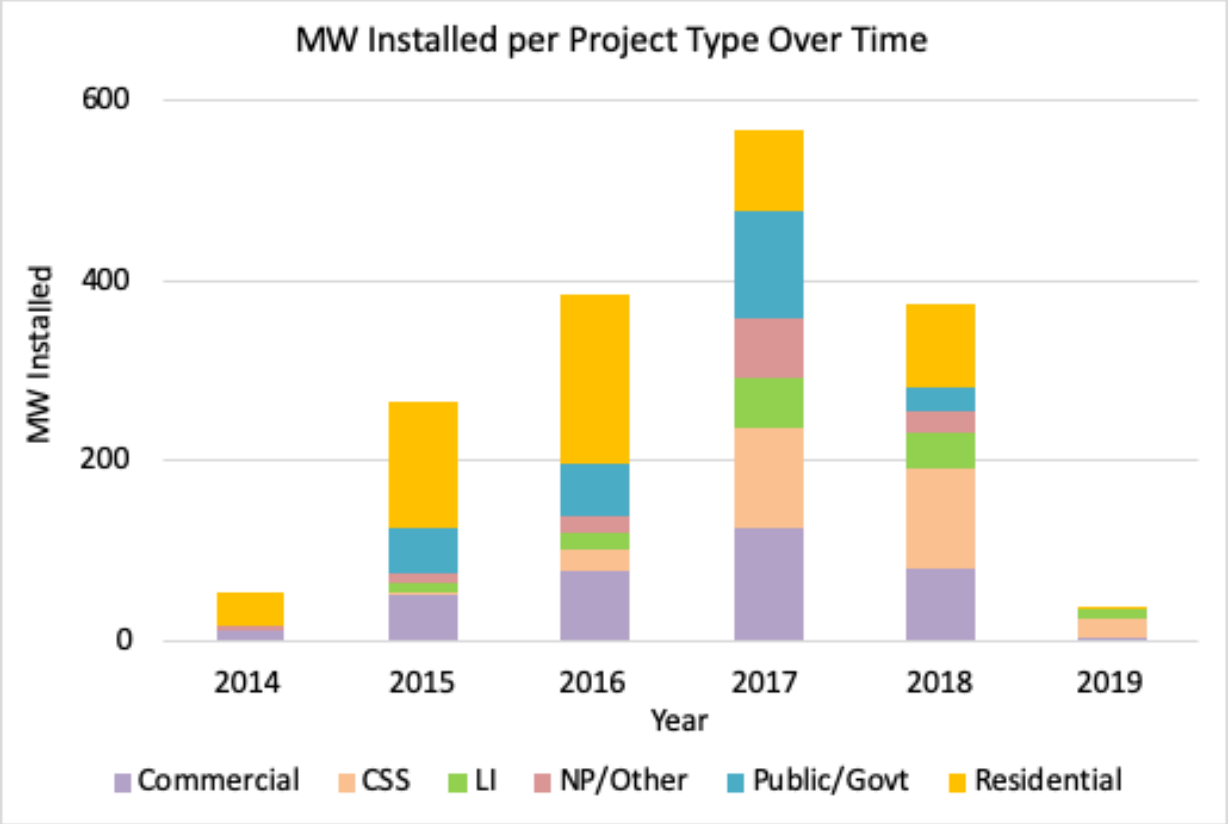
Table 9. Economic Rent Recipients for Direct Ownership per Project Type

Rent Recipient for Direct Ownership						
	Com	CSS	LoI	NPO	P&G	Res
Commercial	100%					
Low Income			100%			
Non-Profit				100%		
Public/Govt					100%	
Residents		100%				100%
Solar Financiers						

5. Preliminary Findings and Discussion

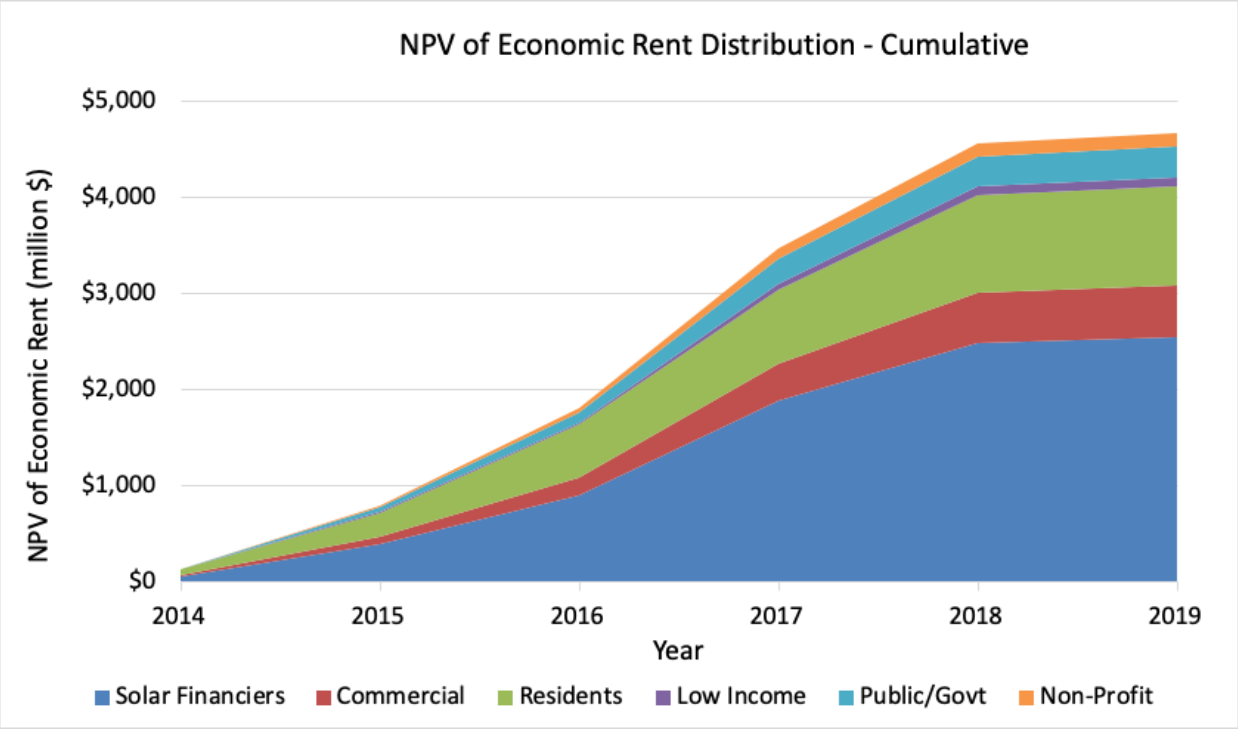
The solar capacity installed each year during the SREC II program was categorized into the six project types shown in Figure 1. This data does not differentiate the installations by ownership arrangement. The bulk of the programs' capacity was fulfilled in years 2016, 2017 and 2018, and the most robust year in terms of capacity and diversity of project types was 2017.

Figure 1. Installed Capacity by Project Type over Program Years

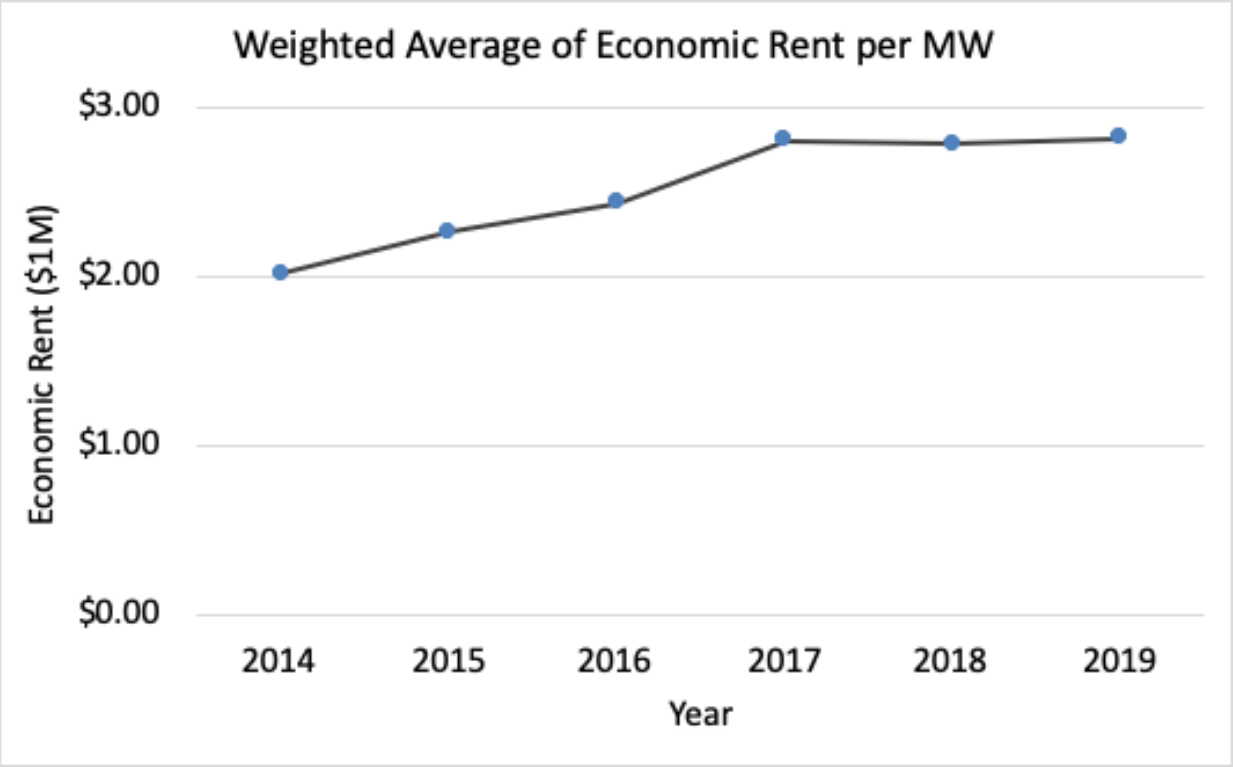


Applying our cash flow analysis to these installed capacities and assumed trend of direct and third-party ownership provide in Table 7, we are able to calculate the 30-year NPV and distribution of the program's economic rent across the rent recipients. The cumulative NPV of economic rent by recipient is shown in Figure 2. Our initial results find that over the project lifetimes, recipients will accrue more than $4.5 billion, and that more than half of that will accrue to the non-host financiers of solar projects.

Figure 2. Cumulative NPV of Economic Rent Distribution per Recipient over Time

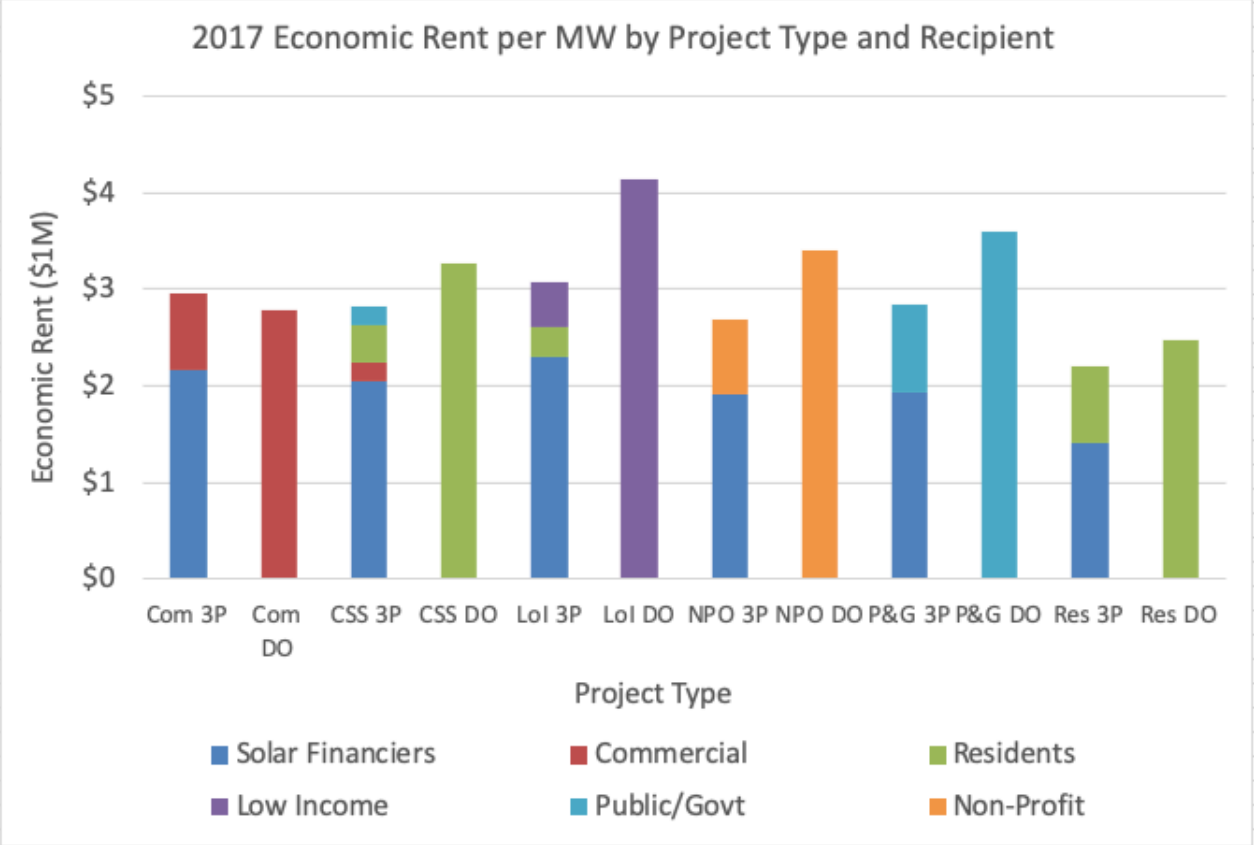


To more closely analyze the magnitudes and distributions of economic rent by project type and ownership, we next focus on one year of the program. Figure 3 demonstrates that the economic rent per MW installed is relatively stable over the program duration, so selecting a single year as representative is reasonable. We focus on 2017 because it was a particularly robust year in terms of installations and breadth of installations across project types.



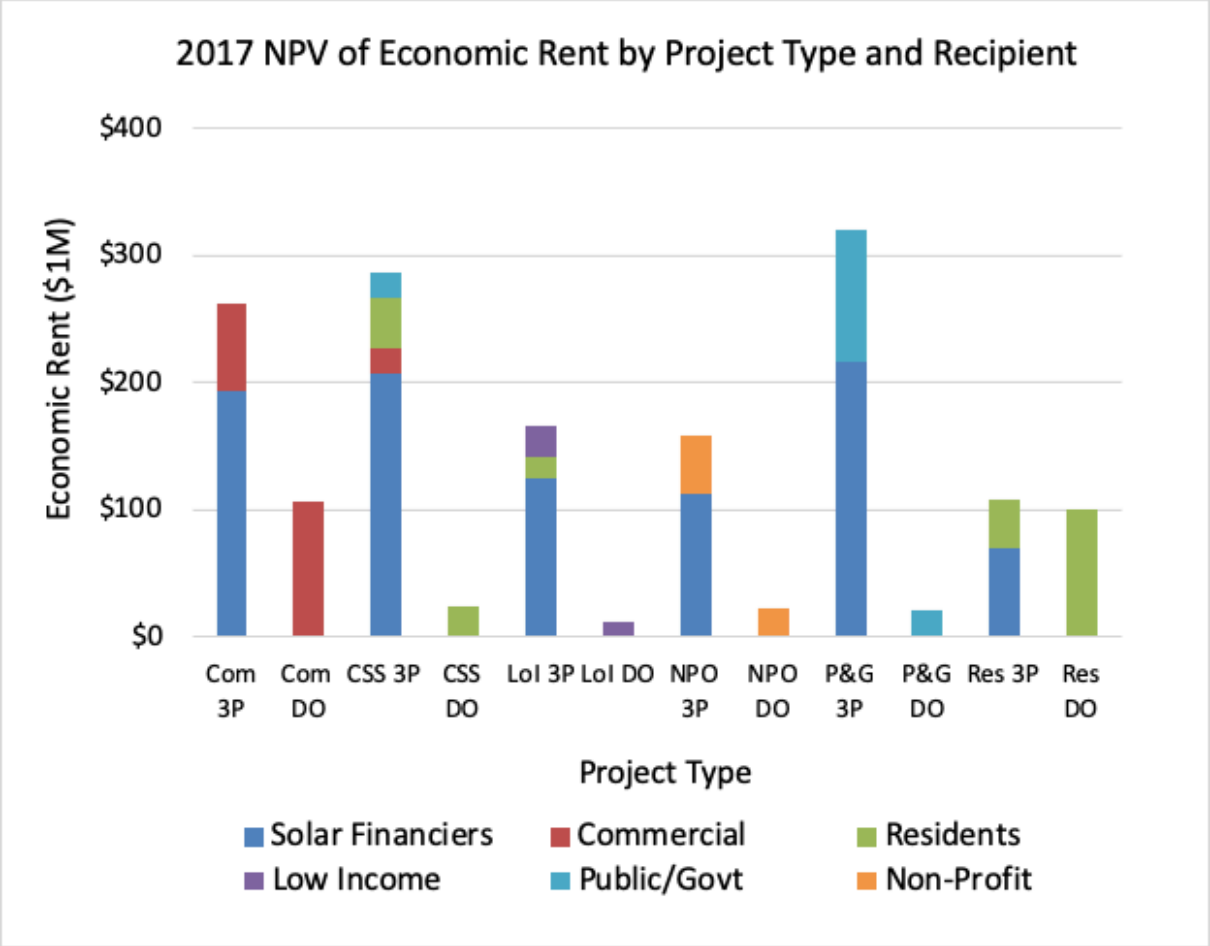
To evaluate the generation and distribution of economic rent by the SREC II program, it is helpful to consider the distribution and magnitude by project type and ownership arrangement both on a per MW basis, and over the total installed MWs. Figure 4 shows the economic rent per MW for each of the cash flow scenarios. The results demonstrate that NPV of rents per MW from direct-owned projects are generally larger and solely accrue to the owner, whereas the third-party owner arrangements have multiple beneficiaries with the large majority going to the third-party owner.

Figure 4. 2017 NPV of Economic Rent per MW by Project Type and Recipient



To evaluate the actual NPV of rents of the SREC II program in 2017, we consider the capacity installed across project types and under the two ownership arrangements. These results are shown in Figure 5, which significantly skews the magnitude and distribution of economic rent to the market prevailing project types and ownership. With our assumption that third-party ownership was more common than the direct-ownership model, solar financiers will accrue most of the 2017 installed economic rent over the next 30 years. Solar financiers, which include third-party, nationally-based solar companies and affiliated project equity investors, have been the main beneficiary while commercial and resident beneficiaries are secondary. The results demonstrate that for Community Shared Solar, only small amounts of rent have accrued to "community" participants, and likewise only small rents are gained in Low Income projects by low income constituents. The results do show that the more substantial use of direct-ownership in the residential market has resulted in significant rents distributed to homeowners in Massachusetts.

Figure 5. 2017 NPV of Economic Rent by Project Type and Recipient



6. Next Steps

This work provides a beginning step to launch more robust look at equity across the solar market in Massachusetts and other jurisdictions. This report documents preliminary modeling and findings, and more work must be done to draw more definitive conclusions on SREC II's magnitude and distribution of economic rent. Most particularly, the analysis is based on assumption values for the SREC II market that have not been well vetted. As part of the Seed Grant we will be consulting with our industry partner Sustainable Energy Advantage, LLC to review and finalize our financial and ownership assumptions base on their comprehensive market data and insights. This update will provide more confidence in our findings and enable us to be in a position to publish our work and seek new grant opportunities that could assist the continued research of economic rent. Key expanded research topics include 1) broadening our analysis to other solar and other distributed energy markets (storage, energy efficiency, demand response), 2) mapping the rent distribution into the income and wealth distribution of the economy, and 3) identifying policy levers and market opportunities to enable more equitable flow of economic rent from decentralized energy markets.