Capturing the Sun: How to Monetize Solar Energy in Multi-family Developments

by

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Submitted to the Program in Real Estate Development in Conjunction with the Center for Real Estate in Partial Fulfillment of the Requirements for the Degree of Master of Science in Real Estate Development

at the

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Signature of Author____

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ABSTRACT

Solar energy has become increasingly accessible. By 2020, forty-two states are expected to reach grid parity. However, most of the 39 million residents who live in 5+ unit multi-family buildings in the United States lack access to alternative, affordable green energy sources such as solar.

This thesis recognizes the perception of the lack of financial incentive for the capital providers as one of the key reasons for the slow adaptation and endeavors to assess whether owners and developers of multi-family developments can generate income from solar investment in their communities within the state of Massachusetts.

The paper views solar energy through the investors' lenses and seeks practical solutions while exploring all the applicable federal and state programs to determine the best investment strategy for decision-makers. It reviews the tangible and non-tangible benefits of solar energy in multi-family communities and concludes that there are strategic pathways for the adoption of solar energy at multi-family properties that, in addition to societal and economic benefits for the community, are financially desirable for property owners. In today's highly competitive market, where innovators are constantly pushing to find untapped value, solar energy not only provides attractive financial returns but also differentiates the asset and enhances its value.

Thesis Supervisor: Jennifer Cookke
Title: Lecturer, Center for Real Estate, Department of Urban Studies and Planning

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1 INTRODUCTION

Figure 1 - Rooftop Solar[1]

According to the National Multifamily Housing Council (NMHC), there are nearly 684,000 5-unit or more multi-family housing properties, with 39 million residents in the United States[2]. The majority of these communities and residents are purchasing electricity from the grid at a cost higher than what they could produce from alternative sources[3]. Concurrently, discussions surrounding climate change mitigation goals and environmental justice issues regarding access to clean energy are emerging popular topics in the public realm.

The primary reasons behind this lack of access to cheap, clean energy in multi-family developments are the split incentives and unfamiliarity with the technologies and regulations. Split incentives (a similar concept to Principal-agent problem) happen when energy consumers (the tenants) are not the same entity responsible for capital investment decisions (owners/developers). The property owners would only consider the investment when there is a reasonable payback on the upfront cost, such as selling the generated electricity. However, some states like Massachusetts forbid landlords to charge tenants for electricity[4]. The tenants, who would benefit from solar the most, often do not have the option, nor the capital to install solar panels. Split incentive, along with unfamiliarity with solar technology and regulation, has resulted in the slow growth of solar in the multi-family sector.

In this thesis, we will discuss the state of the solar industry and the benefits of solar to the community, society, and the grid. We will analyze several use, ownership, and investment strategies. In conclusion, this paper will apply the knowledge in two case studies and examine the impact of solar addition on OPEX, NOI, and property value in order to determine the best outcome for all stakeholders.

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1 Source: Center for Sustainable Energy

2 https://www.nmhc.org/research-insight/quick-facts-figures/quick-facts-apartment-stock/

3 20 states reached grid parity by 2016, 42 states are expected to reach grid parity by 20. https://www.greentechmedia.com/articles/read/gtm-research-20-us-states-at-grid-parity-for-residential-solar

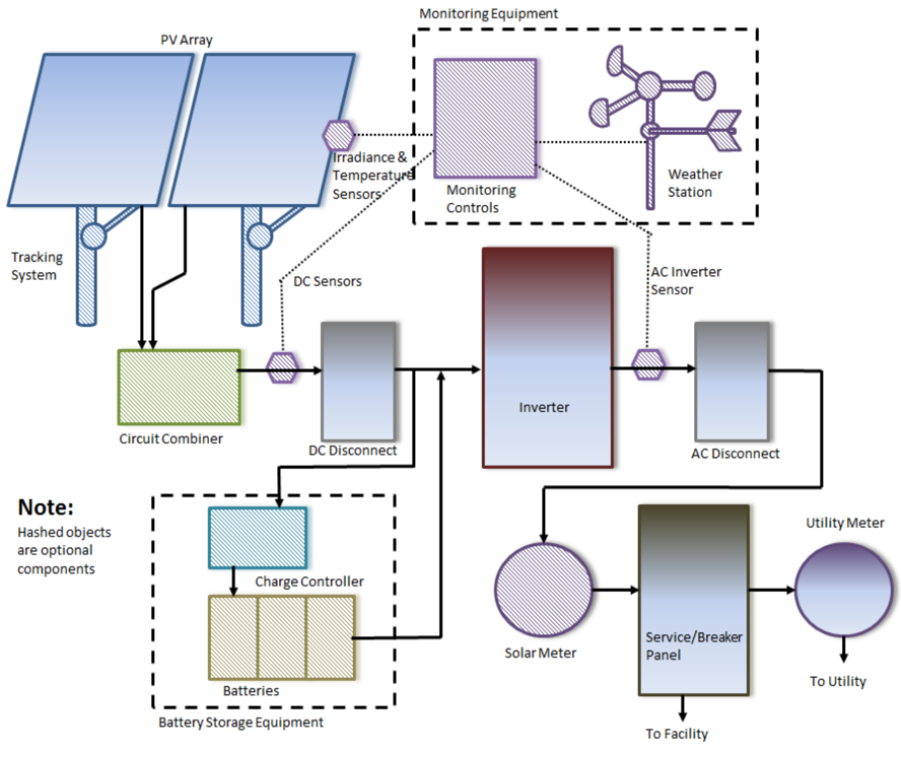
4 MGL Ch 164 Section 2

1.1 WHAT IS SOLAR POWER AND SOLAR PV

The Sun does more than providing light during the daytime. Each particle of sunlight (photon) that reaches Earth contains energy that fuels our planet. According to the US department of energy, enough solar radiation hits the surface of the planet each hour to theoretically fill our global energy needs for nearly an entire year[5]. This energy, when converted into thermal or electrical energy, is known as solar power.

Devices that generate electricity directly from sunlight are called photovoltaic (PV) devices. PV devices generate electricity via a process that occurs in certain types of material, called semiconductors. In semiconductors, electrons are freed by solar energy and can be induced to travel through an electrical circuit. This energy can be used to power electrical devices or send electricity to the grid. PV systems produce energy by converting photons into direct current (DC). The amount of current produced depends on the amount of light hitting the semiconductor material from which PV modules are fabricated, and the efficiency of the system. DC equipment can use DC electricity with no or minimal conditioning. Alternatively, the DC can be converted into alternating current (AC) electricity and used by AC equipment.

In most commercial building applications, the output of the PV system is converted to AC electricity and consumed by the loads associated with the building or facility. When a facility's electricity needs are lower than the PV system's output, the excess AC electricity is fed back into the electric grid. Figure 2 shows major solar components and the process in which solar is converted into electricity:



Core Components

- PV Array
- Inverters
- Optimizers
- Racking/ Mounting System
- Disconnect Switches
- AC Circuit Breaker
- Meters

Optional Components

- Monitoring System
- Tracking System
- Battery Storage System

Figure 2 - Major Components of PV System [6]

[5] Source: US Department of Energy
[6] Source: Navigant

1.2 REVOLUTION IN THE ELECTRIC POWER INDUSTRY

The global electric power industry is constantly adapting to keep up with the ever-evolving market demands. The industry has developed from a model that relied on large centralized power plants owned by large utility companies to one that is decentralized and diverse in generation sources and their ownership. Technological advancements in the off-grid solutions are creating a tipping point in the energy industry, enabling residential and business consumers to create their own electricity. Concurrently, the increase in global planet awareness to the negative externalities of conventional energy has motivated companies to seek cleaner energy sources.

The electric power industry in the United States is not exempt from these changes. The US uses many different energy sources and technologies to generate electricity. The three major categories of energy for electricity generation are fossil fuels (coal, natural gas, and petroleum), renewable energy sources, and nuclear energy. These sources and technologies have changed over time. A transition from using coal as the primary energy source to more diverse new resources such as renewables was made just a decade ago.

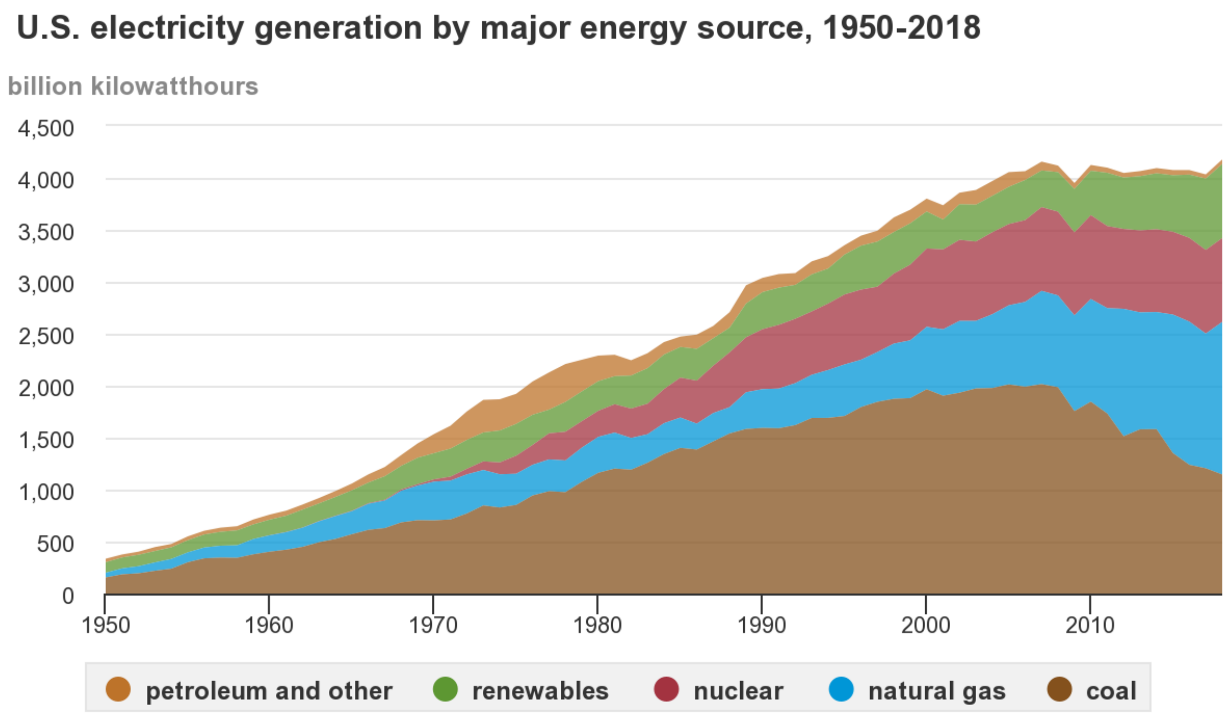


Figure 3 - US Electricity Generation by Source overtime [7]

According to the U.S. Energy Information Administration, the use of renewable energy sources has increased by 87% in only ten years. In 2018, renewable energy sources provided nearly 20% of US electricity needs with solar power fulfilling 2% of this group[8] (Figure 3 & Figure 4). Furthermore, large centralized power plants owned by large utility companies which used to monopolize electricity generation are now competing with solar farms and homeowners who are independently generating energy. Understanding sources of energy and changes in the energy sector helps the real estate industry to react accordingly and improve client satisfaction.

[7] Source: US Energy Information Administration, Monthly Energy Review, March 2019

[8] https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php

Energy Source	2008 (Billion kW)	2018 (Billion kW)	Change (Billion kW - %)
Coal	1,986	1,146	-840 (-42%)
Natural Gas	883	1,468	585 (66%)
Nuclear	806	807	1 (0%)
Renewable Energy	381	713	332 (87%)
Petroleum and Other	63	44	-19 (-30%)

Figure 4- US Electricity Generation by Source 2008 Vs. 2018

1.3 GROWTH IN THE SOLAR INDUSTRY

The revolution of energy sources continues to shape the global market for solar PV. With an increasing demand for solar energy, the global market for annual PV installations has crossed the 100 GW milestone. In 2019, the PV market has generated $154.3 billion and added 124.6 GW in capacity.[9] New PV markets are opening around the world as installation prices fall, and financing sources are becoming more accessible. China, with a 35% market share, has dominated the global market for SPV (Figure 5).

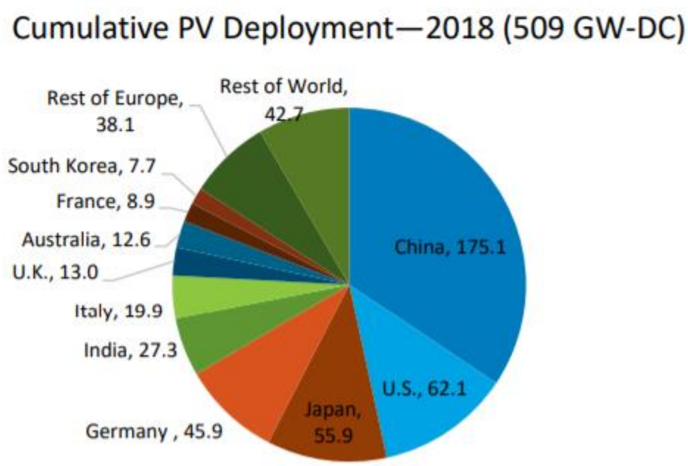


Figure 5- PV Global Market Share by Country[10]

The United States, as the second-largest solar market globally, reached 69.1 GW of total installed capacity in 2019, enough to power 13.1 million American homes. More than 15 GW of PV capacity is being installed annually, and the total installed U.S. PV capacity is expected to double in the next five years.[11] Solar PV has become one of the most popular new electricity generating sources and accounted as the source of 36% of all additional energy generation in the first half of 2019.[12]

The adaptation of solar PV varies between states. California has dominated the U.S. solar market traditionally (Figure 6), but with solar becoming more attainable over the last decade, new states have joined the race. According to the Solar Energy Industry Association (SEIA), twenty-five percent of new additions in 2018 were located in states other than the top ten.

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[9] Source: Navigant Research
[10] Source: Solar Power Europe
[11] SEIA U.S. Market Insight, Sep 2018 (https://www.seia.org/us-solar-market-insight)
[12] Source: Wood Mackenzie Power & Renewables, FERC (all other technologies)

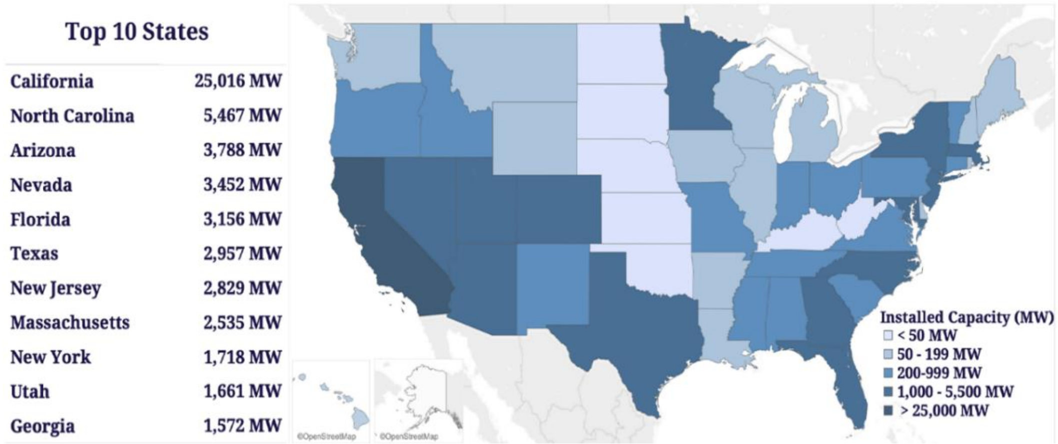

Figure 6- Top 10 States by Installed Capacity-2018 [13]

It has become evident that the world of solar investment will continue to grow. Bloomberg New Energy Finance (BNEF) forecasts that renewables will account for around 65% of an estimated US $13.3 trillion investment in all forms of energy generation between now and 2050[14]. Over the same period, PV is expected to jump from 2% of installed global generation capacity to around 26% — more than any other energy source.

One of the primary reasons in which the solar industry is growing so fast is due to its significant cost reduction for installation. The National Renewable Energy Laboratory (NREL) benchmarks US PV system costs. Per NREL's 2018 report, the average cost of PV panels has dropped by nearly 50% in the past five years. Figure 7 shows the historical and current pricing levels for different sized systems. In addition, today's panels are much more efficient than just a decade ago.

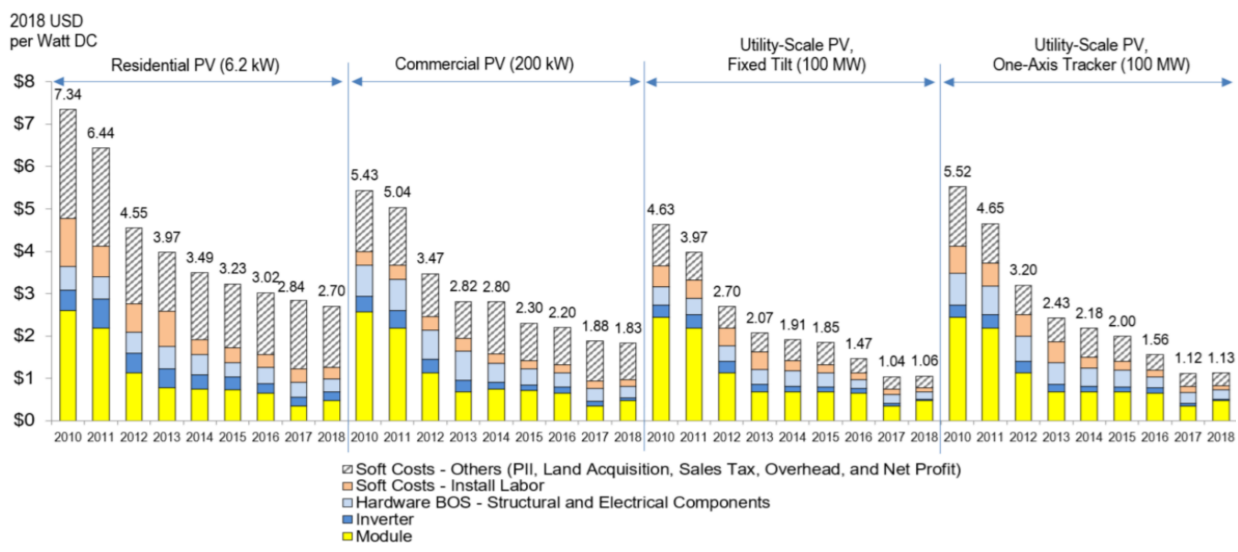

Figure 7- Total Installed Cost-Inflation Adjusted[15]

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13 Source: Wood Mackenzie Power and Renewables Research
14 Source: Bloomberg New Energy Finance Report
15 Source: NREL PV Cost Benchmark: Q1 2018

1.4 SOLAR IN COMMERCIAL REAL ESTATE AND MULTI-FAMILY SECTOR

Large capital investments in renewable energy and grid parity have increased the number of utility-scale and residential solar projects significantly. However, it is interesting to note that commercial and industrial (C&I) property owners have been slow to adapt to solar energy. A report published by Berkeley Lab published in September 2019 revealed that most states have commercial PV penetration of less than 0.5%. Only five states (CA, MA, NM, NJ, NV) plus DC have commercial PV penetrations over 1.5%. Among all property types, commercial housing, and retail, have had the least PV penetration (Figure 8*).* [16]

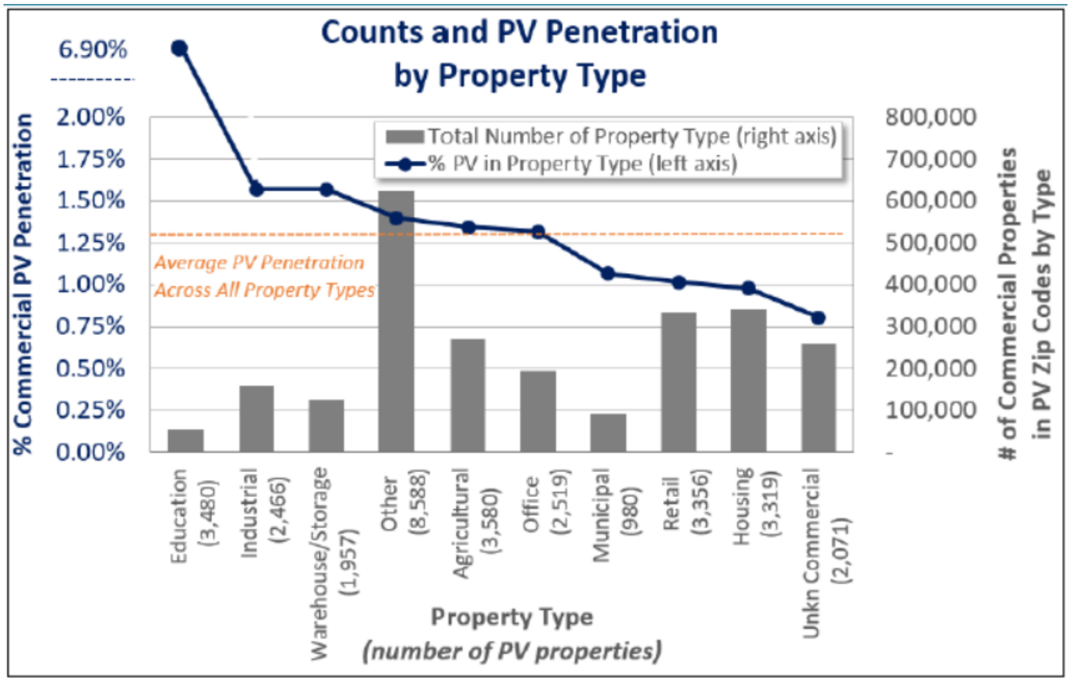

Figure 8- Count and PV Penetration by Property Type[17]

To date, C&I solar has been predominantly deployed at, or procured by Fortune 500 headquarters and retail outlets. However, large real estate developers such as Prologis, General Growth Properties, and Hartz Mountain have also been actively installing solar (Figure 9).

With rising utility costs together with state and federal incentives, solar panels are becoming even more desirable, so much that they can be viewed as a standalone investment or a new line of business. Prologis, the world's largest owner, operator, and developer of industrial real estate, developed a line of business designing, developing, and constructing rooftop solar projects on its properties. A separate entity typically owns the US-based Prologis projects in order to take advantage of tax incentives. These companies pay Prologis rental income to lease the rooftop and sell nearly all of their solar-generated electricity to the grid.[18]

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[16]Commercial PV Property Characterization (September 2019): https://escholarship.org/content/qt4wt0p3nk/qt4wt0p3nk.pdf?t=pyfnli&nosplash=5a77eecb3e86bdc7235ec731ad540818

[17] Source: Commercial PV Property Characterization by Lawrence Berkeley National Laboratory

[18] Source: https://americas.uli.org/uli-connect/solar-energy-commercial-real-estate-navigating-opportunities-risks/

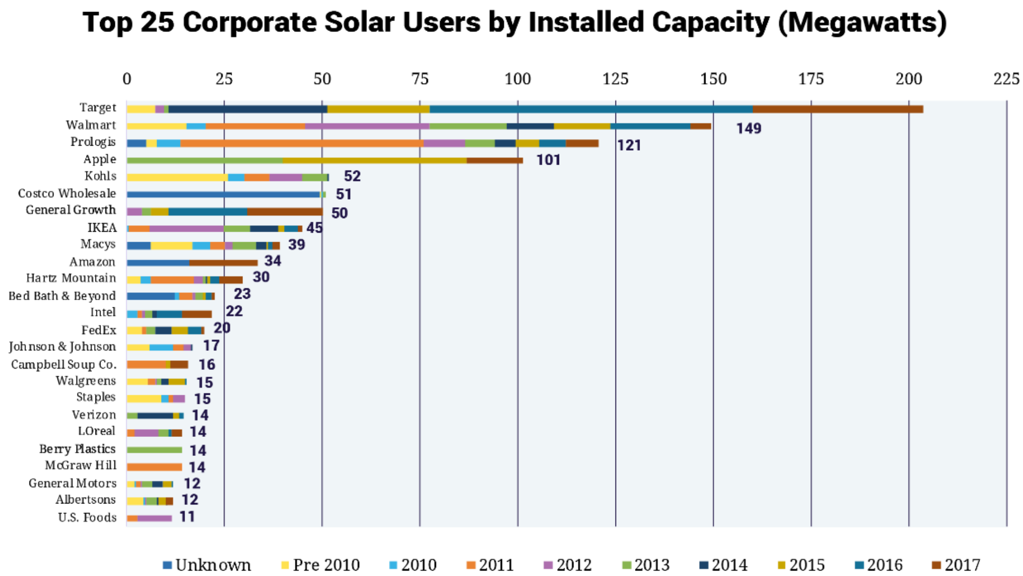

Figure 9- SEIA 2018 Top 25 Corporate Solar Users

Multi-family Sector:

In the U.S., nearly $19 million households or 39 million residents [19] live in 684,000 properties of 5+ units multi-family housing.[20] Given the large number of multi-family properties, high percentage of renters nationwide, and low PV penetration, a significant untapped opportunity exists.

The use of solar energy at multi-family properties is relatively new, and few owners and developers have extensive experience with it, but there are many benefits to explore these new grounds. One of the residential developers that has been a frontier in bringing solar and green energy to their developments is AMLI Residential. In an unprecedented move, AMLI equipped all its Houston and Dallas-area communities with rooftop solar panels. The energy generated by solar is intended to satisfy a portion of the energy needs in their amenity and common areas. [21]

The primary benefit of solar on multifamily properties is reducing operational costs. Through solar, multifamily sites can produce their energy, offsetting costs from the more expensive electricity purchased from the utility provider. These savings are used to repay solar investments and are typically paid back within a few years. Once the upfront investment has been recovered, multifamily properties would have essentially secured free energy for decades.

[19] Source: 2017 American Community Survey, 1-Year Estimates, US Census Bureau. Updated 9/2018
[20] https://www.nmhc.org/research-insight/quick-facts-figures/quick-facts-apartment-stock/
[21] https://www.amli.com/blog/amli-brings-solar-clean-green-energy-dallas

1.5 STATE AND MUNICIPAL REGULATIONS AND EFFORTS IN PROMOTION OF RENEWABLE ENERGY

1.5.1 Overview of Massachusetts Efforts

In 2019, the State of Massachusetts was named the most energy-efficient state in the nation by the American Council for Energy-Efficient Economy (ACEEE) for the ninth consecutive year[22]. Part of Massachusetts's success is due to its regulations and efforts in promoting renewable energy sources. Massachusetts, similar to some other states, implemented enforceable goals to replace some of its energy sources and required utility companies to purchase electricity from renewable energy producers. In April of 2016, The Massachusetts Division of Energy Resources (DOER) designed a new solar incentive program known as SMART (Solar Massachusetts Renewable Target). This 1600 MW, declining block program, poses a tariff-based incentive to be paid directly by the utility company to the system owners who generate energy from renewable sources. All three investor-owned utility companies in Massachusetts, Eversource, National Grid, and Unitil are participating in the SMART program.

<u>2019 Massachusetts Solar Facts</u>[23]

- Solar Installed: 2,566.8 MW (320.6 MW installed in 2018)
- National Ranking: 8th (10th in 2018)
- Enough Solar Installed to Power: 434,000 homes
- Percentage of State's Electricity from Solar: 11.81%
- Solar Jobs and Ranking: 10,210 (3rd in 2018)
- Solar Companies in State: 539 companies total; 87 Manufacturers, 203 Installers, 249 Others
- Total Solar Investment in State: $6.58 billion ($631.54 million in 2018)
- Price Declines: 32% in the last five years
- Growth Projections and Ranking: 1,530 MW over the next five years (ranks 14th)

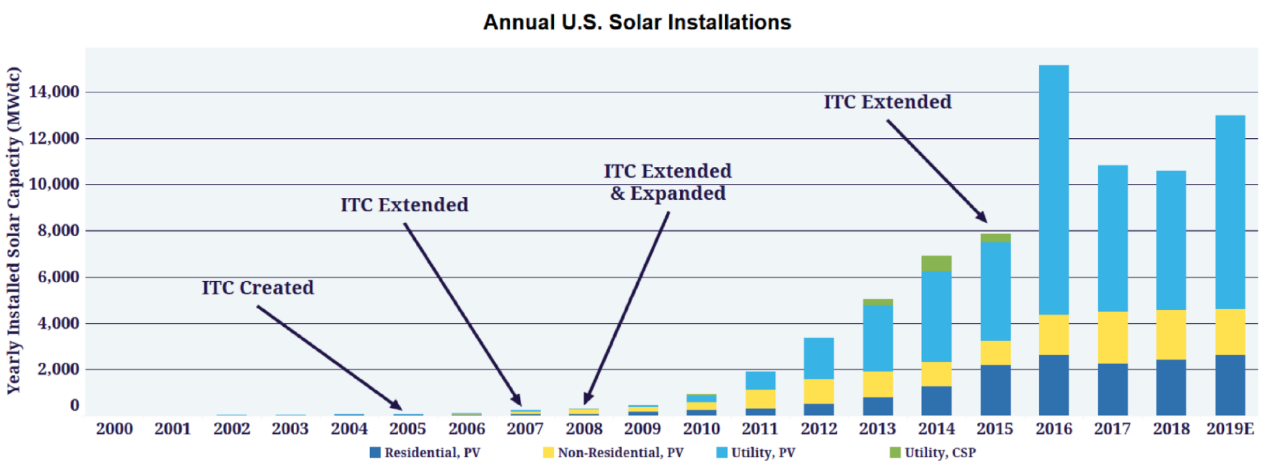

Figure 10 – MA Annual Solar Installations[24]

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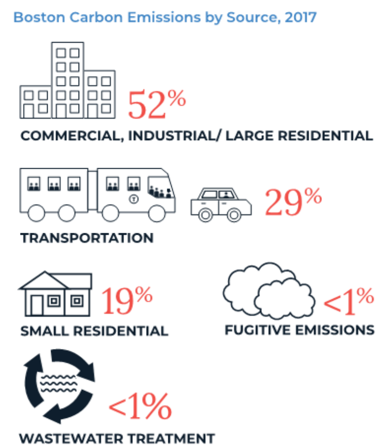
22 https://www.mass.gov/news/massachusetts-named-most-energy-efficient-state-in-nation-0
23 https://www.seia.org/sites/default/files/2019-09/Factsheet_Massachusetts.pdf
24 Source: https://www.seia.org/state-solar-policy/massachusetts-solar

1.5.2 Overview of City of Boston Efforts

The city of Boston has been a frontier in implementing new programs and policies in the state. To better understand the local market and future policies in other Massachusetts cities and towns, it is essential to study Boston.

In 2007, the City of Boston began releasing a Climate Action Plan with goals to reduce emissions and strategies to prepare for the impacts of climate change. In April 2013, the City enacted the Building Energy Reporting and Disclosure Ordinance (BERDO).[25] BERDO requires all commercial and residential buildings larger than 35,000 sqft or over 35 units to report their energy and water use to the city annually. BERDO covers over 2,200 buildings, and the compliance rate reached 90 percent of total square footage by 2018. The reporting provided the city with a tool to measure and analyze the sources of carbon emissions. The data, along with the successful implementation of other policies, enabled the city to increase its emissions reduction goal in 2017 to achieve carbon neutrality by 2050 with an interim carbon reduction goal of 50 percent by 2030. Becoming carbon-neutral means that by 2050, Boston will release no net carbon emissions into the atmosphere. The Carbon-Free Boston analysis[26] concluded that in order to reach carbon neutrality, Boston must:



(1) Reduce demand for energy by increasing efficiency;
(2) Convert nearly all fossil-fueled engines to run on electricity; and
(3) Buy 100 percent carbon-free electricity.

The analysis concluded that a number of essential steps are required, which include adopting a Zero Net Carbon (ZNC) standard for new construction by 2030 and retrofitting and electrifying at least 80% of existing buildings. A ZNC building is a low-energy fossil-fuel-free building that meets its annual energy needs from a mix of on- and off-site renewable energy assets. In order to reach carbon neutrality in existing buildings, four out of five buildings in Boston will need to implement deep energy retrofits and electrification by 2050.

Currently, all new constructions subject to Article 80 Large Project Review (generally 50,000 square feet and over) are required under Article 37 of the Boston Zoning Code to meet minimum sustainability standards. The Article 37 review process also includes a sustainability narrative, a climate change resiliency checklist, and coordination with the Smart Utilities Policy. In 2011, the city adopted the Massachusetts Stretch Energy Code, which sets higher building energy efficiency and performance standards above the state's Base Building Energy Code. In 2019, a new energy advisory committee was selected to introduce net-zero energy provisions into the energy code. A Zero Net Energy (ZNE) building is a low-energy building that meets all its annual energy needs with on-site renewable energy. ZNE buildings are typically connected to the electric grid. Some buildings are even energy-positive and feed surplus energy to the grid.

These changes are a clear indication to developers and property owners that significant upgrades to energy efficiency requirements, and the use of alternative energy sources will be popularized in the near future.

[25] https://data.boston.gov/dataset/building-energy-reporting-and-disclosure-ordinance
[26] https://www.boston.gov/environment-and-energy/reducing-emissions

1.5.3 Overview of other Towns and Municipalities Efforts:

Many other Massachusetts towns and municipalities have also implemented similar forward-looking regulations. In late 2018, Watertown became the first town in New England to require solar panels on new commercial constructions. Watertown, in the midst of a development and redevelopment boom, decided that the new developments presented an opportunity to boost solar power generation. Hence an ordinance has been implemented to require all new commercial buildings larger than 10,000 sqft to install solar panels.

Other cities, such as Cambridge are evaluating similar initiatives. In December 2013, Cambridge created the “Getting to Net Zero Task Force” charged with advancing policies to achieve a “net-zero community,” with a focus on carbon emissions from building operations. The city of Cambridge has implemented similar strategies and provides incentives for alternative sources of electricity generation to businesses and residents.

2 ASSESSING BENEFITS OF SOLAR ENERGY FOR MULTI-FAMILY DEVELOPMENTS

Solar benefits can be categorized into (3) groups:

1. Benefits to the property owners or developers
2. Benefits to the grid
3. Benefits to society

The value of solar energy is beyond its realized economic benefits. Benefits from utilizing solar energy can be tangible and non-tangible, with its non-tangible benefits being more challenging to measure objectively. The risen global awareness for using greener energy sources has stimulated research interests to quantify non-tangible solar benefits. Acadia Center, a research center focused on advancing a clean energy future, published a white paper on the true value of solar.[27] The paper studied the grid and societal benefits of six marginal solar PV systems and concluded that the value of the solar ranges from 22-28 cents/kWh, with an additional societal value of 6.7 cents/kWh (Figure 11)

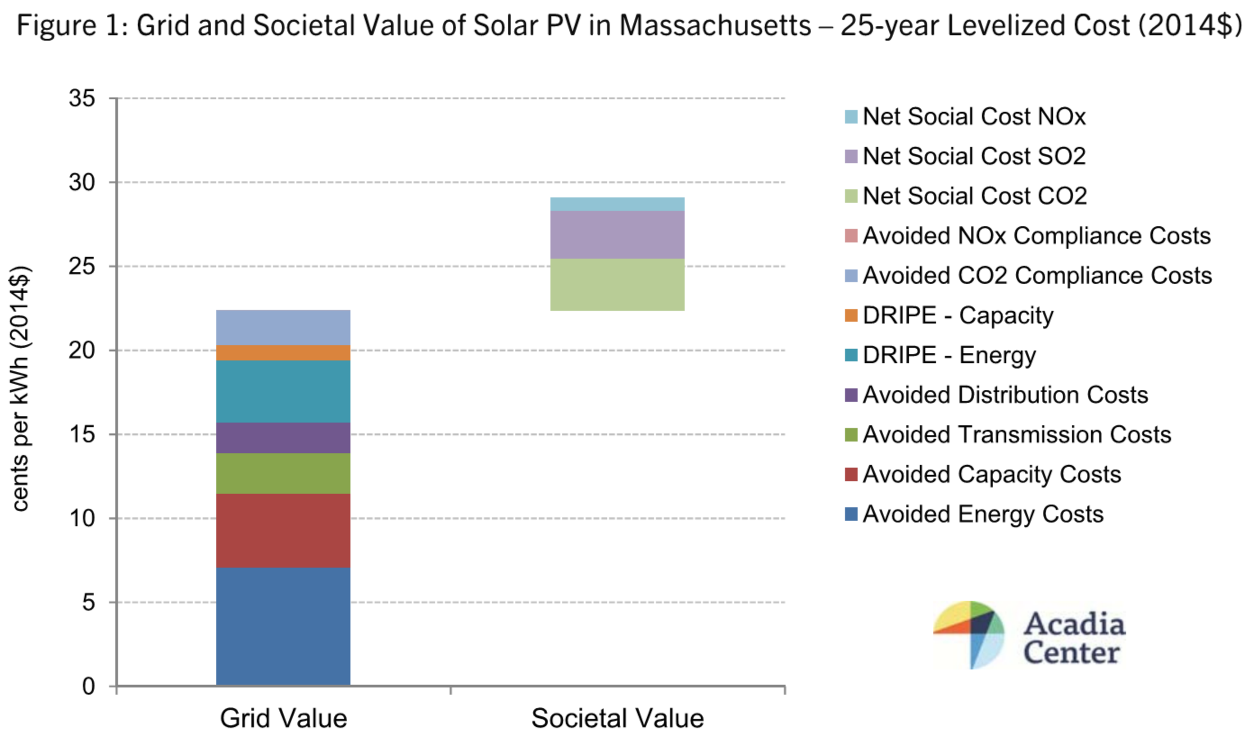


Figure 11- Total value of Solar [28,29]

Multi-family developers need to consider the total value of solar, as their decisions to adopt solar energy have a direct influence on the life of their residents. In the following sections, we will study some of these benefits:

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[27] https://acadiacenter.org/document/value-of-solar-massachusetts/
[28] Source: Acadia Center
[29] **DRIPE:** demand reduction induced price effects

2.1 FINANCIAL BENEFITS

The financial value of a solar PV system is derived from the ability to either offset energy and demand charges with a cheaper alternative or additional income through generating and selling energy to the Grid. Two components drive the return from a PV system – the total amount of electricity produced and the net value of that production. Since electricity is measured by kilowatt-hours (kWh), the value of a solar installation is dictated by the amount of kWh produced and their value after expenses. To be able to measure solar PV against different investments, these three metrics have been standardized in the commercial solar market:

- Payback Period: Measures how long it will take to recoup the initial investment. Payback from a directly owned system would consider the reduction in utility bills or additional income, tax credits, and other incentives. Therefore, historical and current electricity pricing should be reviewed when calculating the potential benefits of a solar PV installation.

- Levelized Cost of Electricity (LCOE): LCOE captures the life cycle costs and lifetime energy production. For LCOE calculation, the net system cost and total power generation over the life of the system need to be discounted to the present value. The net cost includes O&M, insurance, and financing costs. Incentives such as tax credits and depreciation need to be included in the calculations.

- Internal Rate of Return (IRR): IRR will allow us to compare investment returns in solar with other investments. The total cost of ownership, maintenance, monitoring, insurance, and any other applicable factors will need to be included in IRR calculations; IRR can be calculated levered or un-levered.

Solar financial benefits are realized in two ways: (1) Increased net operating income (NOI) (2) Increased property value:

2.1.1 Increased Net Operating Income

PV systems allow commercial building owners to become energy generators instead of energy users. The generated energy can be monetized in several ways. Owners have the flexibility to size their system to meet different demands. At multifamily sites, both rooftop and parking areas provide an opportunity for solar panel placements. Income categories are as follows:

1) Avoided energy cost from offsetting usage; the resulting savings reduce building operating expenses and increase NOI,
2) Additional income from the lease of roof area to 3rd party solar developers
3) Incentive payments received from utility companies (SMART incentives)

2.1.2 Increased Property Value

Little academic research has been conducted over the years across the U.S regarding the solar impact on commercial property valuation. However, the U.S. Department of Energy's Lawrence Berkeley Lab performed a series of analyses of the price premium on single-family homes with host-owned solar PV energy systems. The thesis concluded that home buyers are consistently willing to pay a premium for PV homes across various states. Average premiums from all studied cases equate to approximately $4 per Watt premium or $15,000 for an average-sized 3.6-kW PV system. [30]

Although such data does not exist for multi-family properties, there are studies on "high-performance" commercial buildings that are relevant to our study. By definition, "high-performance" buildings have several unique characteristics, and adding a solar component by itself does not qualify the building as "high-performance". Nonetheless, these buildings have similarities that are notable: lower operations cost, better protection against energy prices, a higher level of sustainability, and being more environment-friendly. A report published by the Institute for Market Transformation (IMT) and Appraisals Institute (AI), shed light on the value of high-performance buildings for lenders. This report identified four components of value—revenue, occupancy, operating expenses, and risk. It suggested that "high-performance" buildings perform better in all four categories and therefore, must be valued higher in addition to enjoying lower cap rates. [31] This equation demonstrates the connection between the four components of value identified:

Gross Revenue	*Higher rents*
- **Vacancy**	*Lower vacancy vs. market*
= Effective Revenue	*Revenue up*
- **OPEX**	*Lower utility bills, maintenance, reserves*
= Net Operating Income (NOI)	*NOI up*
NOI/Cap Rate = Value	*Lower cap rate*

Considering the result of these researches and the additional income that the property generates, one can argue that solar equipped multi-family properties should trade for a higher value in the market. The increased value should depend on the size of the system, age of the system, value of future cash flows, and many other factors.

2.2 Energy Independence and Resiliency

Investing in a PV system is, in a way, hedging against future energy prices. Electricity production from solar will replace the energy that otherwise will be purchased from a utility. Unlike conventional sources of electricity, solar sources do not rely on volatile energy supplies such as natural gas and coal. Besides, solar modules are durable, reliable, and require minimal maintenance costs. Instead of relying on utility power, solar provides a predictable and stable electricity source for the lifetime of the system (25+ years). When combined with storage, an electricity supply is no longer completely reliant on vast infrastructure nor fuel supplies that can be disrupted for different geographic or political events.

Although it is difficult to predict future electrical rates, historical data from the Bureau of Labor Statistics showed that the electricity rate for urban customers in Boston-Cambridge-Newton MSA has increased by 46% from 2009 to 2018, equating to an average year-over-year increase of 4% (Figure 12). In addition to reliability, adding solar PV to a roof will reduce the building's cooling

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[30] Selling into the Sun: Price premium analysis of a multi-state dataset of solar homes (2015)

[31] High-performance buildings and property value https://www.imt.org/wp-content/uploads/2018/02/LenderGuide_FINAL.pdf

load. Furthermore, solar canopies also provide shading. Both of these configurations reduce the urban heat island effect.

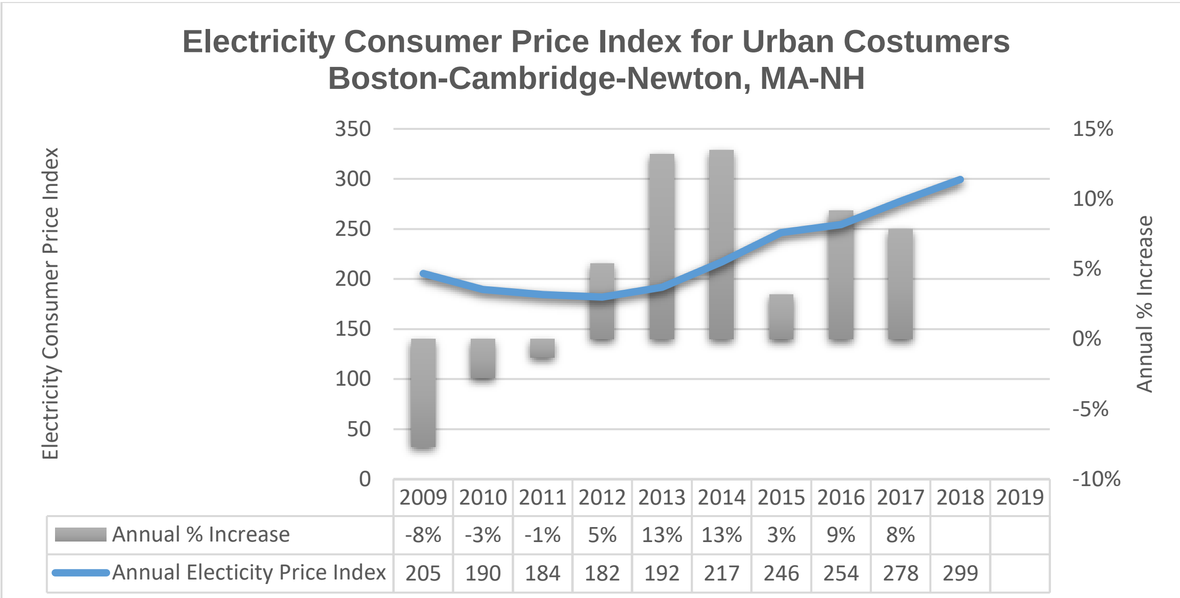


Figure 12 – Electricity consumer price index in Boston-Cambridge-Newton, MA-NH [32]

2.3 Carbon Emissions Reduction

In addition to gaining economic values, the usage of solar energy plays a pivotal role in achieving a greener environment. Solar technology generates electricity without the combustion of fossil fuels; thus, it does not emit greenhouse gases (GHGs) and other pollutants into the atmosphere. This method of energy generation not only contributes to the global climate change mitigation but also results in an improvement in local air quality and public health. When considering a lifecycle analysis of PV systems, carbon emissions are much lower than conventional forms of electricity, such as natural gas, oil, or coal. Research published in Nature Energy Magazine discovered that 78–110 grams of CO2 per kWh is emitted from every kilowatt-hour of electricity generated from fossil fuel carbon capture and sequestration plants, which is comparatively higher than 6 grams of CO2 per kWh produced from solar power.

2.4 Green Energy Curb Appeal

With the increase of public awareness and concerns surrounding climate change, the significance of green initiatives has been highlighted for both renters and investors. NHMC/Kingsley recently published their 2020 National Apartment Resident Preference report, which surveyed 370,000 apartment renters around the US. When residents were asked to indicate their interest level in sustainability/ green Initiatives in their community, 73% of residents indicated a high level of interest. Residents were also asked to indicate their interest level in having on-site renewable energy in their community, whereby 63% of residents indicated a high level of interest and expected an additional rent of $30.01 per month for this amenity. These numbers were respectively 65% and 55% back in 2017. It is important to note that these features ranked even

[32] Source: Bureau of Labor Statistics

higher than some of the top-rated resident amenities such as clubhouse/party room, dog park, and rooftop space.

AMLI residential in their 2019 National Sustainable Living Index Survey reported eighty percent (80%) of respondents believe “living in a green apartment is beneficial to their health,” with younger residents being more likely to report a supposed benefit than older residents. [33]

Solar PV is a highly visible asset with several marketing benefits; for corporate or organizational with sustainability goals, solar PV will help meet targets. For property leasing, solar will give the property marketing edge and attracts residents who include sustainability and green initiatives in their decision making.

2.5 Attracting Impact Investors

Many real estate funds have mandates to place a portion of their funds in investments that generate financial returns but also create positive, measurable social, and environmental impact. There are numerous strategies within real estate impact investing, including green real estate, affordable housing, and sustainable communities. Environmental impact can be attained by improving energy efficiency, using renewable energy sources, improving water efficiency, reducing waste, and many other measures. One of the many available benefits to commercial properties from on-site renewable energy sources is attracting fund managers and investors who are looking for assets that meet such requirements.

2.6 Economic Development and Job Creation

Solar deployment has a positive impact on property owners through direct financial benefits, as well as the local community by providing economic stimulus through industry development and job creation. Solar development jobs are high-quality jobs that foster local participation in this growing market.

California created 75,000 solar jobs in 2015 (36% of total solar jobs nationwide). The number of solar jobs in the US grew 123% between 2010 and 2015 and is expected to continue rising as installation capacity increases. [34]Besides, the median wage of U.S. solar installers in 2014 was almost three dollars an hour higher than the U.S. average median wage. The opportunity for high-quality employment combined with lower utility bills provides both economic and social benefits for the whole community.

2.7 Benefits to the Grid

In addition to other benefits listed above, there are benefits and cost savings to both private owners and municipalities from alternative sources of energy. A handful of these benefits are identified in Figure 13:

[33] https://www.businesswire.com/news/home/20190807005608/en/AMLI-Residential-Releases-Results-2019-Sustainable-Living

[34] http://www.cleanenergyroadmap.com/wp-content/uploads/2016/11/SER-Multifamily-Solar-Master-Planning-.pdf

Solar – Grid Benefits[35]		
Grid	Energy	Avoided electricity generation
		Reduced line losses
		Market price response
	Capacity and Grid Investments	Avoided capacity investment
		Avoided transmission and distribution investment
		Reduced need for grid support services
	Risk and Reliability Benefits	Reduced exposure to price volatility
		Improved grid resiliency and reliability
	Compliance	Reduced environmental compliance costs

Figure 13 – Solar – Grid Benefits

35 [1] Based on a number of studies, including The true value of solar by Gideon Weissman, ICF, Review of Recent Cost-Benefit Studies Related to Net Metering and Distributed Solar, https://www.icf.com/blog/energy/value-solar-studies; and Rocky Mountain Institute, A Review of Solar PV Benefit and Cost Studies 2nd Edition, September 2013, archived at https://web.archive.org/web/20190614151829/https://rmi.org/wpcontent/uploads/2017/05/RMI_Document_Repository_Public-Reprts_eLab-DER-Beneft-CostDeck_2nd_Edition131015.pdf.

3 SOLAR INCENTIVES

Developing a PV project requires significant upfront capital investment. To encourage the development of solar projects, government agencies and utilities offer various incentives, such as loans, tax credits, deductions, net metering, grants, as well as rebates, to offset the initial investment. The nature of incentive programs varies depending on the location (state and utility) and type of the project. For example, different incentives apply to businesses and residences. Despite the rapidly declining costs of solar systems, incentives are still a crucial part of the cost-effectiveness of a project and can maximize the return from the investment.

Four primary sources of incentives are federal, state, local government, and utility companies. Each has a different purpose behind providing incentives, from supporting energy independence and environmental responsibility (federal) to reducing grid capacity costs and demand (state and utility), but all believe renewable energy and energy efficiency merit financial support. Incentives are typically targeted, yet dynamic to encourage investments in the areas that are deemed most beneficial to all stakeholders.

Some of the most beneficial incentives for multi-family owners are Federal ITC, accelerated depreciation, net metering, and Massachusetts SMART program:

3.1 FEDERAL

In addition to some special loan programs, Figure 14 demonstrates a list of federal incentives that apply to commercial customers:

Name	Territory	Category	Policy/Incentive Type
Business Energy Investment Tax Credit (ITC)	US	Financial Incentive	Corporate Tax Credit
Modified Accelerated Cost-Recovery System (MACRS)	US	Financial Incentive	Corporate Depreciation
Low-Income Housing Tax Credits (LIHTC)	US	Financial Incentive	Corporate Tax Credit

Figure 14 - Summary of Solar Federal Incentives for Commercial Properties

3.1.1 Federal Business Energy Investment Tax Credit (ITC)

ITC is perhaps the most significant renewable energy incentive in the country. The federal ITC program offers a dollar-for-dollar tax credit for eligible (construction and equipment) project costs towards the business's federal tax liability.

ITC benefits also apply to the cost of all the enabling work for solar projects such as tree removal and roof preparation. For the PV projects, the tax credit amount is currently set at 26% of the eligible cost and will gradually decline to 10 percent, as shown in Figure 15.[36]

[36] For additional information, download the Department of the Treasury Internal Revenue Service (IRS) Form 3468 instructions at www.irs.gov/pub/irs-pdf/i3468.pdf

Type of energy property	Date construction begins	Date placed in service	ITC percentage
Solar PV	Before 1/1/20	Before 1/1/24	30%
	1/1/20 – 12/31/20	Before 1/1/24	26%
	1/1/21 – 12/31/21	Before 1/1/24	22%
	Before 1/1/22	On or after 1/1/24	10%
	On or after 1/1/22	Any	10%

Figure 15 - ITC Incentive Schedule

In order to qualify for this credit, the owner needs to maintain ownership of the system for at least five years from installation. According to IRS instructions on Section 48 of energy investment tax credit, if the investment credit property gets disposed of before the end of five full years after the property was placed in service, the tax credit would need to be fully or partially recaptured. To clarify its regulations, the IRS released a Notice (2018-59), providing guidance on the commensal of eligible energy property construction for purposes of determining the ITC. Per IRS instructions, two methods are provided for taxpayers to determine the beginning of construction: (1) 'Physical Work Test' (2) 'Five Percent Safe Harbor.' Construction is considered initiated as soon as a taxpayer has satisfied either one of the two different methods. As long as the continuity of work or effort is maintained, the requirement for the 'Physical Work Test' is met. Under 'Five Percent Safe Harbor,' the owner is required to show proof of 5% expenditure related to the solar project. This requirement can easily be satisfied with a down payment to the vendor at the start of system design and procurement.

3.1.2 MACRS Bonus Accelerated Depreciation

Similar to any other physical asset or equipment, investments in a PV solar system can be depreciated to reduce taxable income. PV owners are eligible to depreciate the value of their systems using the Modified Accelerated Cost Recovery System (MACRS) deduction method over a 5-year recovery period.

Under MACRS Bonus accelerated depreciation and as a result of the Tax Cuts and Jobs Act, solar owners can depreciate 100% of the cost of their system in year one as long as the physical properties were acquired and placed in service after September 27, 2017, and before January 1, 2023. Depending on the entity's effective tax rate, MACRS can provide another significant tax shield to businesses. Figure 16 shows how a business owner with an effective tax rate of 27% can get 23% of the system cost in tax benefit under MACRS. The bonus accelerated program allows this amount to be used in year 1:

System Cost	*600,000*
Depreciable Amount after ITC	*87%*
Assumed Tax Rate	*27%*

Year	% Depreciation	Depreciated amount	Tax deduction	
1	20.00%	$ 104,400	$ 28,188	
2	32.00%	$ 167,040	$ 45,101	
3	19.20%	$ 100,224	$ 27,060	
4	11.52%	$ 60,134	$ 16,236	
5	11.50%	$ 60,030	$ 16,208	
6	5.80%	$ 30,276	$ 8,175	
		$ 522,104	**$ 140,968**	23%

Figure 16 - Example of MACRS Benefits Calculation

3.1.3 Low-Income Housing Tax Credits (LIHTC)

LIHTC offers a dollar-for-dollar tax rebate for private investment in new low-income affordable housing. State regulators usually administer this federal rebate and it is available for for-profit or non-profit developers who invest in affordable housing projects. Affordable developers can include renewable energy systems in their projects and receive a rebate increase equal to the lesser of the net cost of the solar energy system or 5% of the total basis limits.

3.2 STATE OF MASSACHUSETTS

Local governments are equally eager to encourage the usage of greener energy sources. The state of Massachusetts has been promoting renewable energy sources through regulations and incentive programs. Figure 17 provides a list of the most significant incentives for commercial customers.

Name	Territory	Category	Policy/Incentive Type
Renewable Energy Property and Sales Tax Exemption	MA	Financial Incentive	Property Tax Incentive
Net Metering	MA	Regulatory Policy	Net Metering
Solar Massachusetts Renewable Target (SMART) Program	MA	Financial Incentive	Performance-Based Incentive

Figure 17 - Summary of MA Solar Incentives for Commercial Properties

3.2.1 Massachusetts Property and Sales Tax Exemptions

There are two tax exemptions for commercial solar owners in the state of Massachusetts: the sales tax and property tax incentives. Under Massachusetts Sales Tax Law, equipment directly related to solar, wind-power, or heat-pump are tax exempt. Additionally, Massachusetts law provides that solar or wind energy systems used to supply the energy needs of taxable property, are exempt from local property tax for 20 years. This policy allows the adopters of solar systems to complete installations without reassessment of their property tax. Without this tax exclusion, the value of the solar systems would be subjected to increases in property taxes and would likely hinder solar adoptions, rendering them less cost-effective.

3.2.2 Net Metering

In Massachusetts, all utility companies are required to provide net metering for the customers. Net metering allows customers to send energy to the grid when there is an excess generation in exchange for credit against future bills. Because the on-site power production does not necessarily match the consumption on a moment-to-moment basis, net metering provides flexibility for the system owners to avoid losing the excess generation, which is especially important for locations with seasonal weather differences. Each electric bill clearly outlines the amount of electricity used and the electricity produced. If there is a net excess generation, the electricity bill displays a dollar credit to offset future charges. All solar net metering facilities will generate market net metering credits for 25 years once the system has been approved and interconnected to the grid.
There are two types of net metering:

- Regular net metering: where a single account co-located with the solar system, has net metering credits applied to it.
- Virtual net metering: where a portion or all the credits from solar is applied to other electric accounts. In commercial properties, this allows multiple tenants to participate and receive net metering credits. For virtual metering, there are two requirements: (1) the receiving meter is under the same distribution company as the solar system (e.g., National Grid customers can only receive virtual net meter credits from another National account) and (2) the meter is located in the same electricity load zone.

How much credit can the system receive? The amount of net metering credits received depends on whether the system is exempt from the cap and when it was activated. The cap is the maximum amount of solar the utility company is required to purchase from customers. This amount varies by utility companies and is based on whether the system is public or private. For (a) systems exempt from the cap (nameplate rating less than 10 kW on a single-phase circuit or 25 kW on a 3-phase circuit) or (b) solar projects that received a cap allocation before 1/8/17, customers are compensated for 100 percent of the excess energy they produce. For all other facilities with a cap allocation after 1/8/17, customers are only compensated for 60% of excess energy.

How does virtual metering work? To allocate credit to other accounts, a form (Schedule Z) needs to be completed with the account numbers and percentage of allocated generation to each account. This allocation can only be modified twice per year.

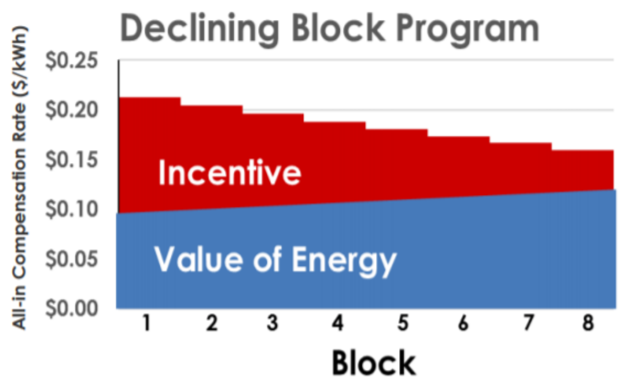
How do the credits get calculated? The utility company calculates credits by multiplying 60% of the excess energy produced by the local basic service charge, distribution charge, transmission charge, and the transition charge, all on a per unit of energy basis (kWh). It does not cover the fixed customer service charge and additional mandatory funds or demand charges. Credits appear on the bill as a dollar amount, not a kilowatt amount, at the host's customer rate.

What if the cap is reached? Once the cap is reached, the excess on-site generation can be sold to the grid as a Qualifying Facility (QF) at the hourly wholesale clearing rate. The wholesale rate is significantly lower than the retail rate (ISO-NE September peak rate: $0.0032). [37]

3.2.3 Solar Massachusetts Renewable Target (SMART) Program

Massachusetts's latest incentive program was designed in 2016, replacing all the previous programs. The SMART program presents a new approach for solar customers to receive financial incentives from the state. The program went into effect on November 26, 2018, and is targeting an addition of 1,600 megawatts (MW) alternating current (AC) in the state. SMART is a feed-in tariff program; commercial participants receive fixed per-kilowatt-hour (kWh) incentive compensation for 20 years from utility companies.

[37] Per US energy information administration (EIA), https://www.eia.gov/electricity/monthly/update/wholesale_markets.php#tabs_wh_price-1



As deployment proceeds through the 1,600MW target, the incentive for new participants is set to decline. The program was designed to provide a robust financial signal for early adopters, with reduced incentives as the cost of solar relative gets closer to the retail utility rates.

Figure 18- SMART Declining Block Program [38]

Under SMART, customers receive a monthly payment equal to the amount of electricity their solar facility generates (kWh), multiplied by the amount of the incentive in the assigned block ($/kWh). Block Base Compensation Rates were determined in the initial competitive procurement run in late 2017 and are available for any solar PV system that is 5 MW AC or smaller. The compensation is comprised of a base rate that is determined by the available block and size of the system and an adder that is project-specific. For example, solar built on landfills or project providing electricity to low-income customers, receive extra credits. Also, the use of storage batteries with solar facilities is treated favorably.

Four types of Compensation Rate Adders and one Rate Subtractor are available to eligible facilities:[39]

Rate Subtractor: Greenfield $0.00005/kWh per Acre occupied by solar development.

Rate Adder:

Adder Type	Generation Unit Type
Location-Based	Building Mounted Solar Tariff Generation Unit
	Floating Solar Tariff Generation Unit
	Solar Tariff Generation Unit on a Brownfield
	Solar Tariff Generation Unit on an Eligible Landfill
	Canopy Solar Tariff Generation Unit
	Agricultural Solar Tariff Generation Unit
Off-taker Based	Community Shared Solar Tariff Generation Unit
	Low-Income Property Solar Tariff Generation Unit
	Low-Income Community Shared Solar Tariff Generation Unit
	Public Entity Solar Tariff Generation Unit
Energy Storage	Energy Storage Adder
Solar Tracking	Solar Tracking Adder

Figure 19 - SMART Rate adder schedule

38 Source: Green Ribbon Commission
39 Source: SMART Program, https://www.mass.gov/info-details/solar-massachusetts-renewable-target-smart-program

Multiple adders can apply to each project. The purpose behind adders and the rate structure is to provide financial incentives for developers to direct investments in projects that are determined to be more beneficial to the state and utility companies.

Figure 20 – Solar Carport in Southern California [40]

The compensation structure also differs depending on whether the system is behind-the-meter and standalone facilities. Under SMART, there are two metering options: standalone or behind-the-meter systems.

- <u>Standalone facilities:</u> Any facility with zero on-site use.
  - Three types of compensation: Net Metered, Alternative On-bill Credit, and Non-net Metered Solar Tariff Generation Units [41]
  - Incentive payment varies over the life of the project and is equal to all-in compensation rate (base + adders) minus Value of energy (VOE).
  - VOE calculation:
    - Net Metered Unit: The value of the bill credit determined by the system's net metering eligibility and the time it was placed in service. Commercial properties at 60% of the host facility's retail rate.
    - Alternative On-bill Credit Unit: The value of the bill credit determined by the SMART Tariff (currently proposed at the basic rate, also known as the 'supplier'

[40] Source: Multifamilyexecutive.com
[41] More information on DPU Generation units: https://www.mass.gov/info-details/qualifying-facilities-and-on-site-generating-facilities

or ‘generation’ rate. In Massachusetts, this value has fluctuated between $0.08 - $0.14 per kWh[42])

- Non-net Metered Unit: The value of the compensation subject to the utility company’s Qualifying Facility (QF) Tariff. (At the hourly wholesale rate, ISO-NE September peak rate: $0.0032[43])

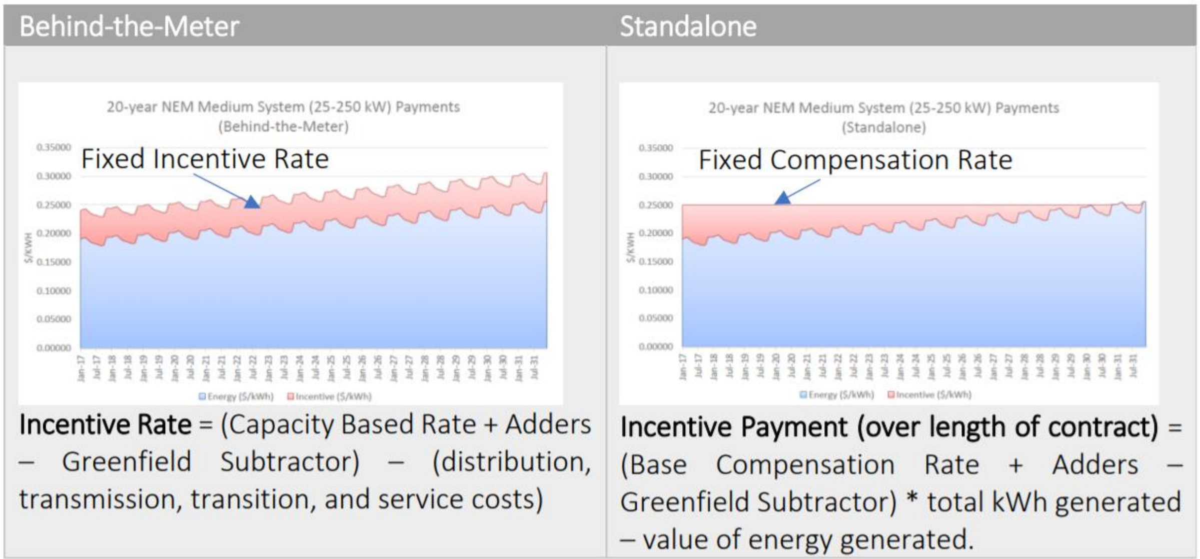


Figure 21 - Incentive Calculation Methodology 44

- <u>Behind-the-Meter (BTM) Facilities:</u> Facilities that do not meet the definition of standalone
  - The incentive payment is fixed for the tariff term and is determined at the time a project is interconnected
  - Facilities may/may not be eligible for net metering, but net metering eligibility has no impact on total compensation rate calculations and the SMART incentive payment
  - VOE: The VOE approximates the avoided costs of electricity from a kWh of on-site load retail cost and is equal to the sum of the following: (from host facility bill and rate class)
    - Current distribution rate
    - Current transmission rate
    - Current transition rate
    - Three-year average basic service rate

42 https://www.suntilityelectric.com/know-your-aobcs-alternative-on-bill-credits-in-massachusetts-smart-solar-program/
43 Per US energy information administration (EIA), https://www.eia.gov/electricity/monthly/update/wholesale_markets.php#tabs_wh_price-1
44 Massachusetts Department of Energy Resources. (2017). Solar Massachusetts Renewable Target (SMART) Final Program Design. Retrieved from http://www.mass.gov/eea/docs/doer/rps-aps/final-program-design-1-31-17.pdf

What is Alternative On-bill Credit (AOBC)? AOBC, similar to net metering, allows the customers to transfer the monetary value of excess generation to other electric accounts. There are a number of operational differences between AOBC and net metering:

(1) The AOBC is only available to standalone facilities, whereas net metering applies to both standalone and BTM facilities.
(2) AOBC is not subject to the caps with projects compensated at the full base rate, while utility companies are permitted to impose net metering caps and projects receive only 60% of net metering compensation rate.
(3) VOE for AOBC customers is not fixed, unlike BTM customers. Instead, the VOE is recalculated monthly, based on the applicable basic service rate. Because the incentive is calculated by subtracting the VOE from the base compensation rate, this results in an adjustable incentive payment. Under net metering, the VOE is established based on an average of the previous three-years' basic service rate (at the time of application), and because electricity rates typically increase over time in nominal terms, the compensation rate might be lower than they would if they were on net metering.
(4) The final difference relates to the locations of the solar facility and the participating customer(s). For AOBC, the customer must only be in the same distribution company service territory, but not necessarily the same utility load zone. For net metering, the customer must be located both (a) in the same distribution company service territory as the solar facility (b) in the same ISO New England load zone.

What is Community Solar? Community solar is when the system owners install a standalone system and allow multiple parties to share the output of a large solar project. Community solar projects are usually established and operated by a third party, typically an energy company.

Customers will sign-up for a subscription with the energy provider and will receive a pre-determined number of kW credits on their electricity bill at a discounted rate. If the credit is enough to offset the entire bill, then the customer will not pay anything to the utility provider. The advantage to the customer is the ability to pre-purchase energy at a discounted rate alongside with the participation and support of solar development, championing for a greener environment.

Figure 22 – The Happy Hollow Solar Farm built on a former gravel pit [45]

Community solar programs are developed on solar farms such as a capped landfill or underutilized farmland and in the utility-scale. Although the management, billing, and customer service for community solar is costly and financially not feasible for multi-family

[45] Source: Solar Industry Mag

developments, it provides an excellent mechanism for multi-family developers to team up with large solar developers on these utility-scale projects, providing low-cost energy to residents. Community solar programs that support low-income properties are compensated generously under the SMART program.

What is a Low-income Facility? In the SMART Program, three types of low-income Generation Units are identified with additional incentives to ensure that low-income residents receive the same level of access to the program as other residents.

1. Low-income Community Shared Solar (CSS) Tariff Generation Unit. A CSS Tariff Generation Unit with at least 50% of its output allocated to low-income customers in the form of direct electricity or net metering credits.
2. Low income Solar Tariff Generation Unit. A small solar program with a generation of less than or equal to 25 kW that serves low-income customers. To qualify for this category, 100% of generated electricity must be provided to low-income customers.
3. Low-income Property Solar Tariff Generation Unit. A large project with a capacity greater than 25 kW that provides all its generation output in the form of direct electricity or net metering credits to low- or moderate-income housing[46]. To qualify for this incentive, two primary qualifications need to be met:

   i. 100% of energy output has to be delivered to low- or moderate-income housing, and
   ii. The property meets low- or moderate-income housing requirements:
      a. at least 25% to be rented to households that are at or below 80% of the Area Median Income (AMI); or
      b. at least 20% to be rented to households that are at or below 50% of the AMI.

Also, the applicant needs to provide proof that deed restrictions will be in place for the above criteria for the duration of the incentives (20 years). [47]

3.2.4 Current Status of SMART program, Net Metering Cap and SMART 2.0

SMART Status: Since the program launch in 2018, 11,300 applications for over 1,000 MW of capacity have been submitted. [48] A large number of projects submitted applications in the first week of the launch and applications progressed unevenly across different service territories. Currently, three out of five service territories (National Grid, Eversource West (WMECo), and Unitil) do not have any capacity for compensation blocks available for the new projects (*Figure 16*).

[46] M.G.L. c. 40T.
[47] SOLAR MASSACHUSETTS RENEWABLE TARGET PROGRAM (225 CMR 20.00) - Guideline Regarding Low Income Generation Units
[48] SMART Program 400 MW Review, 9/5/19

SMART Solar Block Status Update Last Update: 11/8/2019 8:45 AM						
SMALL PROJECTS (<= 25 kW AC) **Electric Distribution Company (EDC)**	**Accepting Applications for Block[1]:**	**Current Block Size (MW)[2]**	**Total Allocated Capacity (MW)[3]**	**Total Pending Capacity (MW)[4]**	**Total Remaining Capacity (MW)[5]**	**Waiting List (MW)[6]**
Eversource MA East	3 of 8	18.303	32.762	6.949	106.718	0.000
Eversource MA West	5 of 8	3.187	13.395	1.471	10.289	0.000
National Grid (Massachusetts Electric)	4 of 8	18.043	53.818	8.203	82.014	0.000
National Grid (Nantucket)	1 of 2	0.604	0.094	0.043	1.071	0.000
Unitil	3 of 4	0.799	1.639	0.066	1.452	0.000
Total			**101.709**	**16.732**	**201.546**	**0.000**
LARGE PROJECTS (>25 kW AC) **Electric Distribution Company (EDC)**	**Accepting Applications for Block[1]:**	**Current Block/Size (MW)[2]**	**Total Allocated Capacity (MW)[3]**	**Total Pending Capacity (MW)[4]**	**Total Remaining Capacity (MW)[5]**	**Waiting List (MW)[6]**
Eversource MA East	3 of 8	73.211	145.244	34.180	406.264	0.000
Eversource MA West	Waitlist	TBD	100.208	56.769	0.000	56.271
National Grid (Massachusetts Electric)	Waitlist	TBD	572.628	34.551	0.000	31.037
National Grid (Nantucket)	1 of 2	2.417	1.000	0.000	3.833	0.000
Unitil	Waitlist	TBD	12.444	10.835	0.000	10.648
Total			**831.523**	**136.335**	**410.097**	**97.956**

Figure 23 – SMART Block Status [49]

Similar to capacity blocks, the net metering cap filled up unevenly. In aggregate across the state, about 16% of total cap capacity is available to customers (Figure 24*)*

Private: Available, Interconnected, Reserved and Pending Capacity (Values in kW)

Company	Net Metering Cap	Interconnected (a)	Reserved Cap Allocations (b)	Pending Cap Allocations (c)	Capacity Available Under Cap (e)	Waiting List (d)
NGrid	359,170	352,348	6,807	0	15	15,994
NStar	348,460	243,273	24,087	651	80,449	0
WMECO	59,780	55,579	4,109	0	92	7,263
Unitil	7,140	7,001	139	0	0	1,580
NGrid-Nantucket	3,500	953	44	0	2,503	0
Total	**778,050**	**659,154**	**35,186**	**651**	**83,059**	**24,836**

Figure 24- Net Metering Status as of 12/20/19 [50]

SMART 2.0: With larger interest and demand than anticipated in some geographic regions, the utility blocks filled up unevenly. DOER launched the 400MW SMART extension review program to address the program oversubscription and make necessary changes to the compensation rates of the original program. The state published its findings in September 2019 and drafted regulations to file an emergency regulation in December 2019 (at this point Q1 2020) with hopes to file a revised tariff program in the second quarter of 2020.[51]

49 Source: http://masmartsolar.com
50 Source: https://app.massaca.org/allocationreport/report.aspx
51 SMART Program 400 MW Review – 9/5/19

Per DOER findings and recommendations and discussion with industry professionals, it is anticipated that an additional capacity of 800 MW with a similar 4% declining block structure will be added to the waitlisted territories. Other noteworthy proposed changes include:

- All generation units larger than 500 kW must be paired with energy storage
- Increase Greenfield subtractor and discourage large ground-mounted projects to diversify project types.
- Encourage projects that have the most geographical value while maintaining location-based adders
- Restructure large building-mounted and canopy system incentives and expand AOBC to BTM systems
- Increase low-income benefits and put in place mechanisms to encourage low-income community shared solar and low-income property systems.

Proposed changes under SMART 2.0 will open new opportunities for multi-family developers to take advantage of SMART incentives. Location-based adders are designed to encourage the use of roof and parking structures. 40B projects meet the requirements of the low-income property category and provide a fantastic opportunity for incorporating solar into these developments.

4 TECHNICAL CONSIDERATIONS

4.1 OWNERSHIP MODELS

There are two primary solar ownership models, direct and third-party ownership.

4.1.1 Direct Ownership

Direct ownership is the most common and economical type of ownership for solar systems. Under this method, the building owner will be responsible for full installation costs and will own the panels throughout the entirety of their shelf life. By 2011, 58% of commercial solar systems were directly owned[52].

Some of the advantages of direct ownership are full control and flexibility, maximizing financial benefits, and the ability to take advantage of government incentives such as the ITC as well as depreciation benefits. Companies that can monetize the tax credits effectively will benefit most from direct ownership. For example, to receive full benefits of ITC, the ownership of investment credit property (solar system) needs to be maintained for five full years after the system was placed in service.

While direct ownership has some key benefits, it does come at the cost of assuming all the financial and operational risks over the life of the system. Some of these risks can be mitigated with the negotiation of production guarantees and extended warranty with the vendors. Most commercial solar companies provide maintenance and monitoring services for a small fee.

4.1.2 Leased or Third-Party Ownership

Property owners have three options under third-party ownership. In all models, a third-party company designs and installs solar panels at the subject property with zero or minimum up-front capital costs to the property owner. They are also responsible for the maintenance and operation of the system:

1. Lease panels and system equipment: Where the property owner pays a fixed monthly payment and gets the right to 100% of the generated electricity.
2. Lease roof space: Where the property owner receives lease payment from the solar developer.
3. Power purchase agreement (PPA): Where the property owner purchases the generated electricity from the solar developer at a discounted rate.

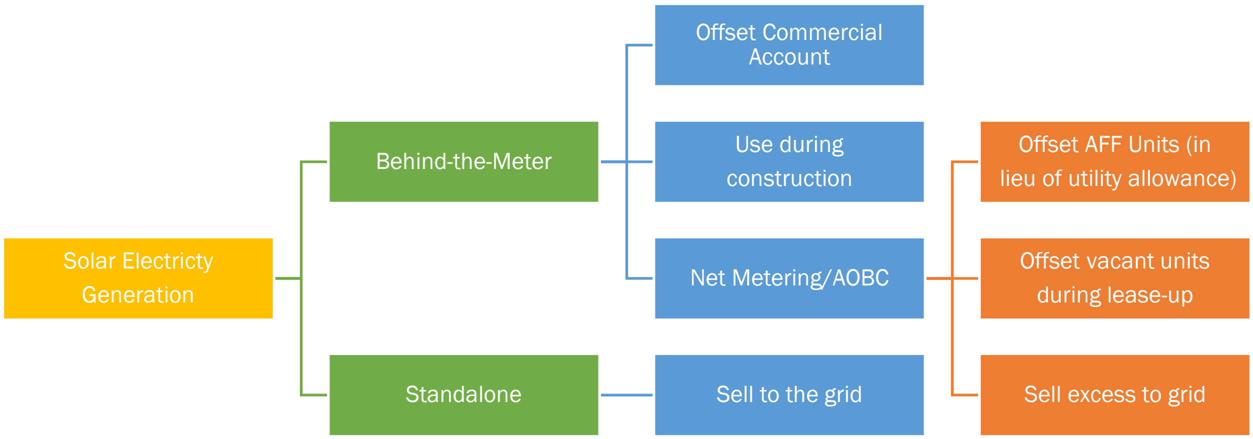
This ownership model requires no upfront investment and provides slow but steady electricity savings or additional income compared to no action. The party that maintains the ownership of the panels will get the rights to all federal and state tax credits. Third-party ownership models also decrease owners' flexibility in future modifications and usage adjustments.

Typical lease contracts used to be 25 years but with the increase in life expectancy of modern systems, new contracts require 30-year terms. PPA contracts are typically 20 years with extension options.

[52] Source: On-Site Commercial Solar PV Decision Guide by solar electric power association

4.2 Metering and Use Options

In general, electricity produced by the renewable energy system may be used by the property load or flow to the utility's network to service other loads. Energy generators have two main options, either sell the entire electricity back to the grid (standalone) or directly use the generated energy at the property (BTM). If the energy generated is sold back to the grid, the property would receive a fixed income at a pre-negotiated rate from the utility provider.



4.2.1 Behind-the-Meter (BTM)

A "behind-the-meter" system means that the solar energy system is paired with the energy load of the building, supplying the building directly with power. A BTM solar system allows us to use the energy generated by the solar system first, before having to consume energy supplied from the grid, directly reducing the amount of energy purchased. As the purchase cost of energy goes up, the owner's energy savings from avoided electricity costs increases. Most BTM systems include a bidirectional meter, meaning if there is excess generated electricity, it will be sent to the grid, and if there is a shortage, the grid will feed the property. In this section, we analyze some potential BTM uses for multifamily developments:

4.2.1.1 Use at the property

Multifamily developments use electricity at the property in many ways:

- Commercial accounts (CAM): The electricity used for common areas, leasing office, clubhouse, pool, elevators, EV Stations, exterior, and site lighting, are typically on general service (G-1) commercial accounts. Depending on the size of the development and common areas, offsetting the usage of these accounts provide significant savings to building OPEX.
- During Construction period: Solar panels can be installed as early as the completion of the roof, together with the commission of temporary electrical meters, this provides an opportunity for the system to be placed in service early to offset utility costs. For larger developments, from roof completion to the beneficial use, there is a significant time in which the utility cost can be offset by solar PV. The utility cost in this period is

typically captured in construction or lease-up (operating deficit) budget since the building has not yet generated income.

4.2.1.2 Net Metering/AOBC:

As described in chapter 3, both net metering and AOBC enables owners to credit excess generated electricity to other meters (assuming AOBC extends to BTM systems in the SMART extension program). As in most of the multi-family developments, the units are individually metered, in order to transfer electricity to other accounts at the property, a mechanism such as net metering or AOBC is required.

- Affordable Units: Typically, in multi-family developments, the landlord provides a utility allowance to the affordable units in addition to subsidized rent. The landlords have the option to provide electricity to the affordable units instead of providing a utility allowance as long as they cover 100% of the electricity bill for the unit. These allowances are pre-determined by the regional housing agency and differ based on the location, size, and type of building or unit.
  To put things in perspective on any 40B project, 20-25% of units are affordable at different AMI percentages, and the ability to remove the utility allowances from the property rent roll can be very meaningful in property valuation and allows affordable units to participate in the benefits of solar energy.
- Vacant units: A similar concept can be applied to vacant units during lease-up. Net metering regulations allow Schedule Z to be modified only twice a year, so this might create an issue if the specific unit listed is leased during this period (the landlord can offer free electricity for the first XX months as part of incentives).

Selling generated electricity to the market-rate units in Massachusetts is not an option, as charging tenants for electricity (electric submetering) is prohibited even when units are individually metered because it is considered resale of electricity. [53]

4.2.2 Standalone

A standalone system sits "in front" of the meter and feeds power directly into the grid, as opposed to using it on-site. The solar energy system is no longer providing electricity to the building, and this allows the property owner to turn its roof into an additional revenue-generating asset – regardless of whether the building is occupied or not. The standalone system owners can sell the electricity either via net metering or AOBSs.

4.3 PROJECT DELIVERY TIMELINE AND MILESTONES:

Like any construction project, multiple steps and several permits/ approvals are involved in solar projects. Below are the steps to deliver the project after the execution of a letter-of-intent (LOI):

- Preconstruction and Design: 6 - 8 Weeks

[53] https://www.mass.gov/service-details/electric-submetering

This phase consists of a site audit, system design, and acquiring necessary permits needed to host the system. In this phase, structural analysis, together with the solar and electrical design, will be completed, and the interconnect application will be submitted to the utility company. Also, the SMART pre-determination letter will be filed with DOER for any clarification or confirmations on the applicable incentive.

- Procurement and construction: 7-8 weeks

After the design is completed, the system approved, the vendor will procure the materials and prepare for on-site operation. With the material ready on-site and construction permits secured, the installation will start. It is typical to allow four weeks for procurement and three to four weeks of construction time for projects smaller than 500 KW.

- Project Commissioning: 2- 4 weeks

The commissioning phase consists of performing technical and utility commissioning, close out of all the permits, and completion of post-commissioning registrations. At the end of this phase, all the permits are signed-off, the system is tested, and the certificate of compliances is received. The system is then ready for commissioning and operation.

- Post-Installation Services (on-going)

The scope of this phase depends on the level of engagement and is contract specific; most of the solar contractors provide the following at no additional charge to the customer for the first year of service with installation:

- Public relations and co-marketing of project
- Assist with solar education opportunities
- On-going monitoring & maintenance
- Preventative maintenance
- Incentive management
- Net metering management

4.4 Case Studies

In the next two chapters, we will apply the knowledge and run different scenarios to examine investment feasibility and returns. These case studies will conclude with investment grade financial analysis to provide the investor with the financial tools necessary for decision making:

- Case study 1: Implementation study and financial analysis of two ownership models and two different direct-ownership metering options for different system sizes in the subject multi-family development.

- Case study 2: Analysis of use of solar energy to offset affordable units’ electricity usage and financial analysis of the impact on property valuation.

5 CASE STUDY 1 - IMPLEMENTATION AND FINANCIAL ANALYSIS OF SOLAR ENERGY IN MULTI-FAMILY DEVELOPMENTS

In this section, we evaluated the solar decision-making process and financial analysis for a sample multi-family development in Massachusetts. All available rooftop solar options for multi-family developments were incorporated and explored in this case study. Two different proposals were reviewed for third-party ownership (PPA and lease options), along with two direct ownership proposals (BTM and standalone) catered for various uses and configuration. The structure below is used to organize this case study (Figure 25):

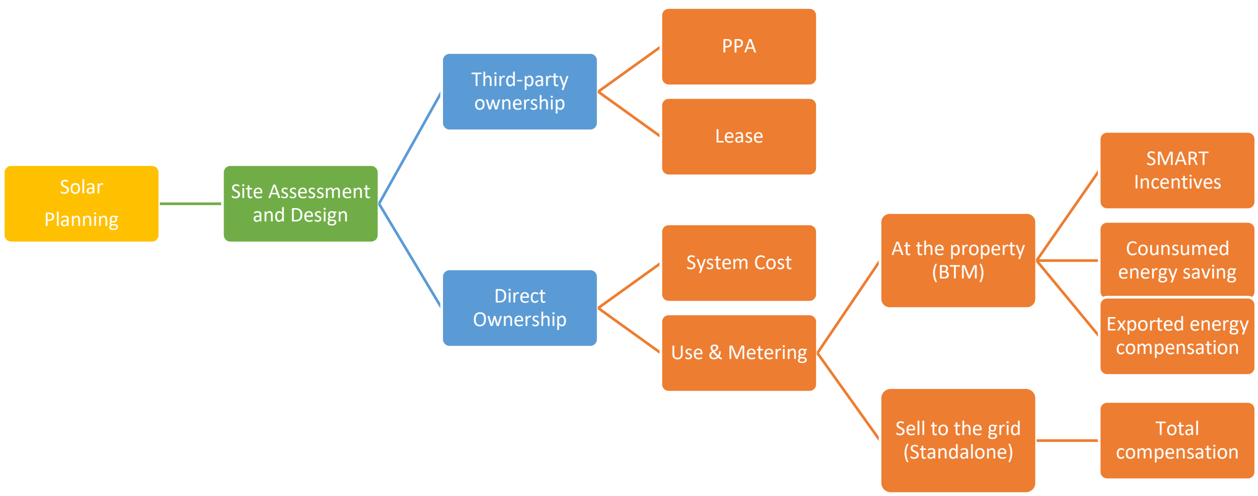


Figure 25 - Case Study 1 structure

5.1 SUBJECT PROPERTY OVERVIEW

To set in context, a newly built multi-family development in Massachusetts is selected. The property has all the characteristics of a typical Class A multi-family suburban development, allowing our site analysis, usage data, and solar pricing to be the most appropriate to this study:

- **Property Type:** Garden style multi-family development with surface parking
- **Location:** Massachusetts
- **Size:** 200+ Units with 25% affordable units (40B)
- **Amenities:** 8,000 SF clubhouse with social spaces and work stations, exterior pool, Fitness center, EV Stations, Outdoor grill stations and terrace, Dog spa and dog park
- **Utility Company Territory:** National Grid
- **Common Areas Electricity Rate:** G-1 – Effective rate 19.6 cents/kWh
- **Common Areas Electricity Usage**: annual 300,000 kWh - monthly average 25,000 kWh (Estimated at stabilization)

5.2 SITE ASSESSMENT AND DESIGN

The subject development is comprised of multiple buildings with ridgelines mostly running east-west. The orientation of the buildings creates a series of long south-facing roof surfaces that are ideal for solar panel placement. The site also offers opportunities for carport systems in the surface parking area, but due to higher cost and other site complexities, this option was not further explored.

In order to calculate the capacity and size of the system, it is essential to assess the amount of usage required to be offset at the property and the capacity of available roof space.

5.2.1 Usage information and battery storage

In order to calculate the system's estimated usage to be offset, it is essential to have 12 to 24 months of utility billing data available to analyze its historical usage. The subject property is in lease-up, and therefore historical usage is not available. This research used a similar-sized development in the same geographic area for use analysis. The property consumed approximately 300,000 kWh on average annually on commercial accounts. Comparing the property and the subject property monthly usage, it is reasonable to assume that a system with 300,000 capacity would satisfy 100% of annual CAM usage at the subject property.

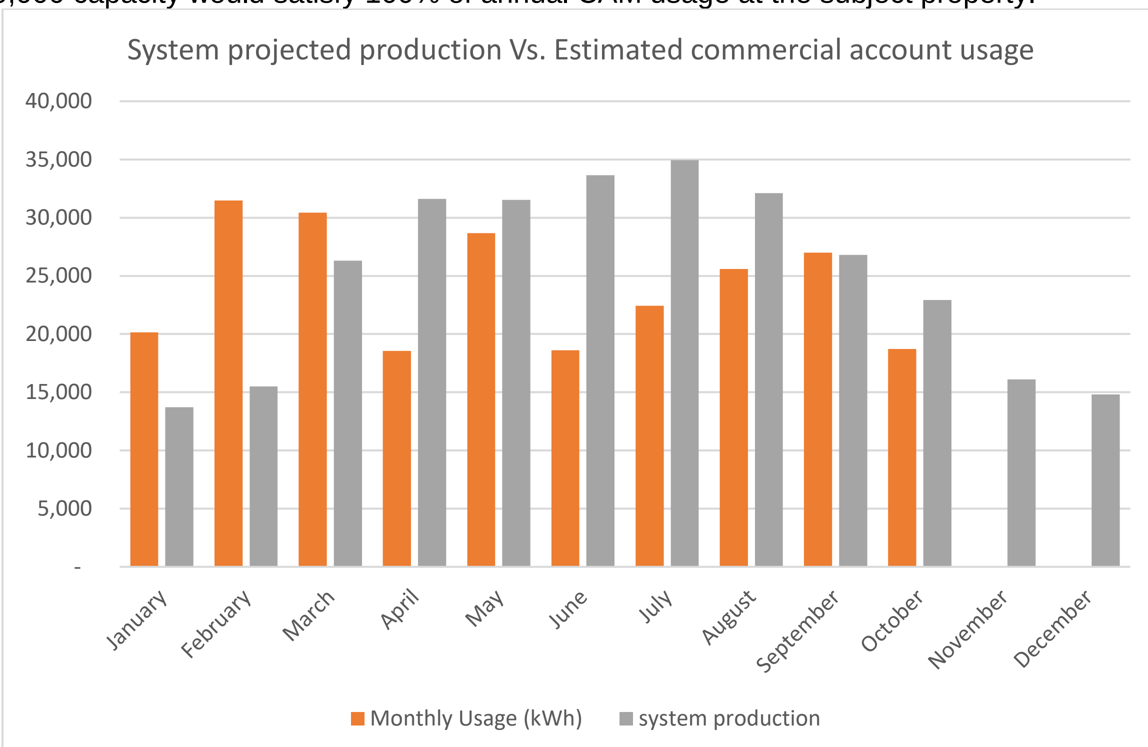


Figure 26 - System projected production Vs. Estimated commercial account usage

As the systems generate different amounts of energy at different times of the year due to soiling, shading, and temperature, the property usage also differs due to seasonal differences. Figure *26* shows the system projected production for a 300,000 kWh system versus commercial account usage from a similar property. When a significant difference is seen between production and usage patterns, two options can be considered:

- <u>Count on Net Metering or AOBC</u>*:* As mentioned in chapter four, most of BTM systems have a bidirectional meter, meaning if there is excess generated electricity, it will be sent to the grid, and if there is a shortage, the grid will feed the property. The problem with this method is the value of the credit for the excess generation, which was concluded that under both net metering or AOBC is not equal to 100% of the retail rate. It is the industry's best practice to size the system to **85% of energy usage** to minimize loss. [54]

[54] Solar PV Master Planning for Multi-family Buildings by Clean Energy Roadmap

- Battery Storage: Another viable emerging option is the use of battery storage along with solar systems. Energy storage devices provide the ability to store excess generated energy on-site for future use without the risk of changes in net metering and credit allocation regulations. The value of battery storage outperforms its cost, and therefore, all system designs include a battery storage solution.

5.2.2 System size

In order to determine roof capacity, it is typical for vendors to use platforms such as HelioScope. Such platforms allow vendors to get high-quality images of the roof in order to estimate roof capacity and determine optimized panel placement. The analysis of available roof space at the subject development concluded that the roof could accommodate 992 panels, which equates to 475,000 kWh of annual production capacity with high-efficiency panels (395-Watt panels).

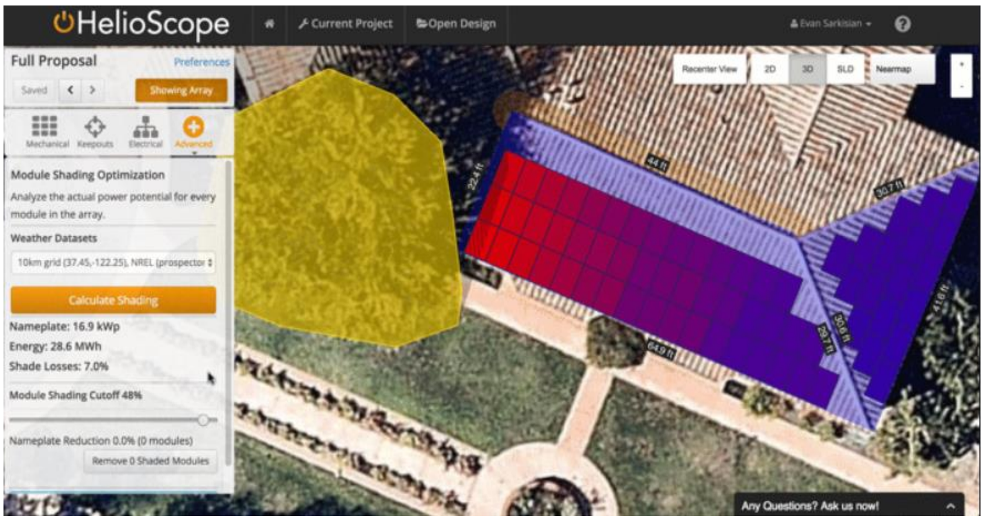


Figure 27 - HelioScope design platform snapshot – sample rooftop system [55]

Based on the usage and roof capacity studies, two system designs below have been chosen for pricing:

- Optimized Roof Solution: an optimized panel placement to achieve production equal to 100% of commercial account usage (**300,000 kWh** system).
- Maximize Roof Space: an optimized system layout to achieve maximum electricity generation from rooftop panels (**475,000 kWh** system).

5.3 Evaluating Proposals

One of the initial decisions required prior to the installation of solar systems is the ownership model. Solar systems can be directly owned or leased from third-party companies; both options have advantages and disadvantages, as discussed in previous chapters.

[55] *Source: https://helioscope.com*

5.3.1 Third-party ownership proposals

Third-party ownership proposals are typically in the form of lease payment or power purchase agreement (PPA). Under the PPA, the vendor would install the system at no cost and sell generated electricity to the owner at a discounted rate. Therefore the system used for analysis was sized appropriately to offset CAM utility usage. For the roof lease option, it is typical to analyze different options and offer the system layout that generates the most amount of lease income for the owner. The vendor analyzed different system sizes and offered the highest and best value option. In the summary table, the offered terms for both options are compared:

Summary Results	Option 1 Power Purchase Agreement	Option 2 Roof Lease Option
System Size	300,000 kWh	300,000 kWh
Goal	Offset CAM Accounts	Highest lease income
Benefit to the owner	Discounted Utility Rate @ 10 cents/kWh with 2% escalator	Monthly Lease Payment (<$10,000/Yea)
Owner up-front Cost	$0	$0
Applicable Contract(s)	Lease Agreement and PPA Agreement	Lease Agreement

Typical Lease Agreement Terms:

- System owner: Project company owned by the third-party company
- Landlord: Property Owner
- Lease Commencement: Upon operation of the Renewable Energy Facility
- Term: 30 years
- Operating and capital expenses: by the third-party company
- Most contracts allow the lease to be transferred in case of building ownership change

Power Purchase Agreement Terms:

- Seller: The third-party company
- Buyer: Property Owner
- Lease Commencement: Upon utility commissioning
- Term: 20 years
- Annual Escalator: 2-2.5%
- Renewal Options: (2) 5-year options at current rate + escalator

5.3.1.1 Investment Analysis:

Based on two proposed options, PPA is the most economical choice for the property owner under third-party ownership. Calculation of first-year savings from PPA is as follows:

- PPA rate: 10 cents/kWh

- Effective current utility rate 19.6 cents/kWh
- Savings: 19.6 – 10 = 9.6 cents/kWh
- Year-1 Annual savings: 300,000 kWh x 9.6 cents/kWh = $28,800/year

Value of PPA:

As shown in Figure 28, the PPA lease offers positive cash flow for the lease term. The value of the PPA for the property can be analyzed with two methods: (1) as a standalone investment with the discounted cash flow model (DCF) or (2) as part of the property value increase:

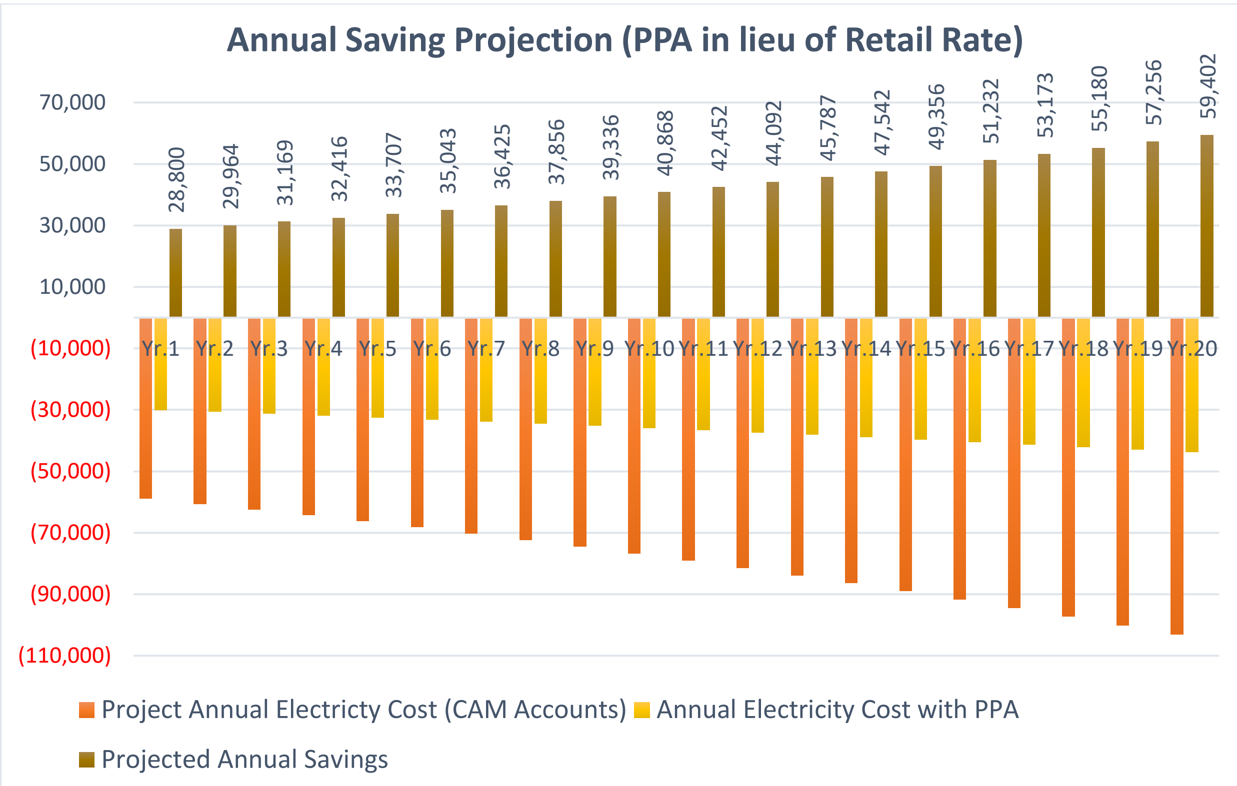


Figure 28 - PPA Annual Cashflow

- Using the DCF model to calculate the value of the PPA lease, the net present value (NPV) is calculated at **$540,000**, with the investment discount rate of **6%** for 25-year investment period.[56]

- Alternatively, as PPA reduces OPEX, consumed energy savings can be capped at the property cap rate to calculate the additional value PPA brings to the property. Boston suburban assets are trading at 4.5 - 4.75% cap rates. With a 0.25% cap buffer, the increased value of the property can be calculated at **$598,361** (Yr.2 Savings/Cap Rate = $29,964/5%).

[56] Different PV financial analysis literature have used different discount rates for NPV calculations: (1) NREL-The Impact of different economic performance metrics on the perceived value of PV (5% discount rate) (2) Solar Electric Investment Analysis by John Hay (4% discount rate) (3) Sun Peak Solar Financial Model Explained (7.5% discount rate). As solar is perceived as a low risk investment, discount rate of 6% is used in this research to accounts for minimum investor return requirements.

5.3.2 Direct ownership proposals

Typical solar purchase proposals offer turn-key solutions; these contracts offer engineering and design, permitting, installation, and incentive management as a lump sum price. These proposals typically include the size of the system in DC capacity, annual electric production (AC), and total system cost along with a proforma that analyzes the estimated system IRR and payback period along with the environmental benefits.

Pricing was requested on both design options mentioned in section 5.2 - Site assessment and Design. A summary of the proposals and return analysis can be found below:

- Option A: A **300,000 kWh BTM** system to offset 100% of energy needs in the amenity and common areas by solar energy.

- Option B: A **475,000 kWh standalone** system to maximize electricity generation from rooftop panels and sell 100% to the grid.

In the following sections, we have undertaken an in-depth review of cost and projected income for both options.

	Direct Option A	Direct Option B	Notes
Ownership	Direct	Direct	
Metering	BTM	Standalone	
System Size (kW DC)	247.7	392	
System Size (AC kWh)	300,418	475,302	
Total Installed Cost	$606,391	$875,857	
Installed Cost Per Watt DC (Pre-incentives)	$2.45	$2.24	
Installed Cost Per Watt DC (Post-incentives)	$1.24	$1.13	*26% ITC & Accelerated Depreciation*
Investment Return Analysis			
Payback Period	4.7	8.5	*years*
Levelized Cost of Electricity (LCOE)	$0.07	$0.06	*25 years*
Levered IRR	103%	78%	*70% loan*
Unlevered IRR	19%	10%	
Cash Multiple	7.77x	3.46x	*25 years*
Yield on Cost (with ITC and depreciation benefits)	11%	7%	
Impact on Property Value (Year-2 EBITDA)	$1,228,239	$1,460,877	*Cap rate = 5%*
Year 1 Total revenue			
Consumed Energy Saving (CAM Accounts)	$58,983	$0	
Consumed Energy Saving (offsetting AFF utility allowances)	$0	$0	
SMART Payment (Incentive or Exported energy compensation)	$9,589	$84,889	*Block 10 with adder*
Lifetime Income			
Consumed Energy Saving (CAM Accounts)	$2,005,084	$0	
Consumed Energy Saving (offsetting AFF allowances)	$0	$0	
SMART Payment (Incentive or Exported energy compensation)	$182,945	$1,999,640	*Block 10 with adder*
Environmental Benefits			
Co2 Emissions Avoided Annually	465000	736000	*lbs.*
Equivalent to			
Annual Co2 emissions from electricity of	22	35	*homes*
Annual greenhouse gas emission from	45	71	*cars*
Carbon sequestered annually in US forests of	200	317	*acres*

5.3.2.1 System Cost

Vendors were requested to provide pricing for both options A and B. Each vendor provided a unique design and used its design to calculate the total system cost. As the system sizes are different in each design to simplify comparison, these proposals are shown on the graph below by system size and price per DC kilowatt (Figure 29).

The graph below also shows pricing for a smaller system as a mean for comparison. It is clear from the graph that the cost per DC kilowatt decreases as the system size increases. To show the value of tax incentives, the system cost is calculated for both before and after incentives. The average price prior to incentives is **2.61 cents per DC kW**:

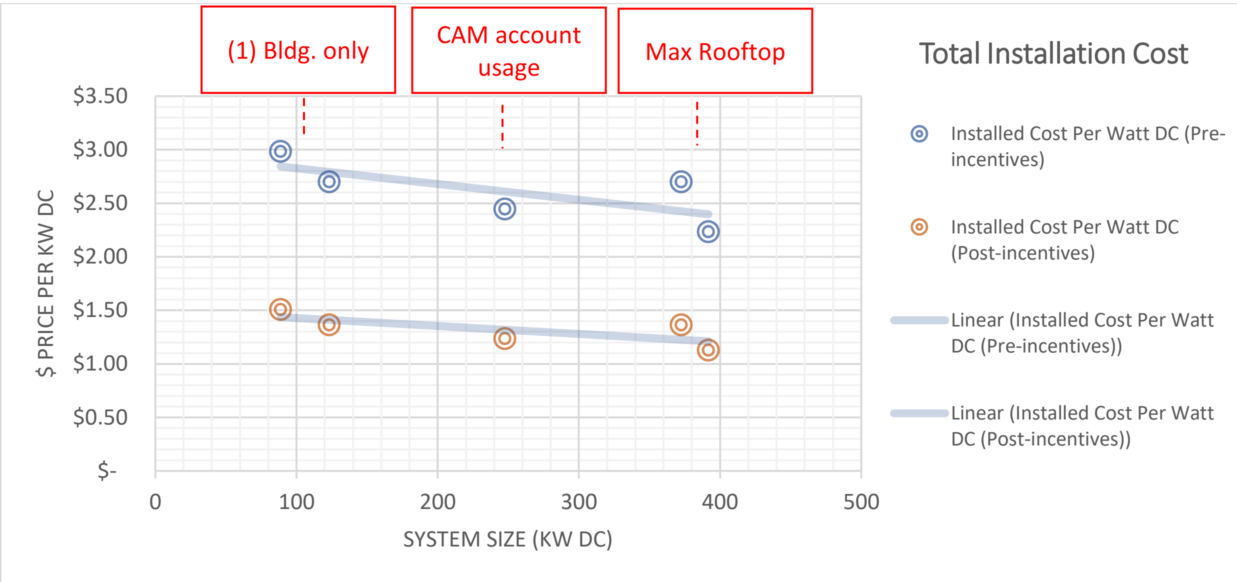


Figure 29 - Summary of direct ownership proposals by price per KW DC and system size

From the options presented, proposals that are selected that offered the most competitive pricing for our intended system sizes. Figure 30 shows a summary of these choices. Both ITC and MACRS bonus depreciation benefits are available in the first tax year of system installation. Combined saving in either scenario is approximately **50% of the total system cost**.

Description	Option A	Option B
System Size (kW DC)	247.7	391.8
System Size (AC kWh)	300,000	475,000
Total Installed Cost ($) (Pre-incentives)	**$ 606,000**	**$ 876,000**
Installed Cost Per Watt DC (Pre-incentives)	**$ 2.45**	**$ 2.24**
Federal ITC @ 26%	$ (157,560)	$ (227,760)
(1) MACRS Bonus Depreciation (27% Tax rate)	$ (142,349)	$ (205,772)
Total Installed Cost ($) (Post-incentives)	**$ 306,091**	**$ 442,468**
Installed Cost Per Watt DC (Post-incentives)	**$ 1.24**	**$ 1.13**

Figure 30 - Selected proposals Summary

5.3.2.2 Income Calculation

There are three sources of income from solar-generated electricity:

1. SMART incentives
2. Consumed energy saving
3. Exported energy compensation

Depending on the metering arrangement (behind-the-meter or standalone), the amount of income from each category will differ. Understanding the calculation methodology will enable multi-family owners to make an informed decision on the metering arrangement.

5.3.2.2.A Behind-the-meter

5.3.2.2.A.1 *SMART incentives*

Following these steps are recommended to calculate SMART incentives for BTM systems:

1. Determine the electric distribution company: As mentioned before, there are a handful of electric companies in Massachusetts, and all participate in the SMART program. Figure 31 shows the territory of each of the participating distribution companies. It is important to determine the electric company that is servicing the property as the amount and availability of incentives are different by each provider. The subject property is located in **National Grid Territory**.

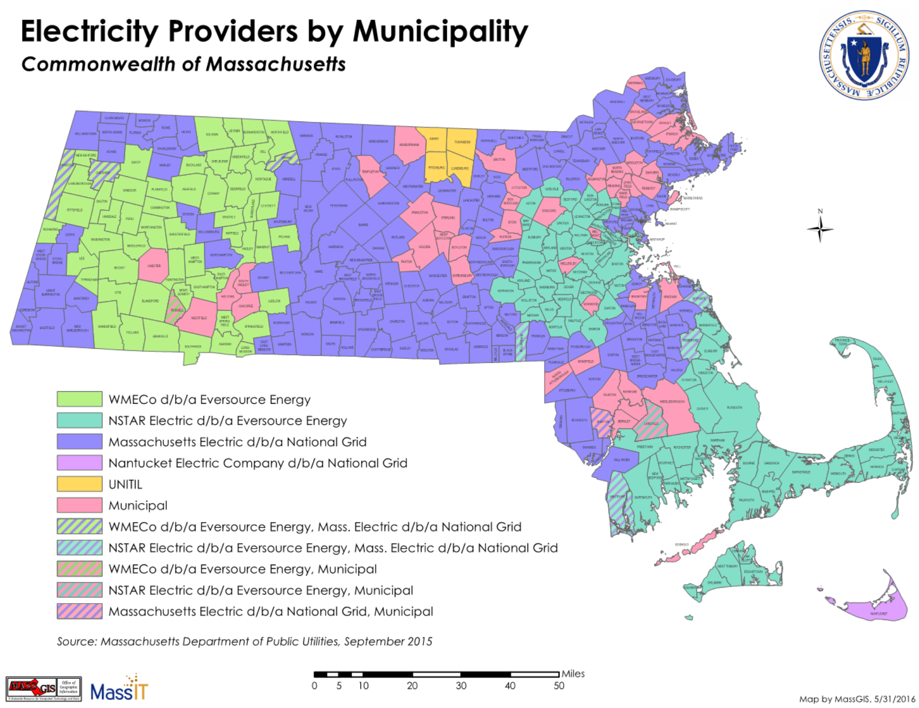


Figure 31 - MA Electricity Providers by Municipality[57]

2. Determine SMART base and applicable rate adder: Once the distribution company is determined, base and rate adders can be calculated.

57 Source: MassGIS

a. Determine Base Rate: The table below shows the available block for each service territory and system size as of 11/8/19. Once the available block is determined, the base compensation rate can be found in the appendix base rate table in the appendix. The program is designed so smaller systems get higher incentive rates than larger systems.

As shown in the block status table below, currently, National Grid, Eversource West, and Unitil for large projects (>25 kW) have no incentive blocks available. The SMART extension program is currently under review to address the program oversubscription and necessary changes are being made to the compensation rates of the original program. As additional blocks are expected to be added in the oversubscribed territories, it is assumed this project would qualify in the extended program at **Block 10** rate of **$0. 1347/kWh**.

SMART Solar Block Status Update

Last Update: 11/8/2019 8:45 AM

SMALL PROJECTS (<= 25 kW AC) Electric Distribution Company (EDC)	Accepting Applications for Block[1]:	Current Block Size (MW)[2]	Total Allocated Capacity (MW)[3]	Total Pending Capacity (MW)[4]	Total Remaining Capacity (MW)[5]	Waiting List (MW)[6]
Eversource MA East	3 of 8	18.303	32.762	6.949	106.718	0.000
Eversource MA West	5 of 8	3.187	13.395	1.471	10.289	0.000
National Grid (Massachusetts Electric)	4 of 8	18.043	53.818	8.203	82.014	0.000
National Grid (Nantucket)	1 of 2	0.604	0.094	0.043	1.071	0.000
Unitil	3 of 4	0.799	1.639	0.066	1.452	0.000
Total			**101.709**	**16.732**	**201.546**	**0.000**

LARGE PROJECTS (>25 kW AC) Electric Distribution Company (EDC)	Accepting Applications for Block[1]:	Current Block/Size (MW)[2]	Total Allocated Capacity (MW)[3]	Total Pending Capacity (MW)[4]	Total Remaining Capacity (MW)[5]	Waiting List (MW)[6]
Eversource MA East	3 of 8	73.211	145.244	34.180	406.264	0.000
Eversource MA West	Waitlist	TBD	100.208	56.769	0.000	56.271
National Grid (Massachusetts Electric)	Waitlist	TBD	572.628	34.551	0.000	31.037
National Grid (Nantucket)	1 of 2	2.417	1.000	0.000	3.833	0.000
Unitil	Waitlist	TBD	12.444	10.835	0.000	10.648
Total			**831.523**	**136.335**	**410.097**	**97.956**

Figure 32 - SMART Solar Block status update 11/8/19 (Source: SMART)

b. Rate Adders: Similar to base rate determination, the status and available tranches for each applicable solar adder are needed to be determined. Figure 33 shows the status of available tranches as of 11/8/19. Once the available tranche for each adder is determined, the compensation rate adder can be found in the rate adder table in section 8.2.
The energy storage adder depends on the storage solution capacity, storage hours as well as the size of the system.

SMART Solar Tranche Status		Last Update:	11/8/2019	8:45 AM
Compensation Adder Type	Accepting Applications for Tranche:	Tranche Size (MW)	Total Allocated Capacity (MW)	Total Pending Capacity (MW)
Agricultural	1	80	6.283	1.000
Brownfield	1	80	8.031	3.040
Building Mounted	2	80	96.329	8.610
Canopy	1	80	36.842	5.905
Floating	1	80	0.000	0.000
Landfill	1	80	26.962	5.000
Community Shared	11	60	609.081	12.425
Low Income Community Shared	1	80	22.119	7.381
Low Income Property	1	80	0.705	0.000
Public Entity	1	80	15.167	1.101
Energy Storage	4	80	278.026	23.204
Solar Tracking	1	80	13.251	0.000

Figure 33 - SMART Solar Tranche Status update 11/8/19[58]

c. <u>Total Compensation:</u>
Figure 34 shows the total compensation rate for this project under the behind-the-meter scenario. The value of energy is calculated by DOER periodically and depends on service territory and meter rate class.

Description	Rate
Base Rate - NGrid Greater than 250 kW AC to 500 kW AC (Block 10)	$0.1347
Rooftop Adder	$0.0192
Low-Income Property Owner	$0.0300
Storage Adder (varies by system size)	$0.0247
Total Compensation Rate ($/kWh)	**$0.2086**
Value of Energy ($/kWh)	$0.1767
SMART Incentive ($/kWh)	**$0.032**

Figure 34 - BTM SMART Total Compensation

58 *Source: SMART*

5.3.2.2.A.2 *Consumed energy saving*

Consumed energy saving is a simple calculation of multiplying the expected energy use by the effective retail electricity rate. Commercial accounts are at rate class of G-1 (small commercial) with an **effective rate of 19.6 cents/kWh**.

5.3.2.2.A.3 *Exported energy compensation*

As mentioned in previous sections, it is essential to size the system properly to receive the most value from excess generation. There are four options available to store or receive credit for excess generated energy. However, as net metering is currently not available, AOBC is under review, and qualifying facility compensation is at the wholesale rate, the storage solutions offer the best value. Our system is designed to store 100% of excess generation for future use at the property. Figure 35 compares all the compensation options for a BTM system:

System	Exported Energy Compensation Rate (Value)	Notes
BTM with storage solution	$ 0.196	Value of stored electricity at the retail rate
BTM Facility Net Metering	$ 0.106	60% of retail rate (0.6*$0.196)- currently not available
BTM Facility QF	$ 0.031	Hourly wholesale rate
BTM Facility AOBC	$ 0.103	Basic service rate (under review SMART extension)

Figure 35 - BTM exported energy compensation rate comparison

5.3.2.2.A.4 *Total revenue*

The formula below is used to calculate total revenue for a BTM system:

$$\begin{aligned} Total\ revenue = & (Total\ generation\ volume\ x\ smart\ incentive\ rate) \\ & + (Total\ consumed\ volume\ x\ effective\ retail\ rate) \\ & + (Total\ exported\ volume\ x\ compensation\ rate) \end{aligned}$$

Description	Assumption	Option A
System Capacity	kWh	300,000
Use at Property	100%	300,000
Exported Energy	0%	-
SMART Incentives	$0.032	$9,600
Consumed energy saving	$0.196	$58,800
Exported energy income		$0
Total annual revenue		**$68,400**

5.3.2.2.B Standalone

For this model to maximize income, the system is designed at the maximum generation capacity of 475,000 kWh with 100% generation sold to the grid. Similar to the BTM system, specific steps would need to be taken to calculate total revenue.

5.3.2.2.B.1 *SMART incentives*

Following similar steps, the SMART compensation rate is calculated as shown in the table below. Low-income adder does is not applicable anymore as no load will be used at the property:

Description	Rate
Base Rate - NGrid Greater than 250 kW AC to 500 kW AC (Block 10)	$0.1347
Rooftop Adder	$0.0192
Low-income Property Owner	N/A
Storage Adder (varies by system size)	$0.0247
Total Compensation Rate ($/kWh)	**$0.1786**
SMART Incentive ($/kWh)	**Depends on the compensation method**

5.3.2.2.B.2 *Consumed energy saving*

Not applicable

5.3.2.2.B.3 *Exported energy compensation*

The electricity in the standalone model can receive compensation under either net metering, AOBC or qualifying facility. No matter what method is used the total compensation stays the same as shown in section 5.3.2.2.B.1.

System	Exported Energy Compensation Rate	Total Compensation Rate	SMART incentive
Standalone facility Net Metering	$0.106	$0.1786	$0.0726
Standalone facility QF	$0.031	$0.1786	$0.1476
Standalone facility AOBC	$0.103	$0.1786	$0.0756

5.3.2.2.B.4 *Total revenue*

The formula below is used to calculate total revenue for a standalone system:

$$Total\ revenue = (Total\ generation\ volume\ x\ total\ compensation\ rate)$$

Description	Assumption	Standalone
System Capacity	kWh	475,000
Use at Property	0%	-
Exported Energy	100%	475,000
SMART Incentives (AOBC)	$0.076	$35,910
Consumed energy saving	$0.000	$0
Exported energy income (AOBC)	$0.103	$48,925
Total annual revenue		**$84,835**

5.4 INVESTMENT ANALYSIS

Aside from the third-party roof lease option that is not economical, in previous sections, we discussed three different configurations. In this section, the economics of these options will be compared side-by-side to allow the reader to choose the best option for their property.
The three different configurations discussed are as follows:

Third-party PPA: A 300,000 kWh system installed by a third-party vendor with a power purchase agreement with the owner to offset 100% of energy needs in the amenity and common areas by solar energy.

Direct Option A: A 300,000 kWh BTM system to offset 100% of energy needs in the amenity and common areas by solar energy.

Direct Option B: A 475,000 kWh standalone system to maximize electricity generation from rooftop panels and sell 100% to the grid.

Summary Results				
	PPA	Direct Option A	Direct Option B	Notes
Ownership	Third-party	Direct	Direct	
Metering		BTM	Standalone	
System Size (kW DC)	271 kW DC	247.7	392	
System Size (AC kWh)	300,000	300,418	475,302	
Total Installed Cost	$0	$606,391	$875,857	
Installed Cost Per Watt DC (Pre-incentives)	$0.00	$2.45	$2.24	
Installed Cost Per Watt DC (Post-incentives)	$0.00	$1.24	$1.13	*26% ITC & Accelerated Depreciation*
Investment Return Analysis				
Payback Period	N/A	4.7	8.5	*years*
Levelized Cost of Electricity (LCOE)	$0.13	$0.07	$0.06	*25 years*
Levered IRR	N/A	103%	78%	*70% loan*
Unlevered IRR	N/A	19%	10%	
Cash Multiple	N/A	7.77x	3.46x	*25 years*
Yield on Cost (with ITC and depreciation benefits)	N/A	11%	7%	
Impact on Property Value (Year-2 EBITDA)	$598,361	$1,228,239	$1,460,877	*Cap rate = 5%*
Year 1 Total revenue				
Consumed Energy Saving (CAM Accounts)	$28,800	$58,983	$0	
Consumed Energy Saving (offsetting AFF utility allowances)	$0	$0	$0	
SMART Payment (Incentive or Exported energy compensation)	$0	$9,589	$84,889	*Block 10 with adder*
Lifetime Income				
Consumed Energy Saving (CAM Accounts)	$1,182,896	$2,005,084	$0	
Consumed Energy Saving (offsetting AFF allowances)	$0	$0	$0	
SMART Payment (Incentive or Exported energy compensation)	$0	$182,945	$1,999,640	*Block 10 with adder*
Environmental Benefits				
Co2 Emissions Avoided Annually	465000	465000	736000	*lbs.*
Equivalent to				
Annual Co2 emissions from electricity of	22	22	35	*homes*
Annual greenhouse gas emission from	45	45	71	*cars*
Carbon sequestered annually in US forests of	200	200	317	*acres*

5.4.1 Levelized cost of electricity

One of the useful metrics for the evaluation of alternative energy sources is the levelized cost of electricity (LCOE), which provides a good comparison between the effective cost of generated electricity and the retail rate per kWh. To calculate LCOE, total system cost (including ITC and depreciation incentives) is added to the NPV of system operation and maintenance cost (discounted with escalation rate of 2%) and divided by the total amount of electricity generated for the duration of the analysis.

Figure 36 clearly shows that generated electricity (BTM or PPA) is a better choice over buying electricity from the grid at full retail rate and that BTM offers a better effective rate to customers over a longer period over PPA.

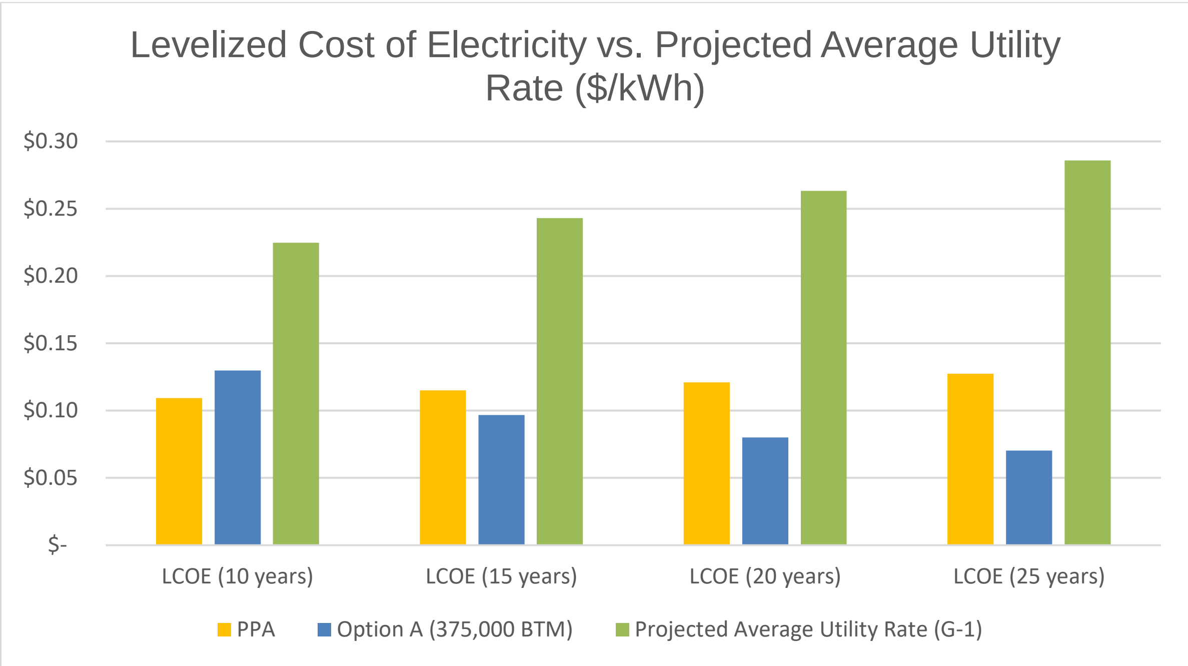


Figure 36- PPA and BTM LCOE vs. Projected Average Utility Rate ($/kWh)

5.4.2 Annual Cashflow

An annual cashflow report is a great tool to fully understand the difference in income structure between PPA, BTM, and standalone systems. The annual cash flow report annual equity return (or income) for all three options.

- The PPA system is at a fixed rate with a 2% escalation and is expected to generate steady savings as long as the retail rate does not drop and escalates at an average forecasted rate of 3%.
- The BTM system generates the highest income for the property as the income is the combination of consumed energy saving and SMART incentives. The consumed energy saving increases as we expect retail electricity increases year over year. The SMART incentive is fixed but is only applicable for the one 20-year term; therefore, as shown on the cashflow report, there is a drop in the income on year twenty-one.
- The standalone system shows a declining income because although the compensation rate is fixed for the 20-year term, system generation is expected to decrease 0.5% annually.

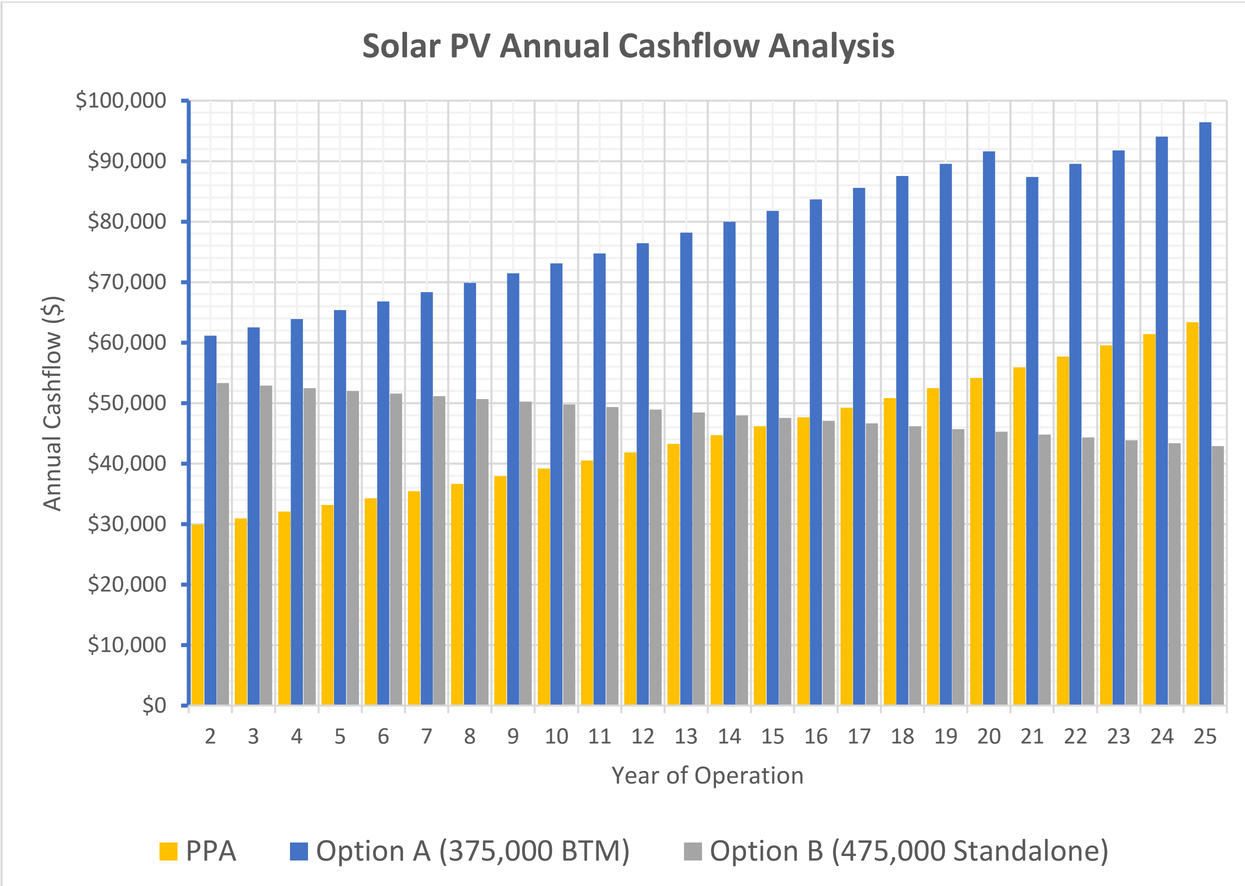


Figure 37 - Solar PV annual cashflow (year 2 and after)

5.4.3 Cumulative Cashflow

The best visual modality to compare the total investment return is with the cumulative cashflow report. The graph shows that the cumulative cashflow is negative until payback periods due to the initial capital investment requirement for direct-owned systems, but PPA generates positive cashflow from year one. It also shows that the 300,000 BTM system (option A) is generating significantly more income than the PPA for the property over the 25-year term.

The 475,000-standalone system (Option B) has a significantly longer payback period and the lowest cumulative cashflow. Although on paper, the system shows a relatively attractive compensation rate, after deducting expenses, the total return is not competitive with behind the meter system.

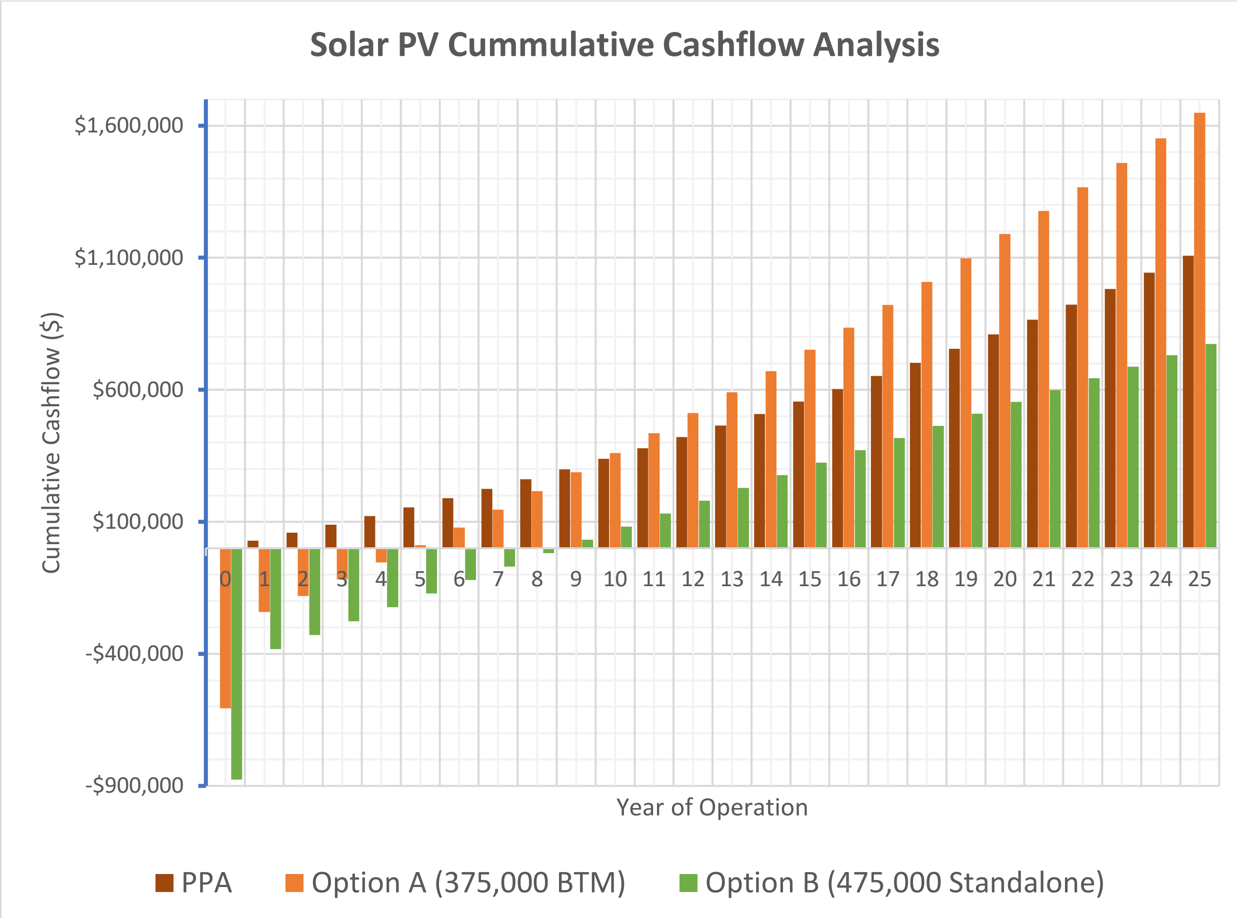


Figure 38 - Cumulative Cashflow Graph ($0 loan for comparison with PPA)

- **Property Value Increase:**

Solar systems, besides their positive impact on property income increase the property value. In Figure 39, the income approach was used to show the impact on property value from the solar system addition. The impact on property value is calculated by using year-2 earnings before interest, tax and depreciation benefits (EBITDA), divided by the market cap rate (Boston suburban MF assets are trading at 4.5%-4.75% cap rate, a cap rate of 5% was used with 0.25% margin).

Solar system A (300,000-BTM system) with the highest annual income, also increases the property value more than the other two options.

	PPA	Direct Option A	Direct Option B	Notes
System Size (kW DC)	271	247.7	391.8	
Installed Cost Per Watt DC (Pre-incentives)	-	$ 2.45	$ 2.24	
Installed Cost Per Watt DC (Post-incentives)	-	$ 1.24	$ 1.13	26% ITC & Accelerated Depreciation
Impact on Property Value (Year-2 EBITDA/Cap)	$ 598,361	$ 1,228,239	$ 1,460,877	Cap rate = 5%
Total Installed Cost	$0	$ 606,391	$ 875,857	
Property Value Increase (net of system cost)	$ 598,361	$ 621,848	$ 585,020	
Property Value Increase	$ 2.21	$ 4.96	$ 3.73	$ / DC Watt
Property Value Increase (net of system cost)	$ 2.21	$ 2.51	$ 1.49	$ / DC Watt

Figure 39 - Solar PV property value impact

5.5 SUMMARY RESULTS

In this case study, two ownership models and two different direct-ownership metering options for different system sizes are reviewed. As discussed in detail, direct and third-party ownership both have advantages and disadvantages that make each attractive to different property owners with different needs, access to capital, and ownership structure. Independent of the ownership preference, it is demonstrated that a direct-owned system is more economical to the owner when compared to an equivalent leased option. We have also proven that a BTM system generates more profit for the property per generated kilowatt both in income and property value. Our financial analysis concluded that the value of solar energy for multi-family developments is maximized with BTM systems when they are sized to 100% of CAM usage and paired with battery solutions to avoid net metering/AOBC/QF discounted compensation rates. These systems are most beneficial when placed in service as early as possible and on meters with the highest retail rate (if possible).

To view the 300,000 KW BTM system (Option A) as a standalone investment through the investors' lenses, the investment metrics over the 25-year investment period are as follows. Comparing to similar low-risk investments, these metrics are very attractive to any investor, rendering solar to a valuable addition to any multi-family property:

- **Yield on Cost:** 11%
- **Unlevered IRR:** 19%
- **Cash Multiple**: 7.7 X

For property developers and owners on a property with an average effective rent of $2,000/Month per unit, the income from solar is equal to approximately **3.5 more units** in their development without accounting for concessions. [59] These financial parameters, combined with the low-risk nature of solar due to long-term contracts, subsidies, and energy price hedging, provide solid, tangible evidence that PV rooftop solar is a value add on multi-family developments.

[59] Yr.2 solar EBITDA $61,412 adjusted for 5% Vacancy & 35% OPEX resulting in additional rent of $87,000/yr

6 Case Study 2 – Financial Analysis of Solar Energy for Affordable Units in Multi-family Developments

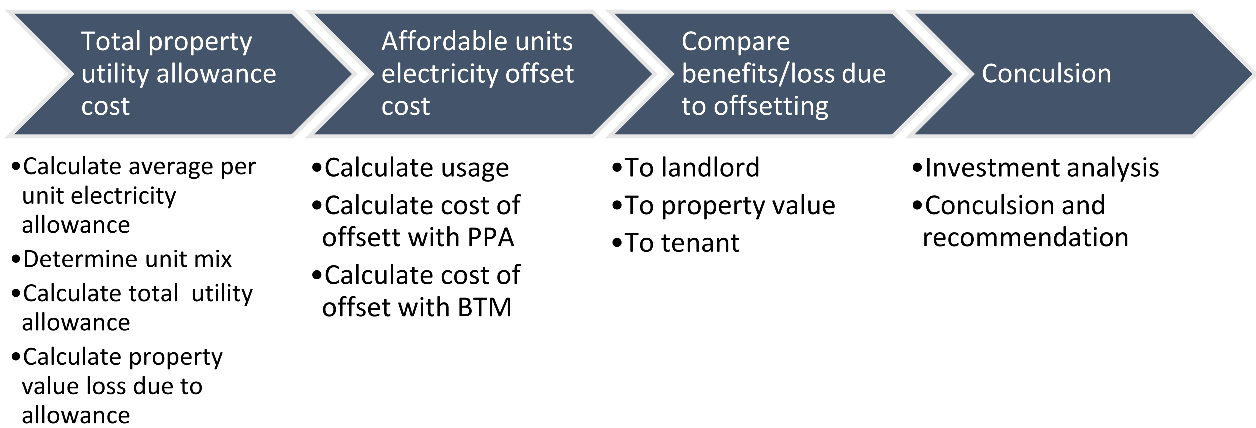
A study published by National Renewable Energy Laboratory (NREL) in 2018 shows that nearly 50% of rooftop solar potential in the US is located at the dwellings occupied by low to moderate-income households or those earning 80% or less of area median income (AMI), but the adoption of rooftop solar has been concentrated in higher-income households. [60]

Many solar studies such as “Rooftop Solar Technical Potential for Low-to-Moderate Income Households in the United States” by NREL have focused on properties with 100% affordable units, but few have addressed market-rate developments that have an affordable component.

In this case study, we intend to focus on these properties and provide a path for multi-family developers to use solar energy for their low to moderate-income units in their developments. We have concluded that there are mechanisms that allow developers to increase NOI and the property value through offsetting affordable units’ electricity costs, in addition to bringing other solar benefits to these residents and the community.

6.1 Methodology

The methodology below will be used to calculate benefits or loss to all stakeholders:



6.2 Affordable units in Massachusetts

In the state of Massachusetts, most of the new developments are required to assign a percentage of their units to households with low to moderate-income households (specific requirements depend on the size and location of the project).

One of the programs in Massachusetts that encouraged many developments is 40B housing. Chapter 40B housing is a program created in 1969 that allows developers to override local zoning bylaws in return for increasing affordable housing in different municipalities. 40B developments are required to set aside 25% of their units for households below 80% of AMI, or alternatively 20% to a household below 50% of AMI. The rent for these units will be subsidized at 30% of household

[60] Rooftop Solar Technical Potential for Low-to-Moderate Income Households in the United States, NREL

income. Furthermore, the landlord is required to provide utility allowance in addition to the subsidized rents.

6.3 LIMITATIONS

Providing solar-generated electricity in BTM systems to multiple meters in multi-family developments is currently only available with net metering. With the net metering cap at capacity in many territories and AOBC expansion to BTM under review, there is no feasible option to provide electricity to these units at the moment. A solution is expected to be announced as part of SMART 2.0 in 2020.
There are a few limitations with net metering:

- Net metering or AOBC only transfer a portion of the real value of the generated electricity (Net metering 60%, AOBC changing with the basic rate)
- Under net metering, the meter number and a percentage of monthly generation are required to be provided to the utility provider (schedule Z).
    - A fixed percentage of allocation for each unit results in loss of excess energy assigned or cost for the shortage that will become the landlord's responsibility if solar is becoming the alternative to the utility allowance
    - Generators can change these assignments only twice a year.

All items above create uncertainty for the property owners and limit their ability to create a solid plan.

6.4 COST OF AFFORDABLE UNITS ELECTRICITY ALLOWANCE

Nine regional agencies administer the utility allowances in Massachusetts. Depending on the location of the project, the regional agency will set the utility allowance rate for each project, but the landlords have the option to offset 100% of the cost of the utility in place of providing these allowances.

6.4.1 Average per-unit electricity allowance

The utility allowances include electricity, gas, water, sewer, trash removal, and appliances if the tenants are being charged for them. Figure 40 shows the list of these agencies with 2020 electrical allowance for the studio to 3-bedroom units. [61]

[61] Source: Mass GOV 2020 Regional Section 8 Utility Allowances (https://www.mass.gov/service-details/2020-regional-section-8-utility-allowances)

Territory		Studio	1 Bed	2 Bed	3 Bed
Region 1 - Berkshire Housing Development Corp (BHDC) (Berkshire County)	Electric Cooking	$4	$5	$7	$9
	Electric	$15	$17	$24	$31
	Total Allowance	**$19**	**$22**	**$31**	**$40**
Region 2 - Community Teamwork, Inc. (CTI) (Lowell/Lawrence area)	Electric Cooking	$13	$18	$23	$29
	Electric	$44	$56	$75	$90
	Total Allowance	**$57**	**$74**	**$98**	**$119**
Region 4 - Housing Assistance Corp. (HAC) (Cape Cod & the Islands)	Electric Cooking	$10	$12	$17	$22
	Electric	$37	$44	$61	$78
	Total Allowance	**$47**	**$56**	**$78**	**$100**
Region 5 – HAP, Inc. (Hampden, Hampshire & Franklin Counties)	Electric Cooking	$10	$14	$18	$22
	Electric	$45	$60	$75	$90
	Total Allowance	**$55**	**$74**	**$93**	**$112**
Region 6 - Metropolitan Boston Housing Partnership (MBHP) (Metro Boston)	Electric Cooking	$13	$18	$23	$28
	Electric	$45	$60	$75	$90
	Total Allowance	**$58**	**$78**	**$98**	**$118**
Region 7 - RCAP Solutions (Worcester Area)	Electric Cooking	$5	$7	$9	$11
	Electric	$31	$39	$51	$60
	Total Allowance	**$36**	**$46**	**$60**	**$71**
Region 8 - South Middlesex Opportunity Council, Inc. (SMOC) (Framingham Area)	Electric Cooking	$6	$8	$10	$12
	Electric	$21	$27	$33	$39
	Total Allowance	**$27**	**$35**	**$43**	**$51**
Region 9 - Housing Solutions for Southeastern Massachusetts (HSSEM) (South Shore)	Electric Cooking	$13	$18	$23	$28
	Electric	$40	$54	$65	$81
	Total Allowance	**$53**	**$72**	**$88**	**$109**[62]

Figure 40 - 2020 Monthly Massachusetts Regional Section 8 Utility Allowance

[62] Source: Mass GOV 2020 Regional Section 8 Utility Allowances https://www.mass.gov/service-details/2020-regional-section-8-utility-allowances

6.4.2 Unit Mix

Regional agencies publish their utility allowances by unit type, therefore to calculate total property allowance, a unit mix is needed. As the percentage of affordability and unit mix of each project differs from one to the other, every property has its unique total utility allowance. For this case study, we are assuming the subject property is a 200-unit development, with 25% units affordable at the 80% AMI with unit mix below. Change in the number of units and unit mix will result in a different total utility allowance.

		Studio	1 Bed	2 Bed	3 Bed	TOTAL
Sample Unit Mix (%)		5%	40%	45%	10%	**100%**
Total units	200	10	80	90	20	**200**
Total Affordable Units	25%	3	20	23	5	**51**

6.4.3 Total utility allowance and impact on property value

Using the unit mix above and the schedule of allowances from section 7.4.1, the total monthly and annual allowances for the subject property can be calculated.
The total calculated amount is what the landlord provides to affordable unit residents annually for their electricity cost. The impact of this payment is reflected in the property rent roll and valuation of the asset. The impact on the property value can be calculated by dividing the lost annual income by the market cap rate (used 5%).

The table below shows independent of geographic locations, on average, a 200-unit development with 25% affordable unit with a similar unit mix used above in the state of Massachusetts pays annually $41,000 in utility allowances, an estimated hit on the property value of $780,000.

Regional Agency	Total Monthly Electric Allowance	Total Annual Electrical Allowance	Property Value Decline Due to Electrical Allowance
			(Annual Allowance * 95% occupancy / Cap Rate)
Region 1 - Berkshire Housing Development Corp (BHDC) (Berkshire County)	$1,410	$16,920	-$321,480
Region 2 - Community Teamwork, Inc. (CTI) (Lowell/Lawrence area)	$4,500	$54,000	-$1,026,000
Region 4 - Housing Assistance Corp. (HAC) (Cape Cod & the Islands)	$3,555	$42,660	-$810,540
Region 5 – HAP, Inc. (Hampden, Hampshire & Franklin Counties)	$4,344	$52,128	-$990,432
Region 6 - Metropolitan Boston Housing Partnership (MBHP) (Metro Boston)	$4,578	$54,936	-$1,043,784
Region 7 - RCAP Solutions (Worcester Area)	$2,763	$33,156	-$629,964

Region 8 - South Middlesex Opportunity Council, Inc. (SMOC) (Framingham Area)	$2,025	$24,300	-$461,700
Region 9 - Housing Solutions for Southeastern Massachusetts (HSSEM) (South Shore)	$4,168	$50,016	-$950,304
Total Average	**$3,418**	**$41,015**	**-$779,276**

6.5 COST OF OFFSETTING AFFORDABLE UNITS ELECTRICITY WITH SOLAR

6.5.1 Electricity usage and Solar system design:

The first step to determine the cost to offset electrical usage is to determine the usage amount. Two sources were used for this analysis: (1) ForRent.com performed a study for utility cost breakdown by unit size nationwide [63], (2) Avalon communities' study of electricity use for their select Massachusetts developments[64]. The average annual usage below was concluded for each unit type. The average 312 kWh per unit/per month is consistent with usage at similar class A multifamily developments:

	Studio	1 Bed	2 Bed	3 Bed	TOTAL
Average Annual Electricity Usage (kWh per unit per)	2,616	3,201	4,109	4,900	190,886

For system sizing a 40% loss factor was applied to the 190,000 kWh (required offset capacity) and a BTM system with 300,000 kWh capacity is chosen for this study.

6.5.2 Calculate the cost of offsetting with PPA/BTM

As described in case study 1, there are two options to provide solar energy to affordable units:

1. A power purchase agreement with 3rd party solar company or
2. Direct ownership BTM System

Using the rates established in case study 1, the rate of 10 cents/kWh for the PPA option, and 25-year levelized cost of electricity of 7 cents/kWh from the 300,000 kWh system for the BTM system will be used. The offset cost is calculated by multiplying the usage amount calculated above by the unit mix from section 7.3.2.

	Studio	1 Bed	2 Bed	3 Bed	TOTAL
Average Annual Electricity Usage (kWh per unit per)	2,616	3,201	4,109	4,900	190,886
Affordable units count	3	20	23	5	51
Total Utility allowance X utility rate =	**2,616 x 3 x Rate +**	**3,201 x 20 x Rate +**	**4,109 x 23 x Rate +**	**4,900 x 5 x Rate**	

[63] https://www.forrent.com/blog/wp-content/uploads/2018/02/apartment-utility-breakdown-costs_IG.jpg

[64] Source: Avalon Communities - Green Living Label for Saugus, Norwood, Framingham, Hingham, Marlborough, Quincy, Easton, Sudbury developments

Additional savings generated will be treated differently from offsetting CAM accounts as they will be added to the rent roll. A vacancy factor of 5% is applied. The additional NOI then was capped at 5% to calculate the property value improvement in for both cases:

	UTILITY ALLOWANCE PROVIDED TO TENANT BY LANDLORD			100% AFF UNIT ELECTRICITY OFFSET WITH PPA @ 10 CENTS/KWH			100% AFF UNIT ELECTRICITY OFFSET WITH DIRECT OWNERSHIP BTM SYSTEM @ 7 CENTS/KWH		
Regional Agency	**Total Monthly Electric Allowance**	**Total Annual Electrical Allowance**	**Property Value Decline due to Electrical Allowance**	**Yr.1 cost of Electricity with Third-Party PPA**	**Yr.1 cost saving to the property**	**Property Value Improvement**	**Yr.1 cost of Electricity with Direct Ownership**	**Yr.1 cost saving to the property**	**Property Value Improvement**
			(Annual Allowance * 95% occupancy / Cap Rate)			Saving on annual cost of electricity * 95% occupancy / Cap Rate			Saving on annual cost of electricity * 95% occupancy / Cap Rate
Region 1 - Berkshire Housing Development Corp (BHDC) (Berkshire County)	$1,410	$16,920	-$321,480	$19,089	-$2,169	-$41,203	$13,362	$3,558	$67,602
Region 2 - Community Teamwork, Inc. (CTI) (Lowell/Lawrence area)	$4,500	$54,000	-$1,026,000	$19,089	$34,911	$663,317	$13,362	$40,638	$772,122
Region 4 - Housing Assistance Corp. (HAC) (Cape Cod & the Islands)	$3,555	$42,660	-$810,540	$19,089	$23,571	$447,857	$13,362	$29,298	$556,662
Region 5 – HAP, Inc. (Hampden, Hampshire & Franklin Counties)	$4,344	$52,128	-$990,432	$19,089	$33,039	$627,749	$13,362	$38,766	$736,554
Region 6 - Metropolitan Boston Housing Partnership (MBHP) (Metro Boston)	$4,578	$54,936	-$1,043,784	$19,089	$35,847	$681,101	$13,362	$41,574	$789,906
Region 7 - RCAP Solutions (Worcester Area)	$2,763	$33,156	-$629,964	$19,089	$14,067	$267,281	$13,362	$19,794	$376,086
Region 8 - South Middlesex Opportunity Council, Inc. (SMOC) (Framingham Area)	$2,025	$24,300	-$461,700	$19,089	$5,211	$99,017	$13,362	$10,938	$207,822
Region 9 - Housing Solutions for Southeastern Massachusetts (HSSEM) (South Shore)	$4,168	$50,016	-$950,304	$19,089	$30,927	$587,621	$13,362	$36,654	$696,426
Total Average	**$3,418**	**$41,015**	**-$779,276**	**$19,089**	**$21,926**	**$416,592**	**$13,362**	**$27,652**	**$525,397**

6.6 COMPARE BENEFITS/LOSS DUE TO OFFSETTING

6.6.1 Saving for the landlord and property value

Per the table above, almost in all scenarios, offsetting the cost of electricity with solar is beneficial to the property owner. With a PPA, the property will receive $21,000 additional value annually. The BTM system brings a higher average saving of $27,000. These amounts respectively result in $416,000 and $525,000 property value increase in addition to other community-based benefits.

6.6.2 Savings to the affordable-unit residents

Utility companies provide discounted electricity to low-income residents under the residential rate (R2). The effective rate ranges between $0.232 to $0.254 per kWh, depending on the usage amount[65]. Applying the R-2 rate to the estimated unit usage amounts in section 7.5.1, the total annual expense of $44,300 can be calculated for all affordable units that are paid by the tenants to the utility company ($0.232/kWh x 190,856 kWh annual usage ~ $44,300).

When comparing this amount to the utility allowance received by the tenants, it appears that the tenants, annually on average, pay $3,200 from their pocket for the electricity cost above their received allowances. Each affordable resident will save on average with solar, $65/year per unit, in addition to all the other benefits that solar brings to the community.

Regional Agency	Total Annual Electrical Allowance paid to AFF resident	Average Utility Expense paid by Affordable unit resident to Utility Company	Yr. 1 Savings to AFF Residents
Region 1 - Berkshire Housing Development Corp (BHDC) (Berkshire County)	$16,920	$44,300	$27,380
Region 2 - Community Teamwork, Inc. (CTI) (Lowell/Lawrence area)	$54,000	$44,300	-$9,700
Region 4 - Housing Assistance Corp. (HAC) (Cape Cod & the Islands)	$42,660	$44,300	$1,640
Region 5 – HAP, Inc. (Hampden, Hampshire & Franklin Counties)	$52,128	$44,300	-$7,828
Region 6 - Metropolitan Boston Housing Partnership (MBHP) (Metro Boston)	$54,936	$44,300	-$10,636
Region 7 - RCAP Solutions (Worcester Area)	$33,156	$44,300	$11,144
Region 8 - South Middlesex Opportunity Council, Inc. (SMOC) (Framingham Area)	$24,300	$44,300	$20,000
Region 9 - Housing Solutions for Southeastern Massachusetts (HSSEM) (South Shore)	$50,016	$44,300	-$5,716
Total Average	**$41,015**		**$3,286**

65 https://www.nationalgridus.com/MA-Home/Rates/Service-Rates

6.7 FINANCIAL ANALYSIS

In previous sections of this chapter, we focused on the financial value of replacing electricity allowance for the affordable units with solar energy. In this section, an investment-grade feasibility analysis was performed for the solar system that meets this demand. This system was compared with the BTM system that was analyzed in Case study 1, and to conclude, a recommendation to the reader will be formed.

It was determined that in order to fully offset the electricity needs of affordable units, a 300,000 BTM system is required. This system (Option C), in addition to savings from the offset of AFF utility allowance cost, is eligible for smart incentives similar to the BTM system that was analyzed in case study 1 (Option A).

Another configuration that is also offered for review (Option D), is a 475,000 BTM system that is sized to the maximum generation capacity from rooftop solar. The primary use of the generated energy is to offset affordable units' usage, and the balance will be used for common areas and amenities. Based on case study 1 analysis, the balance can cover up to 60% of CAM accounts.

Here is the summary of the solar systems that will be compared in the table below:

Direct Option A: A 300,000 kWh BTM system to offset 100% of energy needs in the amenity and common areas by solar energy. (from case study 1)

Direct Option C: A 300,000 kWh BTM system to offset 100% of affordable units' usage by solar energy.

Direct Option D: A 475,000 kWh BTM system to offset 100% of affordable units' usage (300,000 kWh) and 60% of energy needs in the amenity and common areas (175,000 kWh) by solar energy

	Direct Option A	Direct Option C	Direct Option D	Notes
Use of generated Electricity	Offset 100% CAM	Offset 100% Aff units	Offset 100% Aff units + 60% CAM	
Ownership	Direct	Direct	Direct	
Metering	BTM	BTM	BTM	
System Size (kW DC)	247.7	247.7	391.8	
System Size (AC kWh)	300,418	300,000	475,302	
Total Installed Cost (Upfront Cost)	$606,391	$606,391	$875,857	
Installed Cost Per Watt DC (Pre-incentives)	$2.45	$2.45	$2.24	
Installed Cost Per Watt DC (Post-incentives)	$1.24	$1.24	$1.13	*26% ITC & Accelerated Depreciation*
<u>Investment Return Analysis</u>				
Payback Period	4.7	6.7	5.4	*years*
Levelized Cost of Electricity (LCOE)	$0.07	$0.07	$0.06	*25 years*
Levered IRR	103%	85%	97%	*70% loan*
Unlevered IRR	19%	13%	17%	
Cash Multiple	3.45x	2.31x	3.05x	*25 years*
Yield on Cost (with ITC and depreciation benefits)	22%	16%	20%	
Impact on Property Value (Year-2 EBITDA)	$1,228,239	$855,905	$1,615,703	*Cap rate = 5%*
<u>Year 1 Revenue</u>				
Consumed Energy Saving (CAM Accounts)	$58,983	$0	$34,418	
Consumed Energy Saving (offsetting AFF utility allowances)	$0	$41,016	$41,016	
SMART Payment (Incentive or Exported energy compensation)	$9,589	$9,576	$15,172	*Block 10 with adder*
<u>Lifetime Revenue</u>				
Consumed Energy Saving (CAM Accounts)	$2,005,084	$0	$1,170,020	
Consumed Energy Saving (offsetting AFF allowances)	$0	$1,313,755	$1,313,755	
SMART Payment (Incentive or Exported energy compensation)	$182,945	$182,690	$289,443	*Block 10 with adder*
<u>Environmental Benefits</u>				
Co2 Emissions Avoided Annually	465000	465000	736000	*lbs.*
Equivalent to				
Annual Co2 emissions from electricity of	22	22	35	*homes*
Annual greenhouse gas emission from	45	45	71	*cars*
Carbon sequestered annually in US forests of	200	200	317	*acres*

Figure 41 – Case study 2 Financial Return Summary Comparison

6.8 SUMMARY RESULTS

In this case study, the benefits of using solar energy for affordable units in market-rate developments are discussed, and two new use options are proposed and compared with Option A from Case study 1. These use options are:

- Option A – offset 100% CAM usage
- Option C – offset 100% affordable units' usage
- Option D - offset 100% Affordable units' and 60% CAM usage

Avoided utility allowance savings and SMART incentives were used as primary sources of income for offsetting the usage of affordable units. As the amount of allowances differ by location and the regional agency, the average cost from all agencies was used for the study.

In the analysis of the highest return for solar investment, it is evident that the system that is designed to offset affordable units' usage exclusively (Option C) offer less desirable financial returns compared to the system that only offsets common area usage (Option A). The larger combined system (Option D), which was designed to offset 100% of affordable units' and partial CAM account usage, is a better alternative to Option C but offers less desirable return than Option A.

Considering the complexity and limitations of offsetting affordable units' usage outlined in section 6.3 with slightly lower returns, it is apparent that in order to encourage commercial multi-family owners to expand solar energy to their affordable units, additional incentives are required. Higher affordable property rate-adder for SMART incentives, more flexibility on net metering, or a discount from regional agencies for developers can encourage the growth of solar to households who need it the most. If a mechanism can be used to bundle all affordable units' usage and eliminate the risk of individual assignments, a significant risk can be eliminated.

As each property is unique in its energy use, it is highly recommended to hire a consultant to estimate electricity use by each unit type at the property before completing system design. Unit size, heating, cooling equipment, and many other factors play a significant role in the electricity usage of the units. Also, to avoid 40% net metering loss, there are solutions such as the direct connection between solar and affordable-unit meters that can be explored in the early phases of project development. However, this approach may remove the flexibility to re-assign affordable units in the future.

7 CONCLUSIONS

The sun is a powerful source, and even in the least sunny regions, it gives us the unique potential to deliver stable cashflow with minimal operational requirements. Today, solar equipped multi-families represent a small portion of the sector. Fast forward to 2040 or 2050, when solar will become a requirement, it seems inevitable that a significant ramping up is about to happen.

In this thesis, we analyzed two different ownership structures and four different system designs in two case studies. We conclude that a system with the following characteristics is the best choice for multi-family owners and developers in the state of Massachusetts:

- **Ownership:** Direct ownership
- **Location:** Rooftop
- **Metering and use**: Behind-the-meter system for common areas and amenities
- **Size:** 100% annual use of CAM accounts with a battery storage solution
- **Installation Time**: If possible, during construction and upon roof install. Solar systems, due to their high life expectancy, are recommended to be installed on roofs with at least 20-25 years of remaining useful life.
- **Minimum ownership duration**: 5 years to take full advantage of tax benefits

A key challenge for developers will be overcoming the misconception that solar assets are immature, specialized, or particularly complex. In actuality, these systems are easy to design, install, and maintain. They come with long-term warranties, a guaranteed minimum annual generation, and locked incentives for twenty years. But timing is essential –

- It is critical to use subsidies and incentives while they are available. Although the installation cost of solar systems may decrease over time, the subsidies and incentives provide significant savings, which will phase out over time. For example, ITC benefits drop from 26% to 10% for systems with a construction start of 12/31/21 or after.
- Early adopters will get the most benefit from differentiated products and green energy curb appeal.
- In the multi-year process of real estate development, more cities, towns, and municipalities are adopting higher performance standards such as zero net carbon and zero net energy. Developers who ignore the rapid change in the regulations will be left with properties that are only a few years old but require significant capital improvement.

Hold strategies are important in solar decision making, both merchant buildings and long-term hold investors benefit from Solar. Merchant builders are limited on realizing the full benefits of ITC and depreciation but will benefit from the increased asset value upon sale. Owners with long-term hold strategies will be able to realize the tax benefits in full, in addition to owning assets that hold their value. I hope this thesis provides a pathway for multi-family owners and developers who would consider the adoption of solar in their communities.

8 APPENDIXES:

8.1 SOLAR INSULATION IN THE UNITED STATES:

Solar insolation is the amount of solar energy that falls on a given area over some period of time. Insolation is often given in terms of kilowatt-hours (kWh) of energy per square meter per day. The output from a PV array is directly related to the amount of insolation that falls on the array. This is because the current from a PV module increases as the irradiance striking the module increases. The EPA recommends that candidate PV sites have insolation levels higher than 3.5 kWh per square meter per day. Figure 42 below shows the average daily solar insulation in the United States. As shown, most of the continental United States and Hawaii have annual average insolation levels greater than 3.5 kWh per square meter per day.

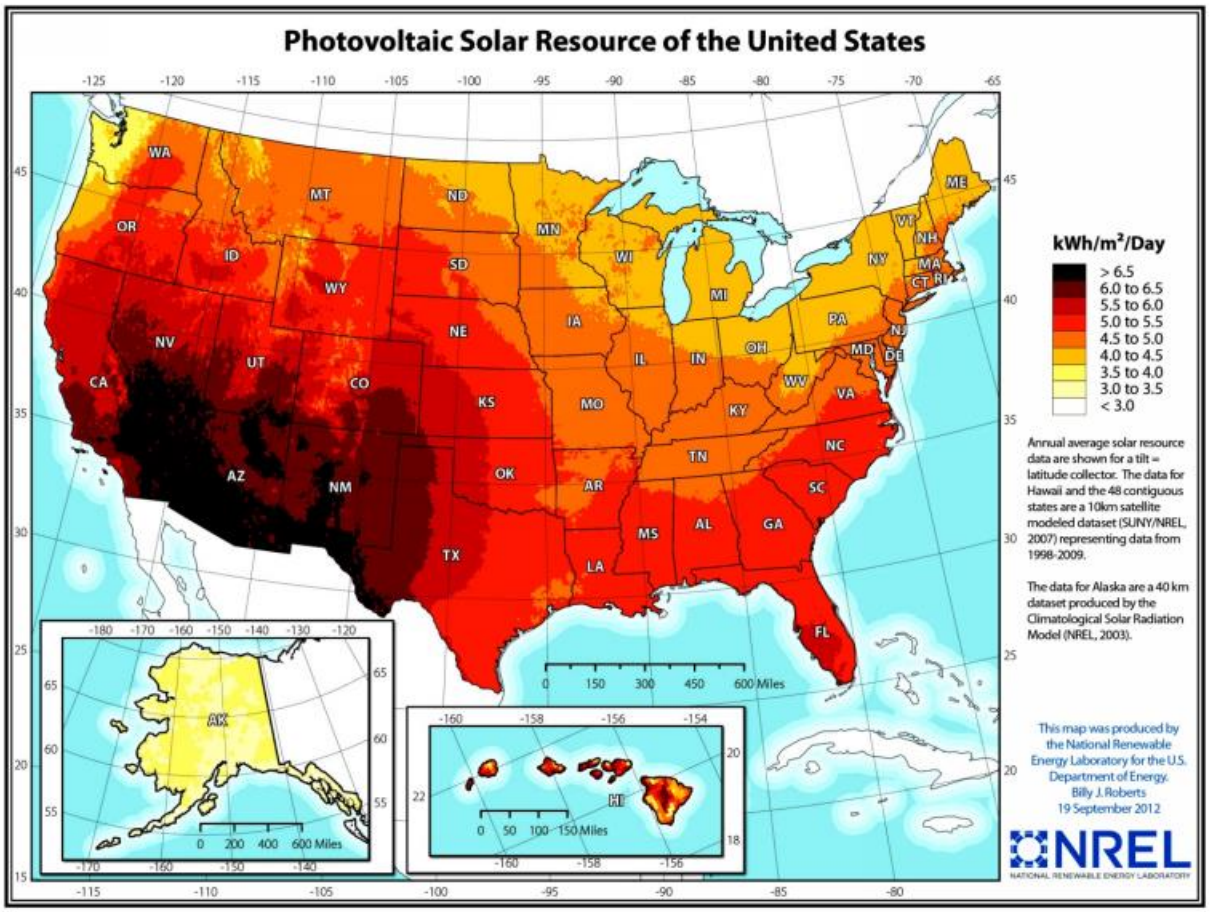


Figure 42 - Average Daily Solar Insolation in the US [66]

[66] *Source: NREL*

8.2 SMART Program Summary of Base Compensation Rates by Service Territory, Generation Unit Capacity, and Capacity Block: [67]

See pages 70 and 71 below

[67] https://www.mass.gov/files/documents/2018/01/11/Capacity%20Block%20Base%20Compensation%20Rate%20and%20Compensation%20Rate%20Adder%20Guideline_0.xlsx

Summary of Base Compensation Rates by Service Territory, Generation Unit Capacity, and Capacity Block

Electric Distribution Company	Generation Unit Capacity	Base Compensation Rate Factor	Term Length	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Block 7	Block 8
Fitchburg Gas & Electric d/b/a Unitil [1] [2]	Low income less than or equal to 25 kW AC	230%	10-year	$0.35795	$0.32645	$0.29772	$0.27152	Not Applicable			
	Less than or equal to 25 kW AC	200%	10-year	$0.31126	$0.28387	$0.25889	$0.23611				
	Greater than 25 kW AC to 250 kW AC	150%	20-year	$0.23345	$0.21290	$0.19417	$0.17708				
	Greater than 250 kW AC to 500 kW AC	125%	20-year	$0.19454	$0.17742	$0.16181	$0.14757				
	Greater than 500 kW AC to 1,000 kW AC	110%	20-year	$0.17119	$0.15613	$0.14239	$0.12986				
	Greater than 1,000 kW AC to 5,000 kW AC	100%	20-year	$0.15563	$0.14193	$0.12944	$0.11805				
Massachusetts Electric d/b/a National Grid [3]	Low income less than or equal to 25 kW AC	230%	10-year	$0.35795	$0.34363	$0.32989	$0.31669	$0.30402	$0.29186	$0.28019	$0.26898
	Less than or equal to 25 kW AC	200%	10-year	$0.31126	$0.29881	$0.28686	$0.27538	$0.26437	$0.25379	$0.24364	$0.23390
	Greater than 25 kW AC to 250 kW AC	150%	20-year	$0.23345	$0.22411	$0.21514	$0.20654	$0.19828	$0.19034	$0.18273	$0.17542
	Greater than 250 kW AC to 500 kW AC	125%	20-year	$0.19454	$0.18676	$0.17929	$0.17211	$0.16523	$0.15862	$0.15228	$0.14618
	Greater than 500 kW AC to 1,000 kW AC	110%	20-year	$0.17119	$0.16435	$0.15777	$0.15146	$0.14540	$0.13959	$0.13400	$0.12864
	Greater than 1,000 kW AC to 5,000 kW AC	100%	20-year	$0.15563	$0.14940	$0.14343	$0.13769	$0.13218	$0.12690	$0.12182	$0.11695
Nantucket Electric d/b/a National Grid [4] [5]	Low income less than or equal to 25 kW AC	230%	10-year	$0.39100	$0.32844	Not Applicable					
	Less than or equal to 25 kW AC	200%	10-year	$0.34000	$0.28560						
	Greater than 25 kW AC to 250 kW AC	150%	20-year	$0.25500	$0.21420						
	Greater than 250 kW AC to 500 kW AC	125%	20-year	$0.21250	$0.17850						
	Greater than 500 kW AC to 1,000 kW AC	110%	20-year	$0.18700	$0.15708						
	Greater than 1,000 kW AC to 5,000 kW AC	100%	20-year	$0.17000	$0.14280						
NSTAR d/b/a Eversource Energy [6]	Low income less than or equal to 25 kW AC	230%	10-year	$0.39100	$0.37536	$0.36035	$0.34593	$0.33209	$0.31881	$0.30606	$0.29382
	Less than or equal to 25 kW AC	200%	10-year	$0.34000	$0.32640	$0.31334	$0.30081	$0.28878	$0.27723	$0.26614	$0.25549

	Greater than 25 kW AC to 250 kW AC	150%	20-year	$0.25500	$0.24480	$0.23501	$0.22561	$0.21658	$0.20792	$0.19960	$0.19162
	Greater than 250 kW AC to 500 kW AC	125%	20-year	$0.21250	$0.20400	$0.19584	$0.18801	$0.18049	$0.17327	$0.16634	$0.15968
	Greater than 500 kW AC to 1,000 kW AC	110%	20-year	$0.18700	$0.17952	$0.17234	$0.16545	$0.15883	$0.15247	$0.14638	$0.14052
	Greater than 1,000 kW AC to 5,000 kW AC	100%	20-year	$0.17000	$0.16320	$0.15667	$0.15041	$0.14439	$0.13861	$0.13307	$0.12775
WMECO d/b/a Eversource Energy [7]	Low income less than or equal to 25 kW AC	230%	10-year	$0.32862	$0.31548	$0.30286	$0.29075	$0.27912	$0.26795	$0.25723	$0.24694
	Less than or equal to 25 kW AC	200%	10-year	$0.28576	$0.27433	$0.26336	$0.25282	$0.24271	$0.23300	$0.22368	$0.21473
	Greater than 25 kW AC to 250 kW AC	150%	20-year	$0.21432	$0.20575	$0.19752	$0.18962	$0.18203	$0.17475	$0.16776	$0.16105
	Greater than 250 kW AC to 500 kW AC	125%	20-year	$0.17860	$0.17146	$0.16460	$0.15801	$0.15169	$0.14563	$0.13980	$0.13421
	Greater than 500 kW AC to 1,000 kW AC	110%	20-year	$0.15717	$0.15088	$0.14485	$0.13905	$0.13349	$0.12815	$0.12302	$0.11810
	Greater than 1,000 kW AC to 5,000 kW AC	100%	20-year	$0.14288	$0.13716	$0.13168	$0.12641	$0.12135	$0.11650	$0.11184	$0.10737

1 Pursuant to 225 CMR 20.07(3)(b), DOER has elected to administratively set the Block 1 Base Compensation Rate for Fitchburg Gas & Electric d/b/a Unitil at $0.15563/kWh. As of January 11, 2018, Fitchburg Gas & Electric has the highest percentage of installed solar capacity of investor-owned service territory in the state relative to the number of its number of customers and total load served. Because of this, Fitchburg Gas & Electric's procurement result suggests that its small service territory and small number of eligible projects in the 1-5 MW range were the primary reasons it did not receive proposals under the initial competitive procurement. Given that Fitchburg Gas & Electric's service territory is geographically surrounded by Massachusetts Electric's service territory, DOER determined it was reasonable to assume that it would have seen a similar result to Massachusetts Electric's procurement if more projects were able to respond to the RFP. Accordingly, DOER used the result of Massachusetts Electric's procurement results to establish Fitchburg Gas & Electric's Base Compensation Rates.2 Fitchburg Gas & Electric d/b/a Unitil has elected to have four Capacity Blocks with an 8.8% decline in Base Compensation Rates per Capacity Block, as permitted under 225 CMR 20.05(3) and 225 CMR 20.07(2), respectively.3 Pursuant to 225 CMR 20.07(3)(b), DOER has established Massachusetts Electric's Block 1 Base Compensation Rate as the mean price of the selected bids received under the procurement conducted pursuant to 225 CMR 20.07(3)(a).4 Pursuant to 225 CMR 20.07(3)(b), DOER has elected to administratively set the Block 1 Base Compensation Rate for Nantucket Electric d/b/a National Grid at $0.17000/kWh. Nantucket Electric's unique geographic location and low levels of solar development to date as compared to other service territories indicates that higher costs are likely a barrier. Accordingly, DOER has determined that it is more than likely that the primary reason that Nantucket Electric did not receive any proposals under the initial procurement is due to these higher than average costs. As such, DOER has established the Base Compensation Rate at the Ceiling Price of the initial competitive procurement.5 Nantucket Electric d/b/a National Grid has elected to have two Capacity Blocks with a 16% decline in Base Compensation Rates per Capacity Block, as permitted under 225 CMR 20.05(3) and 225 CMR 20.07(2), respectively.6 Pursuant to 225 CMR 20.07(3)(b), DOER elected to administratively set NSTAR's Block 1 Base Compensation Rate at $0.17000/kWh. This reflects the price of the single selected bid for a 2 MW project received under the procurement conducted pursuant to 225 CMR 20.07(3)(a). While the NSTAR solicitation was for 46 MW and received 2 MW, the competitive nature of the procurement in other service territories supports a conclusion that the primary reason NSTAR did not receive more than one proposal under the procurement is due to higher costs in its service territory. Accordingly, while DOER considered terminating the solicitation and re-issuing, DOER determined that doing so would likely not yield a significantly different result.7 Pursuant to 225 CMR 20.07(3)(b), DOER has established WMECO's Block 1 Base Compensation Rate as the mean price of the selected bids received under the procurement conducted pursuant to 225 CMR 20.07(3)(a

8.3 Summary of Compensation Rate Adder Values by Type and Adder Tranche

Summary of Compensation Rate Adder Values by Type and Adder Tranche									
Adder Type[1]	**Generation Unit Type**	**Adder Tranche and Value ($/kWh) [2]**							
		Adder Tranche 1 (80 MW)	**Adder Tranche 2 (TBD)**	**Adder Tranche 3 (TBD)**	**Adder Tranche 4 (TBD)**	**Adder Tranche 5 (TBD)**	**Adder Tranche 6 (TBD)**	**Adder Tranche 7 (TBD)**	**Adder Tranche 8 (TBD)**
Location Based	Building Mounted Solar Tariff Generation Unit	$0.02000	$0.01920	$0.01843	$0.01769	$0.01699	$0.01631	$0.01566	$0.01503
	Floating Solar Tariff Generation Unit	$0.03000	$0.02880	$0.02765	$0.02654	$0.02548	$0.02446	$0.02348	$0.02254
	Solar Tariff Generation Unit on a Brownfield	$0.03000	$0.02880	$0.02765	$0.02654	$0.02548	$0.02446	$0.02348	$0.02254
	Solar Tariff Generation Unit on an Eligible Landfill	$0.04000	$0.03840	$0.03686	$0.03539	$0.03397	$0.03261	$0.03131	$0.03006
	Canopy Solar Tariff Generation Unit	$0.06000	$0.05760	$0.05530	$0.05308	$0.05096	$0.04892	$0.04697	$0.04509
	Agricultural Solar Tariff Generation Unit	$0.06000	$0.05760	$0.05530	$0.05308	$0.05096	$0.04892	$0.04697	$0.04509
Off-taker Based	Community Shared Solar Tariff Generation Unit	$0.05000	$0.04800	$0.04608	$0.04424	$0.04247	$0.04077	$0.03914	$0.03757
	Low Income Property Solar Tariff Generation Unit	$0.03000	$0.02880	$0.02765	$0.02654	$0.02548	$0.02446	$0.02348	$0.02254
	Low Income Community Shared Solar Tariff Generation Unit	$0.06000	$0.05760	$0.05530	$0.05308	$0.05096	$0.04892	$0.04697	$0.04509
	Public Entity Solar Tariff Generation Unit	$0.02000	$0.01920	$0.01843	$0.01769	$0.01699	$0.01631	$0.01566	$0.01503
Energy Storage[3]	Energy Storage Adder (Figure 43)	Variable	Variable	Variable	Variable	Variable	Variable	Variable	Variable
Solar Tracking	Solar Tracking Adder	$0.01000	$0.00960	$0.00922	$0.00885	$0.00849	$0.00815	$0.00783	$0.00751

ENTER INFORMATION IN BLUE CELLS ONLY	
Energy Storage Adder Block Tranche #	**4**
Solar PV Capacity (kW DC)	247.7
Storage Nominal Rated Power Capacity (kW)	61.925
Storage Hours at Rated Capacity	2
Adder Multiplier	0.0398
Storage Adder ($/kWh)	$0.0247

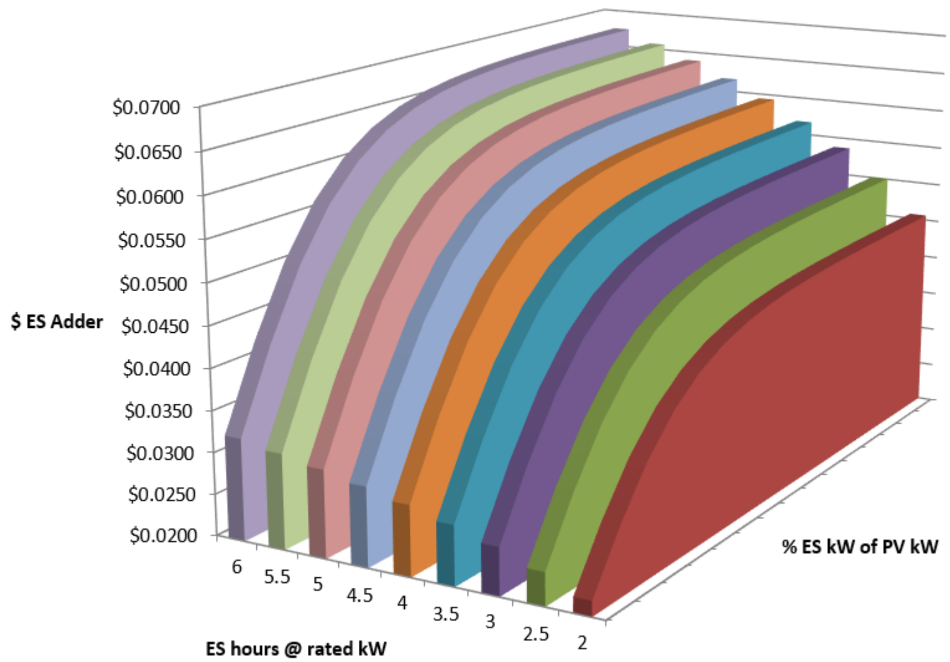


Figure 43 - DOER Energy Storage Calculator