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Boston Zero Net Carbon

On-Site Renewable Energy Technical Advisory Group Recommendations and Considerations

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Table of Contents

This report summarizes the findings and recommendations of the Cadmus Group based on our work with the On-Site Renewable Energy Technical Advisory Groups (TAG) in support of Boston's Zero Net Carbon Building Zoning Initiative. The report is organized into four sections: I. Introduction and Background, II. Recommendations, III. Financial Analysis, and IV. Additional Considerations. Appendix 1 provides additional resources related to solar photovoltaic (PV) system ownership models, financing, and incentives.

I. Introduction and Background

In September 2020, The Boston Planning and Development Agency (BPDA) launched their Zero Net Carbon Building (ZNC) Zoning Initiative seeking to develop to a zero net carbon standard for new construction as a step toward the City's goal of carbon neutrality by 2050. To support this effort, the BPDA created four TAGs: Low Carbon Building, On-Site Renewable Energy, Renewable Energy Procurement, and Embodied Carbon.

The On-Site Renewable Energy TAG was facilitated by BPDA with support from Cadmus. The TAG consisted of 12 members, including representation from the development sector, solar developers, planning and architecture, and engagement of five City staff. Three TAG meetings were held, focusing on 1) initial scoping and strategy, 2) development of recommendations, and 3) review of recommendations and financial analysis. This report summarizes the input and discussion of the TAG and the recommendations that emerged from these discussions.

Context

The City of Boston has long been a leader in solar energy and green buildings. The City first adopted Article 37 in the Zoning Code in 2007 requiring high performance, sustainable building practices in accordance with US Green Building Council Leadership in Environmental and Energy Design (LEED) Rating System(s). The City has also adopted the Massachusetts Stretch Code, which requires designation of a solar ready zone and preparation for electrical interconnection (but does not require installation of the solar energy system).

There is existing precedent in Massachusetts for requiring the installation of solar PV for new construction through municipal zoning. The City of Watertown Zoning Ordinance (Section 8.05, as amended December 11, 2018) requires development undergoing site plan review approval under Section 9.03 (Site Plan Review of Certain Residential and Non-Residential Developments) that is greater than 10,000 gross square feet "shall include a solar energy system that is equivalent to a minimum of 50% of the roof area of all buildings. In cases where a site includes an uncovered parking structure, the structure shall also have a solar energy system installed to cover a minimum of 90% of its top level." There are also numerous cities across the United States that now mandate solar energy installations, including San Francisco, Santa Monica, CA and South Miami, FL.

II. Recommendations

The On-Site Renewable Energy TAG developed the following goals to guide the development of the on-site generation portion of the ZNC policy:

- To ensure ZNC buildings reduce carbon emission through the use of on-site renewable energy resources by establishing minimum standards for installation of on-site renewable energy systems;
- To reward innovation;
- To maximize the deployment of renewable energy in the City of Boston in order to fully realize the benefits of local energy generation (i.e., resilience, jobs, air quality, grid services); and
- To ensure accountability and transparency in compliance with ZNC Regulations.

Furthermore, the TAG sought to ensure that ZNC Zoning requirements for on-site generation maximize the benefits of local generation, including:

- Emission Reductions
- Electric Grid Management
- Local Job & Business Creation
- Public Health
- Resilience

In addition, the group also recognized the following project aspects:

- Physical feasibility: shading, roof uses, setbacks/access
- Regulatory feasibility: utility interconnection, zoning code, building code
- Financial feasibility: costs, incentives, credit, electricity rates, and ownership models

To these goals, the TAG developed the following recommendations:

1. **Net Zero Carbon buildings should optimize on-site renewable energy production.** ZNC buildings should be planned and designed to go beyond "solar ready" and instead be "solar optimized." This means that the opportunity for solar is considered in the earliest stages of project design and that design decisions are made to maximize the capacity and performance of solar PV on rooftops, integrated in building structures, and ground-mount canopies. Solar optimization and building and urban design options and priorities are to be equally considered. The installation of the solar PV should be complete as part of project construction and is a requirement for occupancy.

   To best realize opportunities for solar, the City should engage project teams at the earliest stages of project planning and require building designs to:
   - Maximize south-facing solar opportunities on building roofs, facades, and sites
   - Layout roof to maximize space free of obstructions (including minor MEP)
     - Consolidate mechanicals equipment and vents;
     - Consider complementary uses (solar as shading for roof decks); and
     - Avoid roof forms and slopes unsuitable for solar energy systems.

2. **Define a Minimum Area for Solar.** While the goal is to optimize the amount of solar installed at each ZNC building, in order to ensure that all buildings are integrating solar, the TAG recommends defining a minimum area for solar in the design process. They recommend the minimum area is 50% of the building roof that is flat or oriented between 110 and 270 degrees of true north, 90% of the top level if that is open, and 50% of surface parking.

3. **Allow participation in the SMART Program.** Recognizing the importance of new local renewable energy systems to Boston's carbon neutral goals and that the Solar Massachusetts Renewable Target (SMART) Program is important to the financial feasibility of many solar energy installations the TAG recommends that ZNC buildings are allowed to participate in the SMART Program. However, because the SMART program retains the related RECs for the public utilities the ZNC code will need to provide guidance related to SMART Program participation and energy/carbon accounting (via BERDO). This is a concept that is likely to need additional consideration as the City develops the final policy language and may require legal review. It is important to be clear about REC ownership and who is taking credit for renewable energy. The TAG suggested that the City develop a definition of "SMART Energy" and allow ZNC buildings to comply with on-site requirements using "SMART Energy." By enabling participation in the SMART program, the City could help to incentivize local generation and enable projects to be more financially viable. Section III provides two financial case studies that further illustrate the importance of the SMART Program on project finances.

   Draft definition of "SMART Energy": Solar Energy generated at a ZNC Building by where RECs are not owned by the building owner due to participation in SMART program.

III. Financial Considerations: Case Studies

In the section below, Cadmus aims to demonstrate how the ZNC would affect project finances through two illustrative case studies: a representative lab building and a multi-family home in Boston. The Cadmus team worked with the On-Site Renewable Energy TAG to select the representative building types. Cadmus then modeled the design and estimated output of potential solar PV systems atop the two representative buildings using Helioscope, a web-based PV design software.[1] The theoretical feasibility assessment detailed in this section includes both a technical analysis and an economic analysis of the priority sites. The technical analysis outlines the potential sizes of PV systems and annual electricity generation. The economic analysis includes an estimated cost of the systems; financing and contract options; and payback and return on investment scenarios generated using NREL's System Advisor Model (SAM).[2]

Technical Case Study Overview

The estimated annual solar PV production offered in this analysis can be used to project annual energy savings for building owners under the proposed ZNC. We would expect site-specific energy savings to continue over a 25-year timeline with minimal (approximately 0.8%) annual performance degradation.

[1] Helioscope is a cloud-based solar photovoltaic design modeling software that integrates system design and performance modeling to develop preliminary layouts and energy yield calculations for measuring solar PV feasibility.

[2] National Renewable Energy Laboratory (NREL). System Advisor Model. https://sam.nrel.gov/

For each design below, Cadmus maintained reasonable and consistent technology assumptions, including the use of 370-Watt panels and inverters optimized to produce accurate PV generation estimates. As designed, the PV systems depicted below also ensure that no roof-mounted solar PV system would cause the shedding of ice or snow from the roof into a porch, stairwell, or pedestrian travel area. Cadmus ensured these safety requirements were met by incorporating setbacks and access pathways that exceeded the minimum requirements as defined in the National Fire Protection Association Fire Code.[3] In the depiction of each solar PV design, each blue rectangle represents a single PV module. Orange-shaded areas represent locations where solar PV was not "installed", due to the safety requirements mentioned above, or obstructions like mechanical equipment, access pathways, and stairwells.

Financial Case Study Overview

For the purposes of this financial analysis, both the representative lab building, and the multi-family home were modeled under two direct-ownership scenarios: (1) Direct Ownership without enrollment in the SMART program, which would enable the building owner to retain the RECs generated by their system, and (2) Direct Ownership with enrollment in the SMART program, which sacrifices retention of the system's RECs but provides additional financial return via the SMART program. Each case study was also modeled under a Third-Party Ownership (TPO) scenario, whereby the site host would enter into a power purchase agreement (PPA) with the owner. Under a PPA, Cadmus assumed the developer would require that the PV system is enrolled in the SMART program. Additional details on ownership, financing, and incentives are provided in Appendix 1.

It is important to note that for the ZNC buildings modeled, Cadmus is not comparing the return on investment of solar PV to the option of "doing nothing." All ZNC buildings will be mandated to generate or buy 100% of their energy from renewable energy resources, and the projections below reflect that assumption.[4] For the purpose of this analysis, Cadmus has not factored in the potential reduction of demand charges from solar PV, as it's difficult to predict when a net zero building will experience peak load. The basic financial assumptions used for both the Lab and MFH case study scenarios are summarized in Table 1.

Table 1. Financial Analysis Inputs

Input	Estimated Values
Project Lifetime (years)	25
Energy Yield Ratio (kW/kWh)	1,131
Electricity Bill Escalation Rate	1.5%
Federal Investment Tax Credit (ITC)	26%
Loan to Value Ratio	53.8%
Annual Interest Rate	6.1%
Debt Tenor (years)	10

[3] National Fire Protection Association (NFPA) 1, 2015. Section 11.12 Photovoltaic Systems. https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1

[4] Both case studies' basic service rate for electricity was estimated using the 100% Green Electricity offering via the City of Boston's Community Choice Electricity program. The value of energy was calculated by adding the expected transmission, transition, and distribution charges to the estimated basic service rate for each building type. City of Boston. Community Choice Electricity. https://www.boston.gov/departments/environment/community-choice-electricity.

Inverter Replacement Cost in Year 13 ($/Watt)	$0.30
Decommissioning in Year 25 ($/Watt)	$0.30
Annual O&M Cost ($/kW)	$20.00

Note that for the purposes of the financial analyses below, Cadmus assumed the commercial entities owning the solar PV systems are able to utilize 100% of the state and federal tax benefits for which they are eligible.[5]

Case Study 1: Lab

The representative lab building modeled was designed to demonstrate the technical and financial feasibility of a solar PV project at a large commercial building in Boston. It was estimated that a commercial lab building of this size would have an estimated monthly electricity load of 579,719 kWh, with total annual demand just below 6,957,000 kWh. Informed by the lab building's electricity use profile, Cadmus assumed the utility rates and SMART incentive payments listed in Table 2 below.

Table 2. Lab Building Rates and Incentives

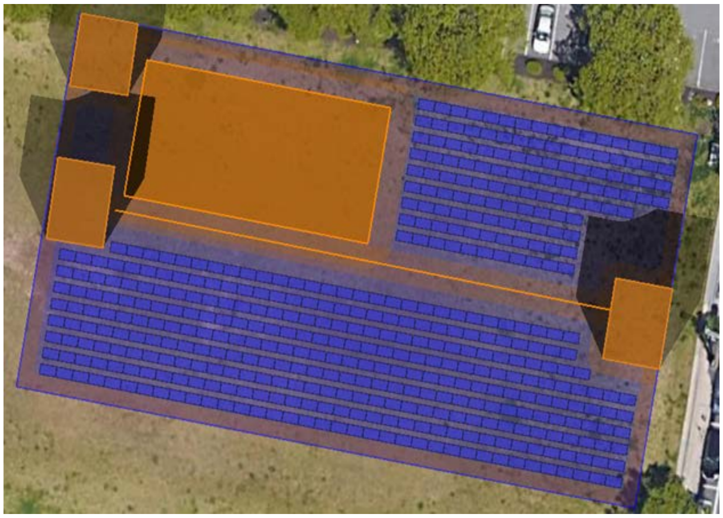
Input	Estimated Lab Value
Average Monthly Usage	579,719 kWh
Estimate Annual Usage	6,956,626 kWh
100% Green Basic Service Rate	$0.1426/kWh
Value of Energy (VOE)	$0.1506/kWh
SMART Incentive Payment	0.1233/kWh

Technical Analysis: Lab

As designed, the lab building modeled is 180 feet tall, with a total building area of 316,500 sq. ft. and a roof area of 25,816 sq. ft. (120 ft. X 215 ft.). The lab building is set back from the nearest street and abutting property line by at least 15 ft. The solar PV system designed at the representative lab building covers an estimated 13,544 sq. ft., or about 52% of the total roof area, in-line with the 50% coverage requirement detailed in the proposed ZNC. As designed, the solar PV system at the lab building would have a 159.8 kW-DC capacity, enough to generate 180,000 kWh for year 1, which represents 2.6% of total estimated on-site electricity load.

[5] This is important to note, because a bank may view these projects as over leveraged given the financing assumptions modeled. As demonstrated in the cash flows depicted in Figure 2 and Figure 4, for example, setting the debt tenor at 10 years may be creating a debt burden that is too high, i.e., cash flows available to service the debt may not be sufficient. Longer-term debt financing may be more beneficial.

Figure 1. Potential Solar PV Design at Representative Lab Building



System Specifications

PV System Area: 13,544 sq. ft.
Roof Area/PV Area: 52%
PV System Capacity (kW-DC): 159.8
PV System Capacity (kW-AC): 125.3
Azimuth: 190°
Annual PV Generation (kWh): 180,000
Annual Load Offset: 2.6%
Installed Cost ($2.50/W): $399,500
Panels: 432

Financial Analysis: Lab

Cadmus' financial analysis indicates that the solar PV system at the representative lab building is cost effective under both direct-ownership scenarios evaluated, in addition to the PPA scenario modeled. When enrolled in the SMART program, the solar PV system generated an internal rate of return (IRR) of about 25%, while the solar PV system without enrollment in the SMART program had an IRR of 5% under a direct ownership model. Under the PPA scenario modeled, the developer's IRR for the project came to an estimated 18%. The PPA scenario assumes enrollment in the SMART program and a 15% discount rate on electricity for the offtaker. Cadmus assumed a solar PV install cost of $2.50/Watt for this system.

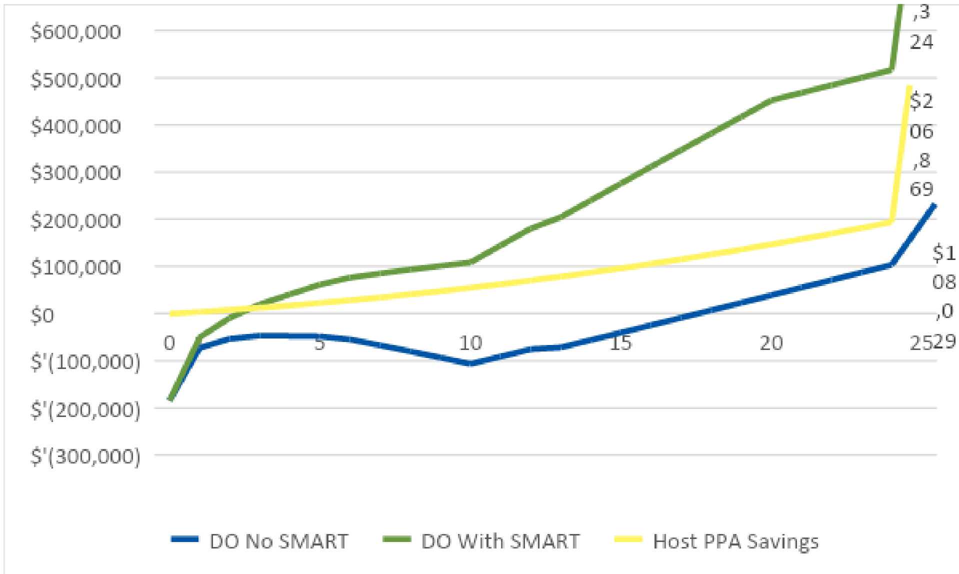
Table 3. Lab Building Direct Ownership Financial Analysis Outputs

Ownership Scenario	Total Capital Install Cost	Value of Federal ITC	Year 1 Avoided Electricity Cost	Year 1 SMART Solar Incentive Payment	25-Year Cumulative After-Tax Cash Flow	Project IRR
Direct Ownership (w/o SMART)	$399,500	$103,870	$27,200	$0	$108,030	5%
Direct Ownership (w/ SMART)	$399,500	$103,870	$27,200	$22,280	$521,325	25%

Table 4. Lab Building Third-Party Ownership Financial Analysis Outputs

Ownership Scenario	Annual Electricity Usage Offset by PV	Utility VOE ($/kWh)	Year 1 PPA Rate (15% Discount)	Est. Annual PPA Savings	Project Owner IRR
PPA (w/ SMART)	180,000	$0.1506	$0.1296	$3,800	18%

Figure 2. Lab Scenario 25-Year Value to Building Owner



As shown in Figure 2, all three ownership scenarios modeled for the representative lab building generate economic value to the building-owner over the 25-year project lifetime. Note that in Figure 2, value to the building owner reflects cumulative after-tax cash flow for both direct ownership scenarios and expected electricity savings for the PPA scenario modeled. The direct ownership scenario with enrollment in the SMART program (orange line) produces maximum benefit to the building owner, producing an estimated 25-year after-tax cashflow of over $500,000. If the system is owned directly and foregoes the SMART incentive (blue line), then cumulative after-tax cashflow over the project lifetime is expected to decrease from an estimated $500,000 down to just over $100,000. This decrease in value is a result of the project sacrificing the $0.123/kWh SMART incentive for the estimated 180,000 kWh the system would produce annually, though it would allow for the building owner to retain the project's RECs.

Under the 15% fixed discount PPA rate scenario, represented by the gray line, the building owner would generate an estimated $200,000 in savings over the project lifetime. Unlike the direct ownership options evaluated, a PPA does not require any upfront investment from the building owner. Instead, the building owner benefits from an immediate 15% savings on their electricity bill for the energy their system produces, equivalent to the PPA discount rate. In year 1, PPA savings to the building owner are expected to be approximately $3,800.

Case Study 2: Multi-Family Housing (MFH)

The representative multi-family residential building modeled was designed to specifications provided by the On-Site Renewable Energy TAG and was selected to demonstrate the technical and financial feasibility of a solar PV project at a multi-family building in Boston. It was estimated that a MFH of this size would have a monthly electricity load of 71,280 kWh, with total annual demand just over 855,000 kWh. Informed by the MFH's electricity use profile, Cadmus assumed the utility rates and SMART incentive payments listed in Table 5 below.

Table 5. MFH Rates and Incentives

Input	Estimated Values
Average Monthly Usage	71,280 kWh
Estimate Annual Usage	855,359 kWh
100% Green Basic Service Rate	$0.1525/kWh
Value of Energy	$0.1950/kWh
SMART Incentive Payment	$0.0789/kWh

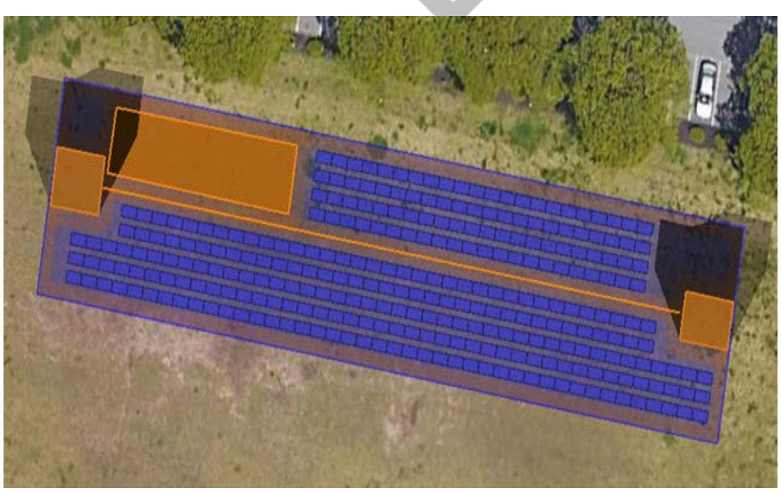
Technical Analysis: MFH

As designed, the MFH modeled is 84 feet tall, with a total building area of 97,290 sq. ft. and a roof area of 15,085 sq. ft. (60.2 ft. X 250.4 ft.). The MFH is set back from the nearest street and abutting property line by at least 25 ft. The solar PV system designed at the representative MFH covers an estimated 8,078 sq. ft., or about 54% of the total roof area, in-line with the 50% coverage requirement detailed in the proposed ZNC. As designed, the solar PV system at the MFH would have a 105.1 kW-DC capacity, enough to generate 118,000 kWh annually or 14% of total estimated on-site electricity load.

Figure 3. Potential Solar PV Design at Representative Multi-Family Home

System Specifications

PV System Area: 8,078 sq. ft.
Roof Area/PV Area: 54%
PV System Capacity (kW-DC): 105.1
PV System Capacity (kW-AC): 82.4
Azimuth: 190°
Annual PV Generation (kWh): 118,000
Annual Load Offset: 14%
Installed Cost ($2.50/W): $262,750
Panels: 284



Financial Analysis: MFH

Cadmus' financial analysis indicates that the solar PV system at the representative MFH is cost effective under either direct ownership scenario evaluated, in addition to the PPA scenario modeled. When owned directly and enrolled in the SMART program, the solar PV system generated an internal rate of return (IRR) of about 23%, while the solar PV system without enrollment in the SMART program had an IRR of 10%. Under the PPA scenario modeled, the developer's IRR for the project came to an estimated 14%. The PPA scenario assumes enrollment in the SMART program and a 15% discount rate on electricity for the offtaker. Cadmus assumed a solar PV install cost of $2.50/Watt for this system.

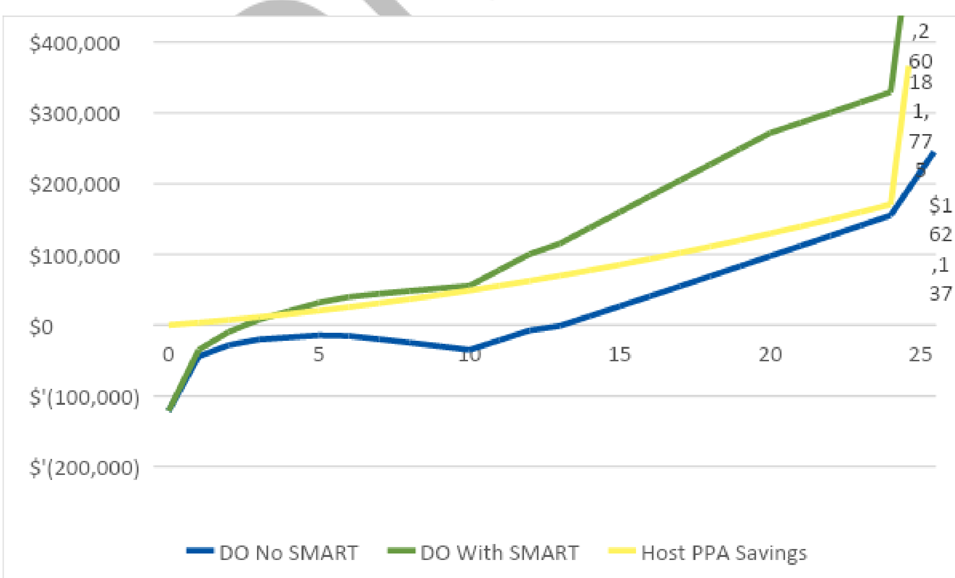
Table 6. Multi-Family Home Direct Ownership Financial Analysis Outputs

Ownership Scenario	Total Capital Install Cost	Value of Federal ITC	Year 1 Avoided Electricity Cost	Year 1 SMART Solar Incentive Payment	25-Year Cumulative After-tax Cash Flow	Project IRR
Direct Ownership (w/o SMART)	$262,750	$68,315	$23,160	$0	$162,137	10%
Direct Ownership (w/SMART)	$262,750	$68,315	$23,160	$9,380	$336,260	23%

Table 7. Multi-Family Home Third-Party Ownership Financial Analysis Outputs

Ownership Scenario	Annual Electricity Usage Offset by PV	Utility VOE ($/kWh)	Year 1 PPA Rate (15% discount)	Est. Annual PPA Savings	Project Owner IRR
PPA (w/ SMART)	118,000	$0.1949	$0.1657	$3,475	14%

Figure 4. MFH Scenario 25-Year Value to Building Owner



Similar to the lab building, all three ownership scenarios modeled for the representative MFH building generate economic value to the building-owner over the 25-year project lifetime. Note that in Figure 4, value to the building owner reflects cumulative after-tax cash flow for both direct ownership scenarios and expected electricity savings for the PPA scenario modeled. The direct ownership scenario with enrollment in the SMART program (orange line) produces maximum benefit to the building owner, producing an estimated 25-year cumulative, after-tax cashflow of over $330,000. If the system is owned directly and foregoes the SMART incentive (blue line), then cumulative after-tax cashflow over the project lifetime is expected to decrease approximately 50%. This decrease in value is a result of the project sacrificing the $0.079/kWh SMART incentive for the estimated 118,000 kWh the system would produce annually, though it would allow for the building owner to retain the project's RECs.

Under the 15% fixed discount PPA rate scenario, represented by the gray line, the building owner would generate an estimated $180,000 in savings over the project lifetime. Unlike the direct ownership options evaluated, a PPA does not require any upfront investment from the building owner. Instead, the building owner benefits from an immediate 15% savings on their electricity bill for the energy their system produces, equivalent to the PPA discount rate. In year 1, PPA savings to the building owner are expected to be approximately $3,750.

The intention of these two illustrative case studies is to show the current technical and financial viability of on-site renewable energy in Boston under the proposed ZNC. As the market for solar PV and other renewable energy resources continue to mature, it is anticipated that project financing opportunities, cost declines, and technology improvements will further improve the financial prospects of renewable energy procurement in the City. Additionally, Boston building owners with on-site renewable energy generation will also be insulated to some extent from electricity cost increases, which Cadmus assumes will continue to rise 1.5% annually.

IV. Additional Details and Considerations

To support solar optimization on ZNC buildings, the TAG recommends a process by which applicants identify the "Solar Zone" which effectively identifies the maximum area available for solar (below is guidance on specific exceptions and exclusions for areas that may reduce the size of the Solar Zone). The Solar Zone should be considered throughout the design and construction process and decisions should be made that reduce potential conflicts and avoid obstructions and intrusions on the Solar Zone. The City should also adopt a Minimum Solar Requirement (further guidance below). The applicant must meet the minimum solar requirement as a condition of building occupancy. This approach is intended to support solar optimization – encouraging project design and decision-making that will maximize solar opportunities- while also providing a clear and enforceable minimum solar standard. The following provides additional details and related definitions and process guidance.

Proposed Minimum Solar Requirement

The On-Site Renewable Energy TAG proposes that a ZNC Building should be planned, designed, engineered, and constructed with a Solar Energy System(s) equal to but not less than:

- 50% of the building roof area(s) that is either flat or oriented between 110 degrees and 270 degrees of true north
- 90% of the parking structure deck(s) uncovered
- 50% of the surface parking area(s)

- Less area reductions due to Solar Exemptions and Solar Exclusions

Physical Exceptions

The following conditions may allow the required Solar Zone(s) to be partially or entirely reduced in size:

- Roof areas where building mechanical and structural systems restrict the available Solar Zone(s).
- Roof, building, and ground plane areas where the Solar Zone(s) is shaded for more than 50 percent of daylight hours annually.
- The total Solar Energy System(s) of a project need not exceed 120% of the annual energy loads of the project.
- Historic Building Preservation or similar Design Overlay District requirements including standards for additional setbacks or other aesthetic exceptions as determined by the Historic Preservation Commission and BPDA Urban Design.

Exclusions

- The Solar Zone(s) may be reduced in size or modified in configuration to accommodate mandatory access and set back areas required by relevant historic preservation, building, and fire codes and regulations.
- The Solar Energy System(s) may be partially or entirely restricted in energy output due to utility electrical distribution system constraints.*
- Solar Energy Systems shall be configured and located so as to ensure the following:
    - Provision of emergency access pathways to and from the roof(s) and roof area(s) required for smoke ventilation as required by building and fire codes. 527 CMR.
    - Snow and ice does not shed into unprotected pedestrian travel area(s).

Proposed Process & Submittals

As part of the BPDA Urban Design and Article 37 Review process projects would provide plans, diagrams, descriptions, and analysis to demonstrate that the Proposed Project has optimized the potential for solar energy production, identified the maximum Solar Zone(s), is planned, designed, and engineered to support the proposed system(s), and that the Solar Energy System(s) is installed and fully operational at construction completion:

- Site and building plans illustrating the maximum feasible Solar Zone(s) for all structures and all ground plane areas including details on any Solar Exceptions, Solar Exclusions, and Electrical Energy Restrictions.
- Solar Energy System(s) description including layout, configuration, system type, size, energy output, controls, storage, and ownership model.
- Post installation Solar Energy System(s) commissioning reports and certificates.
- Other related information deemed supportive or necessary to understanding project and system planning, design, and installation.

Consider a Grace Period

Recognizing that solar incentives, financing, utility interconnection and other issues can impact project timing (and that the City prioritizes on-site generation and is willing to provide some flexibility on timing to overcome these challenges), the TAG recommends the City consider offering a grace period up to

12-months for the installation of solar. During this period, the ZNC building should be required to purchase renewable energy from off-site sources. Projects should be strongly encouraged to complete the installation of solar prior to occupancy, and the City could define a discrete set of circumstances that limit the frequency of granting the use of the grace period and require applicants identify the specific technical or financial constraint that can be resolved within the 12-month period.

Financial Feasibility

As indicated in the financial case studies herein, solar can create economic value and positive cash flow on a variety of project types under today's conditions. As the costs of solar continue to come down, this is likely to be true for an increasing number of projects. By allowing applicants to comply with the on-site requirements through different ownership models and by allowing SMART Program participation, the City is helping to maximize the potential financial returns and enable flexibility. However, every owner has different financial goals and may differ in their access to capital, risk aversion, etc. and the TAG does not recommend that the City define financial feasibility criteria. The City can continue to help educate the development community by publishing case studies and showing how different ownership and financial models are being used to maximize the economic value of on-site solar.

Definitions

Related to the development and installation of On-Site Renewable Energy Generation, the TAG considered and discussed several concepts that require definitions. The following definitions are recommended:

On-Site Generation: On-site renewable energy is located on:

- The building,
- The property upon which the building is located,
- A property that shares a boundary with and is under the same ownership or control as the property on which the building is located, or
- A property that is under the same ownership or control as the property on which the building is located and is separated only by a public right-of-way on which the building is located.

SMART Energy: Solar Energy generated at a ZNC Building by where RECs are not owned by the building owner due to participation in SMART program.

Solar Zone: the building and site area(s) suitable for the Solar Energy System(s)

Appendix 1. Additional Information on Solar Ownership Models, Financing and Incentives

System Ownership Options and Financing

Direct Ownership

This is when the property owner purchases the solar PV system from the installer. Direct ownership normally allows the property owner to collect all eligible federal and state tax benefits, utilize state and local financial incentives, and use the electricity generated by the system.

Third-Party Ownership

The solar installer or a financing partner owns the solar PV system on the municipal property and is responsible for operations and maintenance. The third-party partner collects the tax benefits and financial incentives, including the Federal Investment Tax Credit (ITC), and passes a share of the savings on to the electricity buyer, usually in the form of lower energy costs. Under third-party ownership, there are several options for the property owner to benefit from the solar electric system, the most common of which is a power purchase agreement (PPA). A PPA is an agreement between the energy off-taker and the third-party system owner. The system owner sells the electricity produced by the system to the off-taker at a predictable fixed price per kilowatt hour. The electricity price under a PPA is typically lower than the standard utility price of electricity, so the off-taker receives immediate savings through reduced energy costs. Non-profits often utilize this scheme, because the participant is not responsible for the upfront capital cost of the system or operations and management.

Other third-party ownership options include a site lease agreement between a property owner and solar installer (or a third party) in which the third-party builds, owns, and operates a solar electric system on a host site. The property owner will receive benefits in the form of site lease payments from the third-party. This may be paired with a PPA with the property owner, or the developer may elect to sell the electricity to a utility or another entity. A production guarantee is often included if paired with a PPA, or structured as the leasing of the equipment. Another more complicated option under third-party ownership is the use of a tax equity financing partner, whereby a third-party investor takes passive ownership to receive the tax benefits and cash return on investment. This model in some ways blends the ownership options and may be an option for property owners who favor direct ownership, but don't have the tax liability needed to utilize the federal incentive.

Incentives and Benefits

Massachusetts State Incentives

Massachusetts offers incentives for grid-connected solar projects in investor-owned utility service territories (Eversource, and other MA utilities) through the Solar Massachusetts Renewable Energy

Target (SMART) program.[6] The SMART program provides solar PV system owners with incentives for renewable energy production. Organizations that own the solar electric system will receive the incentive benefit directly, while organizations that opt for third-party ownership will receive the incentive indirectly via the negotiated PPA or lease price. The program provides solar projects an incentive payment in exchange for the environmental attributes of the solar power. The program also contains an array of "adders" which can increase or decrease the incentive payment by project based on its desirability to the state (e.g. large ground-mounted projects are discouraged, and brownfield sites are encouraged). Adder amounts vary and are categorized by location type (e.g. roof, ground), off-taker type (e.g. governmental, low-moderate-income) and energy storage. The program has a declining block framework, so as more projects come online, and a capacity block fills, the incentive levels decline in an effort to mirror forecasted cost declines for the technology. Projects larger than 25 kW-AC receive a 20-year fixed incentive rate determined at the time of application approval, while smaller projects receive a 10-year fixed incentive. The incentive program has been adjusted multiple times throughout its existence and is likely to be modified in the medium-term as the boom in solar installations continue.[7] It is important to note that any solar PV project in Massachusetts that takes advantage of the financial benefits of the SMART program, regardless of ownership option pursued, relinquishes the environmental attributes or renewable energy certificates (RECs) ascribed to the energy their system produces.

Net Metering and Alternative On-Bill Credits

Net metering is the Massachusetts policy that enables owners of solar PV systems to receive monetary credit on their electricity bill for electricity produced by the system and sent to the grid. Bill credits are based on the net energy usage of a facility with solar generation within a given month. The value of these credits varies depending on the size of the solar electric system. See Mass.gov's Net Metering Guide for more information and current rates. An alternative to net metering, Alternative On-Bill Credits (AOBCs) can be monetized by facilities that qualify for the SMART program and are otherwise unable to take advantage of net metering. AOBCs allow bill credits to be transferred across customer accounts, though at a reduced rate compared to net metered systems.

Virtual Net Metering

Virtual Net Metering, also known as a Net Metering Credit Purchase Agreement (NMCPA), functions almost identically to net metering, but introduces a third-party. Under a virtual net metering scenario, a developer builds an off-site solar PV array and the electricity produced by the solar PV array is applied to the off-taker's electric bills in the form of a credit via the utility. Virtual net metering can be a useful tool for those that wish to offset their electricity usage with clean energy, but do not have adequate space to install on-site renewables at the facilities they own. Under this scenario, the developer bills the off-taker

[6] Massachusetts Department of Energy Resources (DOER). Solar Massachusetts Renewable Energy Target (SMART) (2021). https://www.mass.gov/info-details/solar-massachusetts-renewable-target-smart-program

[7] Note: Until the DPU officially approves the new SMART Tariff, the DOER is unable to issue preliminary Statements of Qualification for projects seeking allocation to expanded program capacity. Accordingly, as described in Section 7 of the Statement of Qualification Reservation Period Guideline, projects applying for additional Capacity Blocks in National Grid will be placed on a waitlist called "400 MW Hold." More information will be provided to stakeholders as it becomes available. At the time of this memo, the SMART Tariff had not been officially approved.

separately for credits applied to their electric bills and the off-taker saves money annually by paying less for electricity than they currently pay to the utility. Massachusetts does not differentiate between behind-the-meter net metering (electricity generation consumed on the same site it is generated) versus virtual net metering (electricity generation consumed at a site other than where the electricity is generated). For most purposes, including credit calculation, there is no difference between net metering and virtual net metering. If you allocate net metering credits to a public entity, there is no effect on the public entity's 10 MW limit for net metering, and a public entity may receive an unlimited amount of net metering credits with no effect on its 10 MW limit. The capacity of a net metering facility within the public cap only affects the host customer's 10 MW limit.

Federal Investment Tax Credit (ITC)

Solar PV projects are typically eligible for the Federal Investment Tax Credit (ITC), which allows the owner to receive a one-time tax credit on federal taxes equal to a percentage of the project cost (per Section 48 of the Internal Revenue Code). In late 2020, the ITC step-down schedule was pushed out as part of COVID-relief: projects beginning construction through the end of 2022 will be eligible for a 26% credit; the credit declines to 22% for 2023 and then drops down to 10% thereafter. (Note: non-profit projects would only be able to realize savings associated with the ITC if they partner with a private third-party that is eligible.) Generally, solar PV and energy storage systems also qualify for five-year Modified Accelerated Cost-Recovery System (MACRS) depreciation schedule. The Tax Cuts and Jobs Act of 2017, however, allows for 100% bonus depreciation (in year one) for solar projects through the end of 2022. The rate steps down by 20 percentage points each year thereafter (i.e., 80% in 2023, 60% in 2024, etc.).