Boston Zero Net Carbon Building Zoning - Renewable Energy Procurement TAG Report

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Renewable Energy Procurement TAG Report

Recommendations for Boston's Zero Net Carbon Building Zoning Initiative

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Introduction

The City of Boston is considering renewable energy procurement as a requirement for the City. Buildings proposed to be constructed would be required to install on-site renewable energy and/or procure off-site renewable energy. The requirement is intended to offset building energy use and achieve zero-net carbon.

In September 2020, The Boston Planning and Development Agency (BPDA) launched their Zero Net Carbon Building Zoning Initiative (ZNC Zoning) “in order to assess and identify strategies to strengthen green building zoning requirements to a zero net carbon standard for new construction [as] a critical step for advancing practices to meet the City of Boston's goal for Boston to be carbon neutral by 2050.” The BPDA engaged with Boston residents and professions to join discussions and assist in the development of the ZNC Zoning, including the creation of four Technical Advisory Groups (TAGs) organized around the following areas: Low Carbon Building, On-Site Renewable Energy, Renewable Energy Procurement, and Embodied Carbon.

The Renewable Energy Procurement TAG was facilitated by Architecture 2030 and consisted of fourteen Boston-area professionals and fourteen members of the City of Boston staff from various departments. Four meetings were held by the Renewable Energy Procurement TAG focusing on i) the framework and potential pathways for renewable energy procurement, ii) allowable renewable energy procurement options, iii) minimum requirements for the renewable energy procurement options, and iv) social equity in renewable energy procurement.

This report was developed by Architecture 2030 and draws many recommendations from the organization’s work on the ZERO Code, now a ICC-approved appendix to the the 2021 IECC - Appendix CC: Zero Energy Commercial Building Provisions. This report considers the knowledge, guidance and expertise provided by the Renewable Energy Procurement TAG in order to craft recommendations that are appropriate to the Boston context and align with related policy development, such as the proposed Building Emissions Performance Standard (BEPS) in the Building Energy Reporting and Disclosure Ordinance (BERDO) update.

Architecture 2030 would like to acknowledge and thank the members of the Renewable Energy Procurement TAG for their support in the development of these recommendations.

Summary of Recommendations for RE Procurement Requirements

Under ZNC Zoning it is recommended that, via the Cooperation Agreement, new buildings be required to maintain participation or have a contract for renewable energy procurement for the building's net electricity consumption (annual building electricity use less annual on-site renewable electricity production) using one or more of the following mechanisms:

1. Direct Ownership / Self-owned, Off-Site Project (system can be installed through a power purchase agreement)
2. Virtual Power Purchase Agreements (vPPAs)[1] (multiple organizations can aggregate their buying power and may be able to negotiate better terms)
3. Unbundled Renewable Energy Certificates / Credits (RECs)[2]
4. Green Retail Tariffs / Green Pricing (100% renewable programs can be offered by any electric service provider in Massachusetts, including community choice aggregators like Boston's Community Choice Electricity program)
5. Utility Renewable Energy Contract / Direct Access to the Wholesale Markets
6. Renewable Energy Investment Fund

All off-site renewable energy procurement must satisfy three minimum requirements: (1) the generator must qualify as a Massachusetts Class I generator as defined by the Massachusetts Department of Energy Resources (DOER)[3], (2) RECs must be retired on behalf of the ZNC building, and (3) the annual purchase commitment must be validated via the Building Energy Reporting and Disclosure Ordinance (BERDO).

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[1] Wind or solar generators located outside the ISO New England service territory are allowed for virual power purchase agreements when the generators are located in regions where the carbon emissions of the electric grid are higher than those of the New England ISO.

[2] When the procurement option is unbundled RECs, the Class I generators must be non-emitting; biomass fired generators do not qualify.

[3] Class I Generators shall be built on or after January 1, 1998 and meet the requirements of the RPS Class I regulations. These Units can be located anywhere in the ISO New England control area, as well as in the adjacent control areas (northern Maine, New York, Quebec, or the Canadian Maritime Provinces), provided that they transmit their power into New England and meet other import criteria. DOER maintains a list of qualifying generators. See https://www.mass.gov/service-details/lists-of-qualified-generation-units.

Intent of the Renewable Energy Requirement

The purpose of the Boston renewable energy requirements is to avoid the carbon emissions associated with new building energy use. Residential and commercial buildings are responsible for about 39% of carbon emissions in the United States. About 12% results from the direct use of natural gas and other fossil fuels for heating while 28% results from electricity consumption.[4] In New England, each MWh of electricity generation results in 910 lb of carbon dioxide equivalent (CO_2e) emissions and each therm of gas combustion results in 20 lb of CO_2e emissions.[5] Building energy use and carbon emissions are tightly linked.

New buildings place an additional electric load on the grid and the renewable energy requirement requires that renewable energy be installed on-site and/or procured off-site to make up for this additional load. If new renewable energy production matches the additional load from a building, the carbon impact is close to zero. In effect, the renewable energy requirement accelerates progress toward a clean electric grid by requiring or encouraging new renewable energy generating capacity over and above what the electric service providers are already required to do by the State's renewable portfolio standards (RPS).

The amount of renewable energy required depends on the energy efficiency of the building, the more energy efficient the building, the less renewable energy is needed and the lower the cost of complying with the renewable energy requirement. In the Boston zoning districts, all buildings must use the performance approach to achieve compliance with the locally enforced energy efficiency standards and these energy simulations provide an estimate of the annual net electricity use that must be procured. Net electricity is the annual consumption less that generated by on-site PV systems. While less renewable energy procurement is needed when buildings are more energy efficient, all buildings must comply with the minimum energy efficiency standards adopted by Boston and the State of Massachusetts.[6] A building can never be less energy efficient than code minimum. No matter how much renewable energy is installed or procured, the building has to meet the minimum energy efficiency requirements.

The goal of the renewable energy requirement is that additional renewable energy generators be installed to avoid the carbon emissions from conventional power plants that would otherwise occur. The addition of renewable energy capacity is irrefutable when a PV system is installed on the building roof or building site along with construction of the building. However, this is not always the case with off-site procurement of renewable energy. Minimum requirements are established for all off-site procurement options to address the type of off-site renewable energy generator that qualifies, the length and durability of the purchase contract and to assure that the renewable energy certificates (RECs) are retired on behalf of the building.

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4 These data are based on data from Lawrence Livermore National Laboratory, https://flowcharts.llnl.gov/commodities/carbon. Residential and commercial buildings are responsible for 75% of electricity use in the United States.

5 Carbon dioxide equivalent emissions include both methane and nitrous oxide based on their global warming potential over a 20-year time horizon. Calculations are by the author. These estimates also include the emissions related to extracting, processing/refining the fuel and delivering it to the building or power plant. Methane leaks along the way are a significant portion of these upstream emissions.

6 The stretch code adopted for Boston requires that buildings larger than 100,000 ft^2 and shopping centers, laboratories and conditioned warehouses larger than 40,000 ft2 use the performance approach and show that the energy efficiency of the building is 10% better than Standard 90.1-2013, using the performance rating method from Appendix G. Residential buildings must be "solar ready" and include a dedicated space on the roof for collectors, pathways for plumbing or electrical lines and reserved space on the electric service.

Since buildings account for 39% of carbon dioxide emissions in the United States, the renewable energy procurement requirement can have a big impact on carbon emissions by requiring or encouraging new renewable energy generation when new buildings add electric load to the grid. This will avoid the emissions that would otherwise occur from conventional power generation. This is one of the most effective policy options available to local governments that want to move toward zero carbon emissions.

Residual Electricity in New England

Massachusetts is part of ISO New England which also includes Connecticut, Maine, New Hampshire, Rhode Island, and Vermont. ISO New England acts as the balancing authority for the region. 2019 eGRID data from the United States EPA indicates that most of Massachusetts and about half of New England electricity was generated by natural gas with nuclear being a distant second. These data are displayed in Table 1 and Figure 1. The carbon dioxide emissions rate is 1,264 lb/MWh of electricity generated for Massachusetts and 910 lb/MWh for New England.

Table 1 – Residual Electricity in Massachusetts and New England

		Massachusetts	ISO New England
Generation Mix	Coal	0%	0%
	Petroleum	0%	0%
	Natural Gas	72%	49%
	Other Gases	0%	0%
	Nuclear	10%	30%
	Pumped Storage	0%	0%
	Hydro-electric	3%	7%
	Wood	4%	4%
	Waste	4%	4%
	Geo-thermal	0%	0%
	Solar	5%	2%
	Wind	1%	4%
Carbon Dioxide Equivalent[7] (lb/MWh)	Direct Emissions Rate	884	644
	Indirect Emissions Rate	381	265
	Emissions Rate	1,264	910
Source Energy Conversion Factor (unitless) [8]		2.67	2.66

7 The CO_2e emission rates are calculated author using procedures documented in ASHRAE Standard 189.1-2020. These vary from the EPA figures for a several reasons: (1) They include all greenhouse gases, not just CO_2. (2) They include upstream emissions related to extraction, processing and delivery of fuels to the power plants, including methane leaks from gas pipes and distribution systems. (3) The data is based on a 20-year time horizon for global warming potential.

8 The source energy conversion factor is the ratio of primary energy used to generate electricity to the electric energy delivered to customers. The 2.67 reported value is calculated by the author on ASHRAE Standard 189.1-2020 procedures and assumes that the heat rate for non-combustible renewables is zero.

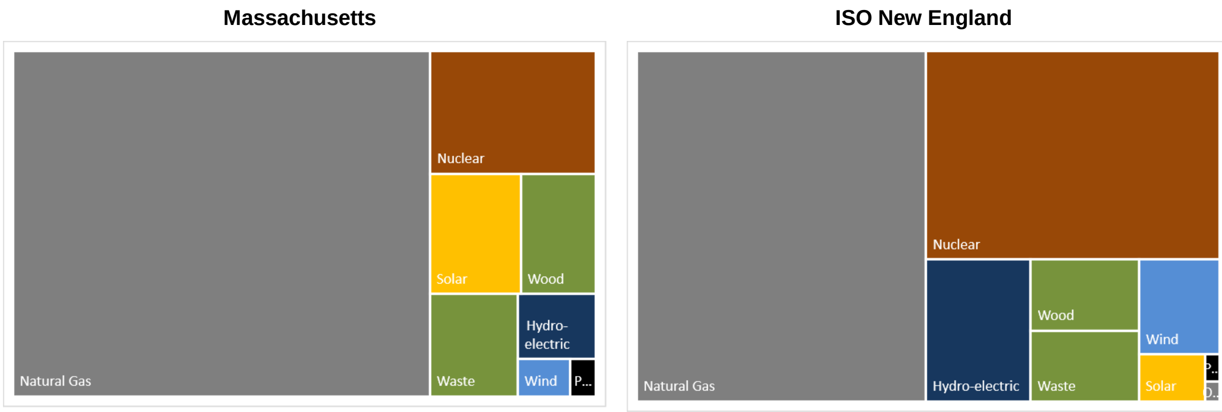

Figure 1 – Mix of Electricity Generation for Massachusetts and ISO New England
Source: 2019 eGRID data

The generation mix in both Massachusetts and New England is becoming cleaner. Figure 2 shows the change for New England that occurred between 2008 and 2017. During this period, coal was practically eliminated as a fuel source for making electricity. Most of the decline in coal was made up with increases in natural gas, although wind grew to 3% of the electricity mix in 2017.

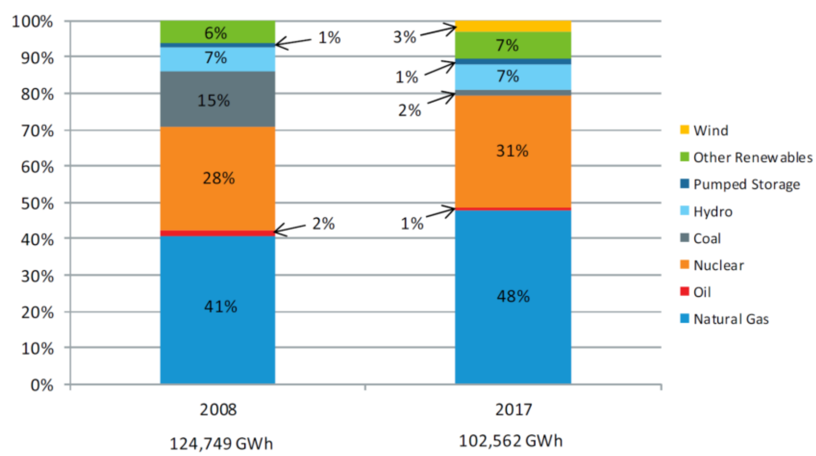

Figure 2 – ISO-NE Percentage energy generation by fuel type, 2008 compared with 2017
Source: 2017 ISO New England Electric Generator Air Emissions Report, ISO New England Inc., System Planning, April 2019, Figure 1-1

The mix of generation fuels is not constant throughout the year. Figure 3 shows the monthly variation in 2017. While oil and coal use are minor on an annual basis, they are still used to some extent during the winter months. Hydro also varies on an annual basis, with peak generation occurring in April and May. In 2017, the data indicate that one or more nuclear facilities were shut down for part of April and the difference was made up with additional natural gas use. In regions with significant solar on the grid, there are significant hourly variation especially on sunny days that coincide with mild temperatures.[9]

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[9] California is a good example. Net load (that which must be met by dispatchable generators and excluding wind and solar) is very low in the middle of the day when the PV systems are producing and then ramps up steeply in the late afternoon and early evening. This change in hourly demand from year to year forms the infamous "duck curve".

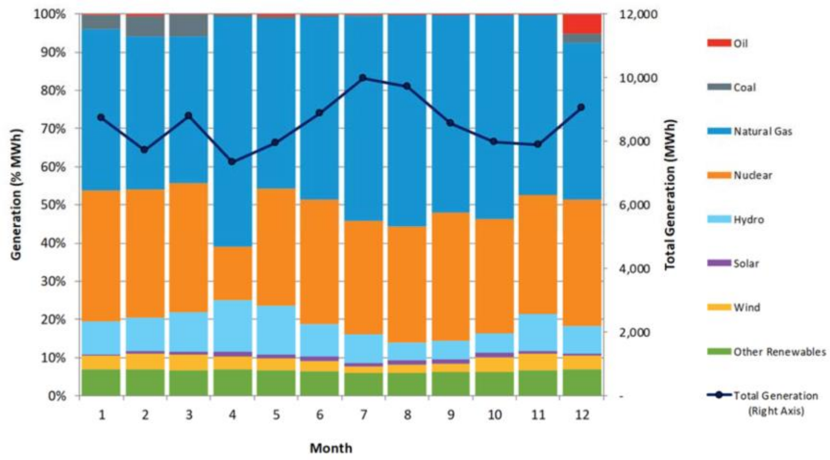

Figure 3 – ISO-NE Monthly Generation by Fuel Type – 2017

Source: 2017 ISO New England Electric Generator Air Emissions Report, ISO New England Inc., System Planning, April 2019, Figure 4-4.

Massachusetts Policies and Programs

Renewable Energy Certificates and NEPOOL-GIS

Generators feed electrons into the New England power grid. Residential, commercial and industrial customers draw electrons from the grid. The generators can be powered by coal, natural gas or oil which results in carbon emissions. Alternatively, the electricity generators can be powered by wind, water, or solar with zero emissions; these are considered non-emitting renewables. Biomass is considered renewable energy in Massachusetts, but it has significant stack emissions at the power plant that must be offset by future carbon capture through photosynthesis. Some of the requirements for renewable energy for ZNC Zoning are limited to non-emitting renewable energy generators.

Once electrons enter the grid, they move according to the laws of physics following the path of least resistance, usually to the closest customer. Electrons generated by coal and solar are indistinguishable; electrons do not arrive with a label saying "I was created by solar". Renewable energy certificates or RECs are used to keep track of the electricity produced by wind, solar and other renewable energy generators. A REC is created for each MWh of electricity generated by renewable energy. RECs can be bundled with the renewable energy (electricity) and sold as a package, or they can be sold separately from the energy (unbundled RECs). There are as many types of RECs as there are renewable energy generators, e.g. wind RECs, solar RECs, hydro RECs, etc. If a customer wants to make a claim that they use 100% renewable energy and they consume 100 MWh of electricity, they must purchase 100 RECs. If they want to be 100% solar, they would purchase 100 solar RECs or sRECs. Once a REC has been used to offset electricity consumption, it is retired. "Retirement means that the REC has been used and can no longer be sold.

If a building owner has solar on their roof but another party owns the RECs, they can't claim that their building is powered by renewable energy. The owner of the RECs has that privilege, even though the solar system may be on someone else's property. This is a common issue with most direct power purchase agreements (PPA). With a direct PPA, a solar system is installed on the customer's roof or parking lot, but it is owned by a third party who often sells the RECs to the electric distribution company to improve the economic viability of the deal. In a case like this, the building owner is helping the electric service provider to meet its RPS requirement, but cannot claim that the building is using renewable energy. The Federal Trade Commission has advised that such a claim would be deceptive.[10]

NEPOOL-GIS keeps track of RECs in New England as well as imported renewable energy from adjacent control areas. It makes sure that RECs are generated by eligible renewable energy generators and are used only once. For each REC, the GIS keeps track of the renewable energy generator that produced it, when the MWh of electricity was generated, who owns the REC, and whether it is active or retired. Other REC tracking organizations work in other parts of the country and provide a similar service.[11] REC tracking systems were first created to manage compliance with mandatory renewable portfolio standards (RPS) requirements, but they are also used to keep track of the sale and purchase of voluntary RECs.

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[10] The Federal Trade Commision (FTC) Part 260– Guides for the Use of Environmental Marketing Claims, Example 5, page 34.. See https://www.ftc.gov/sites/default/files/attachments/press-releases/ftc-issues-revised-green-guides/greenguides.pdf.

[11] See for instance, Renewable Energy Certificate (REC) Tracking Systems: Costs & Verification Issues, Jenny Heeter, NREL, October 11, 2013, https://www.nrel.gov/docs/fy14osti/60640.pdf.

Massachusetts and many other states, require that electric distribution companies provide their customers with a disclosure statement that identifies how the electricity they are selling was generated, e.g. how much came from natural gas, nuclear, solar, wind, etc. The NEPOOL-GIS tracks all generation in New England, not just renewable energy and provides data to electricity providers to enable them to disclose this information to their customers. These disclosure statements are a little like the nutrition labels on food products.

REC Prices

RECs are a financial instrument and like other commodities, the price is a function of available supply and demand. Massachusetts Class I RECs must be produced by Class I generators. See Table 2 and footnotes 3 and 13. This limits the supply. Electric distribution companies must comply with the state RPS requirements by purchasing Class I RECs and a certain amount of these RECs (the solar carveout) must be from Class I solar generators. The RPS requirement creates demand. For these reasons, the price of Massachusetts Class I RECs is significantly higher than non-Class I RECs. Figure 4 shows how the price has changed for the last decade. The price of Massachusetts RECs tracks very closely with those of Rhode Island, New Hampshire and Connecticut. Prices were over $50/MWh and above between 2012 and 2016. Prices are now in the range of $40/MWh after a low in late 2018. The supply of solar RECs is more limited and Massachusetts and other New England bolsters demand by requiring that a percentage of the RPS be met by solar, known as the solar carveout. Figure 5 shows prices of solar RECs for the last decade. Since 2015, Class I solar RECs in Massachusetts have been selling between $300 and $400/MWh, many multiples higher than Class I RECs that are not limited to solar.

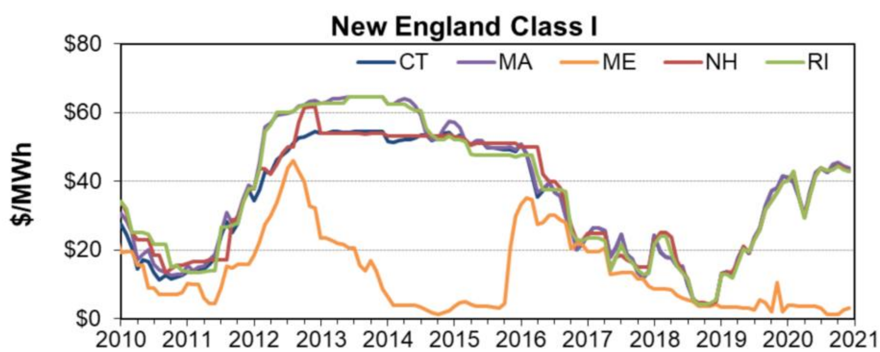


Figure 4 – Price of New England Class I RECs

Source: Galen Barbose, 2021 Annual Status Report, U.S. Renewables Portfolio Standards, February 2021, Berkeley Lab
Class I (Solar) consists of the SREC I, SREC II, and SMART programs; the targets for those programs are denominated in MW and translated here to the equivalent percentage of retail electricity sales.

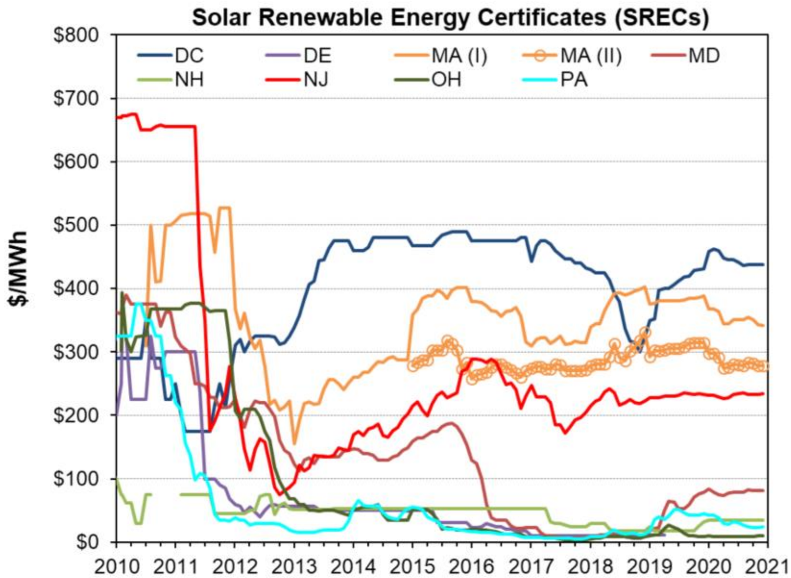


Figure 5 – Price of Solar RECs

Source: Galen Barbose, 2021Annual Status Report, U.S. Renewables Portfolio Standards, February 2021, Berkeley Lab
Class I (Solar) consists of the SREC I, SREC II, and SMART programs; the targets for those programs are denominated in MW and translated here to the equivalent percentage of retail electricity sales.

Many states, including Massachusetts, have alternative compliance payments, which are penalties that electric service companies must pay if they fail to buy enough RECs to meet their mandated RPS targets. Alternative compliance payments set a ceiling price on what eligible RECs would be able to command in compliance markets. In compliance markets, REC prices often hover just below the alternative compliance penalty. See Table 3 for the Massachusetts alternative compliance payments.

When RECs can be produced by any renewable energy generator anywhere in the United States, the price is significantly lower (see Figure 6). In late 2018, prices were around $0.70/MWh, almost 50 times cheaper than Massachusetts Class I RECs. Non-Class I or Class II RECs are commonly used by Massachusetts electricity providers when they offer 100% clean energy (see Table 5). Again, the price of unrestricted national RECs is low because of supply and demand. Wind farms in Texas and the Great Plains are cost effective without the additional revenue from selling RECs. This provides a plentiful supply of non-Class I or non-Class II RECs. More liquidity and supply allow for lower prices relative to current demand.[12]

[12] A blog by Katy Kidwell of the Green Energy Consumers Alliance makes a strong case that not all RECs have the same impact. See https://blog.greenenergyconsumers.org/blog/class-i-recs.

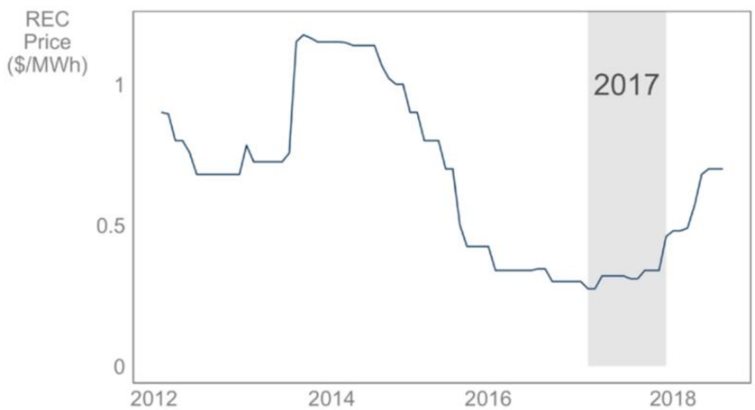


Figure 6 – Voluntary National REC prices, January 2012–August 2018
Source: Status and Trends in the U.S. Voluntary Green Power Market (2017 Data), Eric O'Shaughnessy, et. al. October 2018, NREL/TP-6A-72204

Massachusetts Renewable Portfolio Standards (RPS)

ISO New England serves as the balancing authority for the region and is responsible for assuring that the supply of electricity matches the demand for electricity on a near instantaneous basis. However, the Massachusetts renewable portfolio standards (RPS) require that each electric service provider in the state purchase a minimum amount of renewable energy as a percent of sales. This energy is fed into the ISO New England grid and tracked through renewable energy certificates (RECs). For 2019, the Massachusetts renewable energy portfolio standards (RPS) require that electric distribution companies acquire renewable energy credits (RECs) to represent 14% of their electricity sales. The RECs must qualify as "Massachusetts Class I Compliance RECs"[13], but a carve-out also requires that about 6.2% of electric sales be offset by solar RECs. Table 2 summarizes the number and types of renewable energy generators that qualify for Massachusetts Class I RECs.

[13] The requirements for Class I Generators are laid out in the Code of Massachusetts Regulations (225 CMR 14) and specify the type of generator, its location, when it was constructed and other requirements. It is worth noting that renewable energy generators that ISO New England counts as renewable energy may not qualify as Class I generators. In particular, biomass generators must document that the feedstock comes from forest thinnings, forest residues and other specifically defined sources. Also, legacy hydroelectric plants don't count toward the RPS requirements since the intent of the requirements is to encourage the construction of new renewable energy generators. See also Synapse and Sustainable Energy Advantage, An Analysis of the Massachusetts Renewable Portfolio Standard, Prepared for the NECEC in Partnership with Mass Energy, May 2017.

Table 2 – RPS Class I Renewable Energy Generators

Source: RPS Class I Renewable Generation Units, Updated May 5, 2021.

Fuel / Resource / Technology - Type	Qualified (MW)	Qualified & Operational (MW)	Share
Anaerobic Digester - AD	55.425	35.347	1%
Biomass - BM	1.935	1.935	0%
Hydroelectric - HY	67.884	67.704	1%
Hydrokinetic - MH	0.013	0.013	0%
Landfill Gas - LG	258.783	258.783	5%
Photovoltaic - SL, SM, SMAES, SMANG, SMAUN	1,532.250	1,294.850	24%
Tidal - MH	0.900	0.900	0%
Wind - WD	4,385.175	3,759.175	69%
Total	6,302.365	5,418.707	

If an electricity provider is short on renewable energy acquisition at the end of each RPS compliance period, the company makes an Alternative Compliance Payment (ACP) for the difference. The ACP moneys are invested by the Massachusetts Department of Energy Resources (DOER) in a combination of renewable energy and energy efficiency projects. These payments are shown in Table 3 and are around $70/MWh which is significantly more than the cost of non-solar Class I RECs. However, the cost of Class I solar RECs is just below the ACP.

Table 3 – Alternative Compliance Payment (ACP) Amounts ($/MWh)

	2017 Rates	*2018 Rates*	*2021 Rates*
RPS Class I	$67.70	$68.95	$71.57
RPS Class I Solar Carve-Out	$448.00	$426.00	$384.00
RPS Class I Solar Carve-Out II	$350.00	$350.00	$316.00
RPS Class II Renewable Energy	$27.79	$28.30	$29.37
RPS Class II Waste Energy	$11.12	$11.32	$11.75
APS	$22.23	$22.64	$23.50

Source: https://www.nepoolgis.com/2017/02/01/2017-acp-rates-for-massachusetts-rps-and-aps/ and https://www.mass.gov/service-details/annual-compliance-information-for-retail-electric-suppliers

The Massachusetts RPS requirement for various categories of renewable energy is shown in Figure 7 along with the total which will reach about 60% by 2050 if the goals are achieved. Eversource, the distribution company for Boston, acquires RECs through open solicitations.[14] The Massachusetts Department of Public Utilities requires that customers be provided with information on the source of electricity generation through a Disclosure Label.

Massachusetts also has a Global Warming Solutions Act (GWSA) that works in combination with the RPS requirements. The requirement is for 16% clean electric power in 2018 but increases 2% annually to 80% in 2050. The Act sets a sector-wide, annually declining limit on aggregate CO_2 emissions from 21 large

[14] The following website is a typical RFP for the acquisition of RECs. See https://www.energysage.com/p/eversource/.

fossil fuel-fired power plants in Massachusetts, from 9.15 million metric tons of CO_2 in 2018 down to 1.8 million metric tons in 2050.[15]

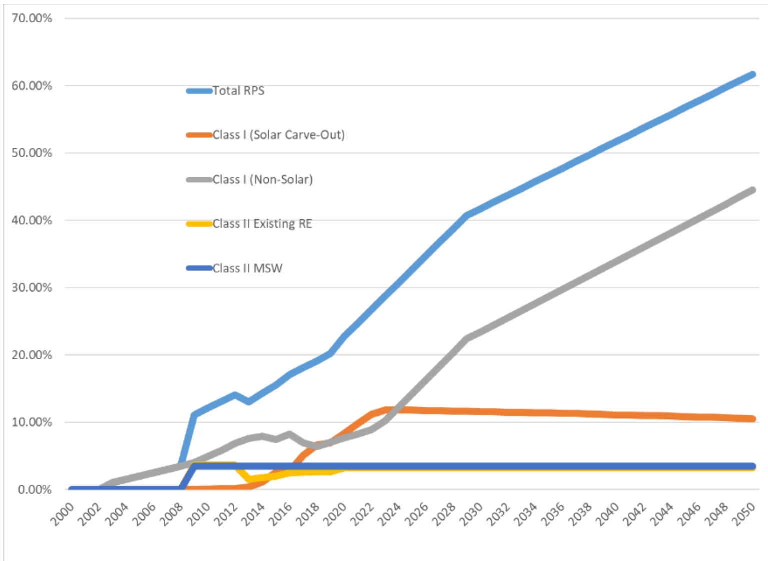


Figure 7 – Massachusetts RPS Percentage Targets

Source: Galen Barbose, 2019 Annual Status Report, U.S. Renewables Portfolio Standards, July 2019, Berkeley Lab
Class I (Solar) consists of the SREC I, SREC II, and SMART programs; the targets for those programs are denominated in MW and translated here to the equivalent percentage of retail electricity sales.

Net Metering

A flexible net-metering program is available for building owners and developers in Massachusetts. With the program, customers are compensated for excess electric power that they generate.[16] However, there are restrictions on renewable energy construction: (1) some areas are not eligible for distributed generating facilities because of interconnection issues,[17] (2) systems must meet minimum requirements set by the distribution company (Eversource),[18] and (3) the total capacity of net-metering accounts is capped at a percentage of the “highest historical peak load, which is the most electricity consumed by the electric company’s customers at any one time”.[19] However, smaller projects are exempt from the cap. These include single-phase systems less than 10 kW (residential and small building scale) and three-

15 See https://www.mass.gov/guides/clean-energy-standard-310-cmr-775. See also https://www.mass.gov/files/documents/2018/09/26/3dfs-electricity.pdf for a more detailed explanation.

16 https://www.mass.gov/guides/net-metering-guide is an excellent summary. The Schedule Z is filed with the distribution company (Eversource).

17 Problem areas within the service territory are called the “Area Network”, where interconnections are not permitted because of “challenges for interconnection to a solar PV system”. The Area Network includes portions of Boston, Cambridge and New Bedford and the neighborhoods of Beacon Hill, Back Bay, Chinatown, Downtown, Fenway area (certain areas), Financial District, North End, South End (certain areas), Theater District, and the West End. See https://www.eversource.com/content/docs/default-source/builders-contractors/boston-area-solar.pdf for more information. There are no maps or detailed descriptions of the “Area Network” for security reasons, but Eversource will provide information to individual property owners when asked.

18 See “Standards for Interconnection of Distributed Generation”, https://www.eversource.com/Content/docs/default-source/rates-tariffs/162.pdf?sfvrsn=6. Sometimes there may be a charge for upgrading the grid when this is needed to accommodate a PV system.

19 See http://www.massaca.org/general-net-metering.asp.

phase systems less than 25 kW. Larger systems must file an Application for a Cap Allocation (ACA) with the System of Assurance of Net Metering Eligibility, which is part of the Massachusetts Department of Public Utilities (DPU). Exported energy for exempt systems is credited at retail rates, however larger systems that need a cap allowance are credited at 60% of the retail rate.

As of December 2019, the NStar (Eversource) net-metering cap is 348,460 kW; 243,273 kW is already interconnected; 24,087 kW has been allocated but not yet interconnected; and 651 kW is pending. The remaining capacity available under the cap is 80,449 kW or about 23%. National Grid, WMECO and Unitil have a waiting list for interconnections.[20] These allocations apply to private systems. Separate allowances apply to public systems and capacity if available except for the areas served by National Grid.

Solar Massachusetts Renewable Target (SMART) Program

The Massachusetts SMART Program is a feed-in tariff program to encourage the construction of solar systems. The program compensates renewable energy developers for energy that they feed into the grid at a rate higher than retail rates. The program is structured in declining tiers. As more solar is installed, the compensation rate declines. However, *the RECs do not accrue to the owner or developer of the system*. Renewable energy developers must sign an agreement that assigns the RECs to Eversource (in the case of Boston). The SMART program helps Eversource and perhaps other electricity service companies in Massachusetts achieve their RPS requirements, but it *does not result in the construction of additional renewable energy over what the RPS program is already requiring*. The SMART Program is a way for electric distribution companies to meet their RPS commitment.

Retail Competition

Massachusetts along with 18 other states (see Table 4) has retail competition for electricity. In these states, deregulation has made the electric transmission and distribution systems open to suppliers other than the distribution company. Electricity customers in Massachusetts can choose their own electricity provider, instead of using the default offering of their local distribution company, Eversource in the case of Boston. As of December 2019, 23 companies were offering electricity to retail customers (see Table 5). Many of these companies offer 100% renewable energy. Virtually all of these companies make this offer through the purchase of wind RECs from out of the region, as opposed to Class I RECs that are needed for compliance with the Massachusetts RPS requirements. However, some offerings provide 100% renewable energy from Class I generators, including Boston's Community Choice Electricity Program, which offers 100% renewable energy at a premium of about $0.015/kWh.

[20] See https://app.massaca.org/allocationreport/report.aspx? for more detail.

Table 4 – States with Electricity Retail Competition

Source: Electric Choice, https://www.electricchoice.com/map-deregulated-energy-markets/

State	*Year*	*State*	*Year*	*State*	*Year*
California[1]	N/A	**Massachusetts**	**1998**	Oregon	1997
Connecticut	1998	Michigan	1998	Pennsylvania	1996
Delaware	1999	New Hampshire	1998	Rhode Island	1996
Illinois	1997	New Jersey	1999	Texas[2]	2002
Maine	2000	New York	1997	Virginia[3]	2007
Maryland	1999	Ohio	1996	Washington DC	2001

Notes:

1 California's electric choice works on a very limited lottery system called DirectAccess.

2 Electricity deregulation is available to 85% of Texans.

3 Electricity choice programs are limited for residential consumers.

Table 5 – Electricity Providers in Eversource Distribution Network

Source: Energy Switch Massachusetts Website, December 10, 2019, Residential Customer Class

	Estimated Monthly Cost (Residential)			
Provider	*100% Renewables*	*Standard Offering*	*Difference*	*Cost ($/kWh)*
Ambit Energy	87.00	81.75	5.25	0.009
CleanChoice Energy	76.80			
Constellation New Energy	77.34	70.74	6.60	0.011
Direct Energy Services	74.64			
Discount Power	77.73			
Eligo Energy MA	84.24	83.04	1.20	0.002
Energy Rewards		71.34		
Green Mountain Energy	82.20			
IGS Energy[1]	76.74	77.34	(0.60)	(0.001)
Indra Energy MA	97.40	96.00	1.40	0.002
Just Energy Massachusetts		74.64		
Liberty Power Holdings	67.73	64.73	3.00	0.005
Massachusetts Gas & Electric		76.74		
NRG Home		85.20		
NSTAR d/b/a Eversource Energy		73.57		
Residents Energy		66.18		
SFE Energy Massachusetts		87.85		
SmartEnergy	83.40			
Starion Energy	66.24	64.44	1.80	0.003
Sunwave Gas & Power		79.08		
Think Energy	75.00			
Town Square Energy	83.82	65.52	18.30	0.031
Verde Energy USA	80.94			
Average from Above	77.80	75.79	4.62	0.008

Notes

1 The 100% renewable rate for IGS Energy requires a 36-month contract term while the standard offering has a 12-month contract term.

2. GreenEnergyConsumers.org is not listed on the Energy Switch website. This organization offers green electricity backed by Massachusetts Class I wind RECs. The cost premium reported on the website is $0.038/kWh ($38/MWh or REC). See http://greenenergyconsumers.org/greenpowered/howswitchingworks#mix.

On-Site Renewable Energy

The most straightforward way to meet the Boston renewable energy requirements is to install solar panels on the roof of the building, over parking lots or elsewhere on the building property[21]. Some large building sites may be able to install wind turbines or incorporate other forms of renewable energy, but solar panels are expected to be the most common form of on-site renewable energy. Large systems must file an Application for a Cap Allowance, but single-phase systems smaller than 10 kW and three-phase systems smaller than 25 kW are exempt. On-site renewable energy systems can be self-owned, or they can be installed through a power purchase agreement, whereby the building owner agrees to purchase electricity from the system for at least 15 years.

The on-site renewable energy requirements of the Boston zoning policy will be recommended via the On-Site Renewable Energy Technical Advisory Group (TAG). The On-Site Renewable Energy TAG will recommend the type of on-site renewable energy qualifies, specifically around how systems installed through the Massachusetts SMART program are considered, given that their RECs do not accrue to the owner or developer of the system. To qualify for ZNC Zoning in general, the RECs must be transferred to the building owner/manager, which is not always the case with direct power purchase agreements.

The net electricity, which is the annual building electricity less the annual on-site PV production, must be provided by 100% renewable energy sources through an acceptable procurement method discussed in the next section.

[21] ASHRAE 189.1-2020 defines an on-site renewable energy system as “renewable energy systems located on any of the following: 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.”

Minimum Requirements for Off-Site Procurement

Boston recognizes several methods for off-site procurement of renewable energy that may be used to supplement on-site systems. The options are listed in the following table along with their applicability in Boston. More detail is provided in Appendix A. See also the ZERO Code technical support document[22].

Table 6 – Boston Off-site Renewable Energy Procurement Options

Procurement Option	*Application to Boston*
Self-Owned Off-site	The Massachusetts net-metering rules support this option. An Eversource customer (host) can allocate excess power generation to other electric accounts (beneficiaries) and the credit shows up on the electric bill of the beneficiary. However, for non-exempt systems, the monetary compensation to utility bills is 60% of the retail rate. However, 100% of the RECs can be assigned.
Community Solar	Limited community solar or community renewable programs are available in Boston, however, the virtual net metering rules allow private systems to be easily set up.
Virtual Power Purchase Agreement	This option is available to large, credit-worthy building owners. The minimum virtual PPA deal is generally 5 MW for solar and 10 MW for wind.
Unbundled RECs	RECs may be purchased by building owners in the open market. Massachusetts Class I Compliance RECs are required for ZNC Zoning.
Green Pricing	Massachusetts has retail competition and many electricity providers offer 100% renewable energy which is commonly achieved through the purchase of non-Class I or non-Class II RECs. See Table 5. The City of Boston's Community Choice Electricity program also offers a green pricing program.
Utility Renewable Energy Contracts	Large customers are able to negotiate with the electric distribution company to supply them with renewable energy through special tariffs or bilateral contracts. No known contracts exist with Boston companies.
Renewable Energy Investment Fund (REIF)	No REIF program exists at the present time, but the City of Boston is considering such a program with a parallel structure to its low-income housing program.

All off-site renewable energy procurement must satisfy three minimum requirements: (1) the generator must qualify as a Massachusetts Class I generator, (2) the purchase commitment must be lasting and verified each year, and (3) RECs must be retired on behalf of the ZNC building. Table 7 lists the common off-site procurement options and shows how each typically complies with the minimum requirements. More detail on these requirements and the exceptions are described below.

Table 7 – Minimum Requirements for Off-Site Procurement Methods

	Minimum Requirements		
Procurement Option	*Generation Source*	*Durability*	*Renewable Energy Certificates*

[22] ZERO Code Off-Site Procurement of Renewable Energy, Technical Support Document, April 2018. The document can be downloaded from www.zero-code.org.

Self-Owned (viable for Boston and supported by virtual net-metering)	Solar is most common but other forms of renewable energy are possible.	The solar system could be sold separately from the complying building, but another acceptable procurement option would be required for BERDO reporting.	Should not be a problem unless the system is installed through a PPA where the seller keeps the RECs or through the Massachusetts SMART program given that the RECs do not accrue to the owner or developer of the system. Forward contracts can be structured to assure that the RECs are assigned to the complying building over the long term, even if the system is sold separately from the complying building.
Community Solar (no known public programs in Boston)	Usually solar but could be another type of renewable energy generator.	It's easy to opt out of most programs, but verification would be provided through BERDO reporting.	Many community solar programs do not provide RECs to the participant. These programs would not be eligible.
Virtual PPA (limited to large credit-worthy organizations)	Wind and solar are the most common, but other generator types are possible.	Not a problem. The renewable energy developer requires a long-term commitment. The contract is verified through BERDO reporting.	Providing RECs to the buyer is the essence of the deal.
Unbundled RECs (Massachusetts Class I RECs are required with few exceptions)	Generator must be *non-emitting* Massachusetts Class I to qualify.	Forward contracts can be used to establish a long-term commitment. Verification is through BERDO reporting.	RECs are the asset being purchased.
Green Tariffs (includes competitive suppliers and CCAs like the City of Boston's Community Choice Electricity program)	Eligible programs must be backed by Massachusetts Class I generators, but some existing programs are backed by out-of-state wind RECs.	The longest typical contract is 36 months and it's easy to opt out, but verification is required through BERDO reporting.	RECs are required in order for the electricity supplier to offer renewable energy.
Utility Renewable Contracts (no known contracts in Massachusetts)	Wind and solar are most typical.	Contracts are typically long-term, but verification is required through BERDO reporting.	Customers contract for RECs and energy.
Renewable Energy Investment Fund (REIF) (multiple investment options)	REIF management establishes criteria.	Contribution can be an up-front payment or a subscription.	RECs should not be a problem, but there are no precedents.

Renewable Energy Generators

The renewable energy generating source shall be photovoltaic systems, solar thermal power plants, geothermal power plants, wind turbines, or other Class I renewable energy generators as defined and approved by the Massachusetts DOER.[23] However, when the procurement option is unbundled RECs, the Class I generators must be non-emitting; biomass fired generators do not qualify. There is only one exception to the requirement for Massachusetts Class I generators: Wind or solar generators located outside the ISO New England service territory are allowed for virual power purchase agreements when the generators are located in regions where the carbon emissions of the electric grid are higher than

[23] See 225 CMR 14.00: Renewable Energy Portfolio Standard – Class I. These regulations allow new run-of-the-river hydro plants and certain biomass electricity generators as long as the fuel is certified to come from forest thinning, forest residues, or other residues. Biomass plants must also have a 60% overall efficiency in order to receive full credit. Elecricity generators currently approved as Class I by DOER are listed in "Eligible Class I Renewable Units 091319.xlsx", dated April 29, 2019.

those of New England ISO. Table 8 lists the carbon emissions for the New England ISO and each of the eGRID subregions.[24]

Table 8 – Electric Grid Carbon Emissions by eGRID Subregion

eGRID Acronym	*eGRID Subregion Name*	*Direct Emissions Rate (lb/MWh)*	*Indirect Emissions Rate (lb/MWh)*	*Emissions Rate (lb/MWh)*
HIOA	HICC Oahu	2,005	458	2,462
MROE	MRO East	1,770	386	2,156
PRMS	Puerto Rico Miscellaneous	1,648	489	2,138
SRMW	SERC Midwest	1,800	337	2,137
HIMS	HICC Miscellaneous	1,511	410	1,921
RFCM	RFC Michigan	1,363	347	1,711
RMPA	WECC Rockies	1,336	310	1,646
AKGD	ASCC Alaska Grid	1,165	411	1,576
NYLI	NPCC Long Island	1,081	464	1,545
RFCW	RFC West	1,225	294	1,519
SRSO	SERC South	1,131	360	1,491
MROW	MRO West	1,233	238	1,471
FRCC	FRCC All	1,001	426	1,426
SPNO	SPP North	1,189	237	1,426
SPSO	SPP South	1,052	328	1,380
SRTV	SERC Tennessee Valley	1,088	271	1,359
AZNM	WECC Southwest	1,017	324	1,340
ERCT	ERCOT All	985	343	1,328
SRMV	SERC Mississippi Valley	949	375	1,324
RFCE	RFC East	798	289	1,087
SRVC	SERC Virginia/Carolina	821	260	1,081
NWPP	WECC Northwest	802	200	1,002
NYCW	NPCC NYC/Westchester	607	305	912
NEWE	**NPCC New England**	**644**	**265**	**910**
AKMS	ASCC Miscellaneous	642	188	831
CAMX	WECC California	577	242	818
NYUP	NPCC Upstate NY	297	133	430

Durability and Enforcement

The building owner shall commit to produring adequate off-site renewable energy for the lifetime of the building. The requirement will be enforced through the City's Building Energy Reporting and Disclosure Ordinance (BERDO). The ordinance requires Boston's large- and medium-sized buildings to report their annual energy and water use. It further requires buildings to complete a major energy savings action or energy assessment every five years.

Projects permitted under zero net-carbon zoning would also have to demonstrate through BERDO that 7the net electricity comes from 100% renewable sources. Any shortage will be adjusted through an alternative compliance payment or the purchase of unbundled RECs. The terms between the City and the

[24] These data are calculated by the author using information from U.S. EPA's eGRID data for 2019 and using the procedure documented in Informative Appendix J of ASHRAE Standard 189.1-2020.

development entity would be negotiated in through a Cooperation Agreement which represents a legal contract between the two parties. The terms of the contract carry over to new owners in the event of property sale. Some of the obligations would be recorded with the property deed.

However the terms of the agreement are expected to be flexible, allowing the building owner to acquire renewable energy through different means over the term of the agreement. If a renewable energy program seizes to exist, the owner can move over to an alternative program without having to renegotiate the Cooperation Agreement with the City. The new or substitute program would just be documented as compliance documents are filed at the end of the BERDO reporting period. Some of the off-site procurement options will require participation for a minimum period of time which will reduce flexibility in some cases. For instance, virtual power purchase agreements typically require the buyer to purchase electricity for a minimum of 15 years.

At the end of each reporting period, the renewable energy procured will be compared to the building's net electricity consumption. If there is a deficit, the building owner will make up the difference through additional RECs purchases or an Alternative Compliance Payment to the City.

Renewable Energy Certificates (RECS)

RECs and other environmental attributes associated with the procured renewable energy shall be assigned to buildings permitted under zero-net-carbon zoning. This requirement prevents double counting of environmental benefits. If the RECs are assigned to another party, they are entitled to claim use of renewable energy, not the building owner. REC ownership is an issue with many community solar programs, some green tariffs and with systems installed through the Massachusetts SMART program.

Renewable Energy Procurement and Equity

The City of Boston's equity framework contains the following goals:

- Institutionalize structures for community decision-making, transparency, leadership, and influence on design of environmental programs and policies.
- Refine environmental policies/programs so that the distribution of individuals and grassroots organizations that participate in and benefit from these programs is equitable and reflective of communities of color, immigrants, refugees, people with low-incomes and limited-English proficiency individuals.

The Renewable Energy Procurement TAG discussed potential equity indicators that could be considered in the development and implementation of the ZNC Zoning requirement for off-site renewable energy. Those included air quality, energy cost burden, workforce development, business/economic development, resilience, access and data collection and transparency.

The Boston Green Ribbon Commission's Carbon Free Boston Report and its associated Social Equity Report 2019 were shared as a reference to the Boston Planning & Development Agency as the report "provides a detailed analysis of the current social equity issues in each of the city's key emissions sectors – buildings, transportation, waste and energy – and identifies how intentional policy design can avoid unintended consequences and use the City's emissions reduction strategies to address historical social inequities. It ends with a synthesis of equity guidance…" The report includes a section outlining questions and consideration for integrating equity, as well as specific recommendations related to renewable energy (on-site and off-site procurement), including strategies for rooftop solar and municipal aggregation, as well as recommendations for "equitably achieving a carbon-neutral energy supply". The Metropolitan Area Planning Council's Equity Goals and Indicators and Equity Framework were also shared for reference by policymakers.

Finally, the Urban Sustainability Directors Network (USDN) recently published a report entitled Equity and Buildings: A Practice Framework for Local Government Decision Makers. The report includes an overview of "critical issues at the intersection of equity and sustainable buildings" and specific steps for policymakers working in building decarbonization to take to achieve positive equity outcomes.

As stated in the Carbon Free Boston Report "explicitly address[ing] the potential impacts of different policies on social equity and acknowledge[ing] that socially just solutions are as important as technically efficient solutions". It is the recommendation of the Renewable Energy Procurement TAG that the Boston Planning & Development Agency actively engage and collaborate with community-based stakeholders and consider the provided resources in order to inform the renewable energy procurement and implementation requirements for the ZNC Building Zoning Initiative.

Precedents for Requiring 100% Renewable Energy

There are a number of cities and governmental entities that are adopting policies to encourage or require the procurement of off-site renewable energy.

San Francisco, California

In 2019, the City of San Francisco added the Renewable Energy for Commercial Buildings Policy to the city's municipal code. It requires large building to purchase all of their electricity from 100% renewable sources. In San Francisco, building owners have two choices. The investor owned utility, Pacific Gas and Electric, offers 100% solar energy through it's Solar Choice program; and the city's community choice aggregator program, CleanPowerSF, offers 100% wind energy from a nearby wind farm. The program begins in 2022 for commercial buildings larger than 500,000 ft^2. The program applies to buildngs larger than 250,000 ft^2 in 2024 and 50,000 ft^2 in 2030. Compliance with the requirements is enforced through the City's energy benchmarking program (similar to BERDO).

Sydney, Australia

The City of Sydney, Australia is considering requirements for on-site and/or off-site renewable energy in addition to building energy efficiency. Click here. The proposed requirements will apply to new commercial buildings in accordance with Sydney's goal to achieve zero net emissions by 2035. The Australian NABERS and Green Star rating tools will be used to verify building energy efficiency and renewable energy can be provided through a mix of on-site systems and off-site renewable energy purchases. Offsite energy generation plays a key role in Sydney's strategy and can be credited through the purchase and retirement of Large-Scale Generation Certificates (LGCs), purchase of Green Power certificates or through power purchase agreements.

New York, NY

New York's Local Law 97 limits greenhouse gas emissions limits for existing buildings and retrofits larger than 25,000 square feet. The requirements may be met through energy efficiency upgrades, on-site renewable energy or the purchase of off-site renewable energy.

Compliance Examples

NOT SURE WHAT DO DO HERE.

DIRECT OWNED

COMMUNITY SOLAR

ABC AGREEGATED VPPA CASE STUDY

THE COST DIFFERENTIAL BETWEEN THE RESIDUAL MIX AND 100% RENEWABLE ENERGY MIX WILL LESSEN OVER TIME AS THE RESIDUAL MIX GETS CLOSER TO 100%.

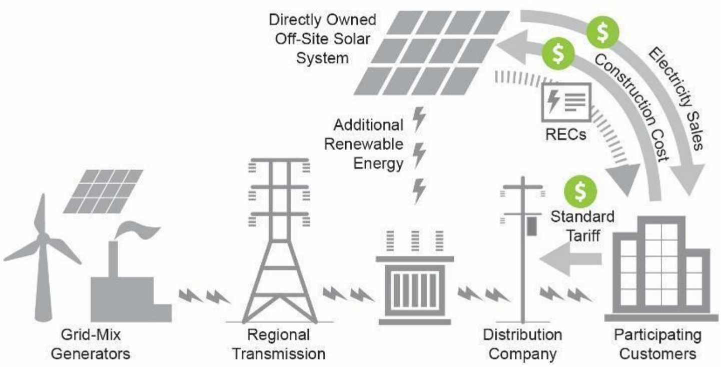
Here are some examples on how the program would work.

Example/Scenario One:

1. A new, three-story, all-electric 60,000 ft^2 office building is designed to the latest ASHRAE and IECC codes and is estimated to use 517 MWh of electricity use each year, based on performance simulatons used for energy code compliance.
2. The building has a solar PV system on the roof that is estimated to produce 300 MWh each year. The net electricity use is 517 – 300 or 217 MWh/y.
3. The building owner signs up for the Boston Community Choice 100% electricity program. The incremental cost of this program is $38/MWh of electricity purchased. If the building performs as predicted by the energy simulations, the annual cost for the green power would be $8,246 (217 MWh * $38/MWh).
4. The building is managed through a triple-net lease such that the electricity costs, including the premium for 100% electricity are paid for by the tenants. The commitment to 100% renewable electricity is in the terms of the green lease agreement. Each tenant is allocated a share of the on-site PV production, based on the gross floor area they lease.
5. In year four, a new tenant moves into the building and takes a whole floor of 30,000 ft^2. They have a lot of energy intensive computers and other equipment and workers arrive early and stay late, both of which increase their building electricity use. The energy simulations estimated that one floor would use 172 MWh/y, but with the special equipment and longer hours, this tenant uses 220 MWh/y.
6. Because of the triple-net lease, the tenant pays for the additional 48 MWh of electricity use using the 100% renewable energy commitment specified in the green lease. However, the tenant's allocation of the on-site PV system does not change. The tenant ends up paying an additional $1,824 for the 100% renewable power.
7. The building owner is required to collect from each of the tenants their energy consumption and renewable energy purchases and report this information to BERDO to demonstrate compliance with the program.

Appendix A – Description of Off-Site Procurement Options and Cost

Self-Owned Off-Site Directly Owned



With self-owned off-site or direct ownership, the complying building developer/owner installs a renewable energy system on a *separate parcel of land* from the complying building. The complying building would draw power from the grid while the off-site renewable energy system would deliver power to the grid. The Massachusetts virtual net-metering program allows some or all of the electricity and RECs to be assigned to the electricity account of the complying building.[25] Renewable energy production is credited to the electricity account(s) as if the renewable energy system were located on-site. Larger renewable energy systems might serve portfolios of buildings or campuses.

Virtual net-metering may also be used in Massachusetts for *on-site* renewable energy systems. See footnote 21 for how on-site renewable energy is defined. An example is an apartment or condominium building where each dwelling unit has a separate electricity account. A shopping center with a common renewable energy system serving multiple stores is another example.

In states like Massachusetts with virtual net-metering programs, keeping track of electricity production and assigning it to specific buildings is handled by the local distribution company. The credit shows up on the bill of the beneficiary account as if the renewable energy system were on-site and behind the meter. The cost credit is 100% of the retail rate for exempt systems[26] but 60% of retail rates for large non-exempt systems. While cost is credited at 60% for non-exempt systems, RECs may be credited at 100%. The owner/operator of the renewable energy system files a Schedule Z with the distribution company (Eversource) which names the electric accounts that are to receive a share of the production. The Schedule Z can be filed twice a year.

A forward contract[27] can also be used to assure that electricity and RECs are assigned to the building for a minimum period of time. This addresses the possibility of the off-site renewable energy system being sold separately from the complying building and assures that the RECs are assigned to the complying building for a specified term. Assignment of the RECs would be verified through BERDO reporting.

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[25] The Massachusetts net metering program allows production from an off-site system to be assigned to one or more electricity accounts through the filing of a Schedule Z with the distribution company. California has a much more limited program available only to local governments and school districts which is called the renewable energy self-generation bill credit transfer (RES-BCT).

[26] Single-phase systems less than 10 kW and three-phase systems less than 25 kW are exempt.

[27] A forward contract is an agreement to buy specified assets at a given price in the future.

Since owning and operating a renewable energy plant is generally not a core competency of most businesses or institutions, many organizations will delegate responsibility for construction and operation to others, especially for large systems.[28]

Cost Considerations

The initial for utility-scale solar PV systems is estimated to be $1,060/kW of installed capacity.[29] The cost estimate for smaller building-scale systems is higher at $1,800/kW of capacity.[30] An investment in solar PV buys the owner both electricity which can be sold into the market or used to reduce the electric bill of a particular building and the environmental benefits or RECs which are needed for projects permitted under ZNC zoning. The electricity that arrives at a building is the same whether it was generated by solar or a conventional fossil fuel generator. The difference is the environmental benefits. The cost differential between solar PV system and a conventional generator is a reasonable estimate of the cost to the building owner of installing solar, either on-site or off-site.

Complying buildings are new construction which add load to the grid. The cost differential can be estimated by comparing the total cost of generating a unit amount of electricity from solar PV, which is the most likely renewable energy system to be used for renewable energy system for self-owned off-site systems, to the total cost of generating the same amount of electricity with a conventional gas generator. The cost difference represents the premium that a building owner would pay and also is a conservative estimate for the value of the associated environmental benefits.

Different types of electric generators can be compared in terms of their levelized cost of electricity (LCOE). LCOE accounts for all costs, including the capital cost or initial cost of building the generator, maintenance and operation costs that occur over the life of the generator, the cost of upgrading the transmission system, annual fuel costs (for fossil fuel generators) and more. These costs which occur in increments over the life of the system are translated into equivalent annualized costs using appropriate fuel prices, fuel escalation rates, discount rate, and system life.

These annualized costs are then divided by the annualized electricity production which accounts for the peak generating capacity and the capacity factor, which is the percent of the time that the generator is expected to operate at full load. The capacity factor for solar is low, on the order of 30%. Wind is 40% to 45%. Combined cycle gas generators are 87% as they are used primarily for baseload while conventional gas combustion turbines are 30% since they are used mostly for reserve and peak loads. The U.S. Energy Information Agency and others have developed procedures for calculating the LCOE of various types of electric generators. The latest data from the EIA are shown in Table 9.

An advanced combined-cycle gas plant (Advanced CC) has the lowest LCOE among conventional dispatchable generators with a cost of $41.2/MWh. More than 75% of the LCOE is fuel. The LCOE of solar PV is $60.0/MWh, but this is reduced to $45.70/MWh when tax credits are factored in. Most of the LCOE for solar PV is capital cost with fuel being zero. The incremental cost of solar PV over advanced combined-cycle gas is in the range of $4.5/MWh to $18.8/MWh, depending on whether or not tax credits

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28 For example, Stanford University contracts with a solar services provider to construct and manage an off-site renewable energy system that offsets power used at the Palo Alto campus.

29 The cost estimate is for non-tracking (fixed) systems. See https://www.nrel.gov/docs/fy19osti/72399.pdf..

30 The cost estimate is for non-tracking (fixed) systems. See "Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2019" (PDF). U.S. Energy Information Administration. 2019. Retrieved 2019-05-10.

are considered. Without tax credits, the $18.8/MWh estimate is about half the cost of purchasing Massachusetts Class I RECs which are currently selling for about $40/MWh.

The LCOE data in Table 9 are based on large utility-scale solar PV systems which cost less to build than smaller building-level systems. Based on the initial cost figures cited earlier, the capital cost increase for small systems is in the range of 70%.[31] EIA publishes the range in LCOE, which is presented in Table 10. From Table 10, the maximum LCOE for solar PV is 78% higher than the simple average without tax credits and 74% with tax credits. However, the LCOE maximum for advanced combined-cycle gas is only 17% higher. Working with the maximum LCOE values for solar PV and combined-cycle gas plants from Table 10, the LCOE increment is $58.8/MWh with no tax credits and $31.4/MWh when tax credits are considered. These values are more reasonable for building level systems where the initial construction costs are higher and align more closely to the price of Massachusetts Class I RECs which are about $40/MWh.

In summary, the cost increment for small systems is $58.8/MWh with no tax credits and $31.4/MWh with tax credits. For large systems, the cost increment is $18.8/MWh with no tax credits and $4.5/MWh with tax credits. The LCOE analysis does not factor in the impact of net metering and virtual net metering. These programs compensate building owners at retail rates, or in the case of non-exempt systems 60% of the retail rate.

[31] This is based on $1,800/kW for small systems and $1,060/kW for utility-scale systems.

Table 9 – Simple Average LCOE for New Generation Plants Entering Service in 2023 ($/MWh)

Source: U.S. Energy Information Agency, Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2019, February 2019, Table 1b.

Plant type	*Capacity factor (%)*	*Levelized capital cost*	*Levelized fixed O&M*	*Levelized variable O&M (Fuel)*	*Levelized transmiss ion cost*	*Total system LCOE*	*Levelized tax credit[1]*	*Total LCOE including tax credit*
Dispatchable technologies								
Coal with 30% CCS[2]	85	61.3	9.7	32.2	1.1	104.3	NA	104.3
Coal with 90% CCS[2]	85	50.2	11.2	36.0	1.1	98.6	NA	98.6
Conventional CC	87	9.3	1.5	34.4	1.1	46.3	NA	46.3
Advanced CC	87	7.3	1.4	31.5	1.1	41.2	NA	41.2
Advanced CC with CCS	87	19.4	4.5	42.5	1.1	67.5	NA	67.5
Conventional CT	30	28.7	6.9	50.5	3.2	89.3	NA	89.3
Advanced CT	30	17.6	2.7	54.2	3.2	77.7	NA	77.7
Advanced nuclear	90	53.8	13.1	9.5	1.0	77.5	NA	77.5
Geothermal	90	26.7	12.9	0.0	1.4	41.0	-2.7	38.3
Biomass	83	36.3	15.7	39.0	1.2	92.2	NA	92.2
Non-dispatchable technologies								
Wind, onshore	41	39.8	13.7	0.0	2.5	55.9	-6.1	49.8
Wind, offshore	45	107.7	20.3	0.0	2.3	130.4	-12.9	117.5
Solar PV[3]	29	47.8	8.9	0.0	3.4	60.0	-14.3	45.7
Solar thermal	25	119.6	33.3	0.0	4.2	157.1	-35.9	121.2
Hydroelectric[4]	75	29.9	6.2	1.4	1.6	39.1	NA	39.1

1 The tax credit component is based on targeted federal tax credits such as the PTC or ITC available for some technologies. It reflects tax credits available only for plants entering service in 2023 and the substantial phase out of both the PTC and ITC as scheduled under current law. Technologies not eligible for PTC or ITC are indicated as NA or not available. The results are based on a regional model, and state or local incentives are not included in LCOE calculations. See text box on page 2 for details on how the tax credits are represented in the model.

2 Because the New Source Performance Standard (NSPS) under Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, EIA modeled two levels of CCS removal: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a three-percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

3 Costs are expressed in terms of net AC power available to the grid for the installed capacity.

4 As modeled, EIA assumes that hydroelectric generation has seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Table 10 – Range in LCOE for New Generation Plants Entering Service in 2023

Source: U.S. Energy Information Agency, Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2019, February 2019, Table 2.

	Without tax credits				*With tax credits[1]*			
Plant Type	*Minimum*	*Simple Average*	*Capacity-Weighted Average[2]*	*Maximum*	*Minimum*	*Simple Average*	*Capacity-Weighted Average[2]*	*Maximum*
Dispatchable technologies								
Coal with 30% CCS[3]	93.7	104.3	NB	124.7	93.7	104.3	NB	124.7
Coal with 90% CCS[3]	89.0	98.6	NB	109.8	89.0	98.6	NB	109.8
Conventional CC	42.4	46.3	42.8	55.0	42.4	46.3	42.8	55.0
Advanced CC	37.8	41.2	40.2	48.1	37.8	41.2	40.2	48.1
Advanced CC with CCS	55.6	67.5	NB	75.7	55.6	67.5	NB	75.7
Conventional CT	84.1	89.3	NB	100.1	84.1	89.3	NB	100.1
Advanced CT	71.1	77.7	77.5	86.7	71.1	77.7	77.5	86.7
Advanced nuclear	75.1	77.5	NB	81.2	75.1	77.5	NB	81.2
Geothermal	38.2	41.0	39.4	46.5	35.9	38.3	36.9	43.1
Biomass	83.1	92.2	92.1	114.1	83.1	92.2	92.1	114.1
Non-dispatchable technologies								
Wind, onshore	38.9	55.9	42.8	72.9	32.8	49.8	36.6	66.8
Wind, offshore	115.5	130.4	117.9	158.8	104.0	117.5	106.5	142.6
Solar PV[4]	40.3	60.0	48.8	106.9	31.5	45.7	37.6	79.5
Solar thermal	138.2	157.1	NB	178.7	107.3	121.2	NB	138.2
Hydroelectric[5]	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1

1 Levelized cost with tax credits reflects tax credits available for plants entering service in 2023. See note 1 in Tables 1a and 1b.

2 The capacity-weighted average is the average levelized cost per technology, weighted by the new capacity coming online in each region. The capacity additions for each region are based on additions from 2021–2023. Technologies for which capacity additions are not expected do not have a capacity-weighted average and are marked as NB or not built.

3 Because the New Source Performance Standard (NSPS) under Section 111(b) of the Clean Air Act requires conventional coal plants to be built with CCS to meet specific CO2 emission standards, EIA modeled two levels of CCS removal: 30%, which meets the NSPS, and 90%, which exceeds the NSPS but may be seen as a build option in some scenarios. The coal plant with 30% CCS is assumed to incur a three-percentage-point increase to its cost of capital to represent the risk associated with higher emissions.

4 Costs are expressed in terms of net AC power available to the grid for the installed capacity.

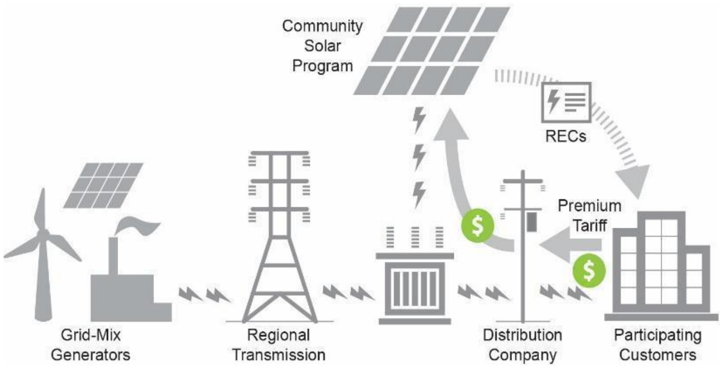
5 As modeled, EIA assumes that hydroelectric generation has seasonal storage so that it can be dispatched within a season, but overall operation is limited by resources available by site and season.

CCS=carbon capture and sequestration. CC=combined-cycle (natural gas). CT=combustion turbine. PV=photovoltaic.

Note: EIA calculated the levelized costs for non-dispatchable technologies based on the capacity factor for the marginal site modeled in each region, which can vary significantly by region. The capacity factor ranges for these technologies are 37%–46% for onshore wind, 41%–50% for offshore wind, 22%–34% for solar PV, 21%–26% for solar thermal, 76% for hydroelectric. The levelized costs are also affected by regional variations in construction labor rates and capital costs as well as resource availability.

Community Solar

With community solar (or wind), a renewable energy developer constructs a renewable energy system and offers capacity to individual building owners or energy users. It works similar to virtual net-metering in that electricity production is credited to the complying building's electricity account. When available, community solar is an attractive option for small businesses and residential customers that have a



moderate load, but can't install on-site renewable energy because of shading or other limitations. The local utility is often a partner with the renewable energy developer, but in Massachusetts, the virtual net-metering rules make this less of a necessity.

There are two participation models for community solar: long-term and short-term. With the long-term model, the building owner/developer purchases or leases enough capacity to offset building energy. The short-term participation model is much more akin to a green pricing program and typically allows the complying building manager to opt out of the agreement on short notice.[32]

While "community solar" or "solar gardens" are the common terms used to describe these programs, most enabling legislation allows other sources of renewable energy, in particular, wind. An advantage of solar is its scalability, in that a portion of the capacity can be easily assigned to each program participant by allocating a number of panels to a particular property. Similar accounting can still be done with wind, but the process is less transparent since most turbines are very large and an individual building would only need a portion of its capacity.

The minimum requirement to assign the RECs and other environmental attributes associated with the renewable energy capacity to the complying building is not satisfied by many community solar systems; most programs keep the RECs and sell them in order to improve the financial viability of the community solar program.[33] Without the RECs, someone else owns the rights to the environmental benefits and participation in such programs does not qualify for buildings permitted through ZNC zoning.

According to the Solar Energy Industries Association (SEIA), 40 states have at least one community solar program on-line, 19 states and D.C. have programs and policies to encourage community solar, and the market is expected to increase by 3.5 gigawatts in the next five years.[34] According to EnergySage, the top states are Minnesota with 120 MW of installed capacity, Colorado with 30 MW, and Massachusetts with 70 MW.[35] Some of the community solar programs operating in Massachusetts are listed in Table 11 along with links to their website.

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[32] Since solar production is seasonal, most programs require at least a year of participation to include both the cloudy and sunny months.

[33] The United States Department of Energy published "A Guide to Community Solar: Utility, Private, and Non-profit Project Development", November 2010. The guide was developed for the National Renewable Energy Lab by Northwest Sustainable Energy for Economic Development, Keyes and Fox, Stoel Rives, and the Bonneville Environmental Foundation. See NREL document 49930. This document provides guidance to organizations what want to set up community solar systems and has examples of programs circa 2010. *Virtually all of the programs cited as examples do not transfer the RECs to the program participants.*

[34] See https://seia.org/initiatives/community-solar.

[35] See https://news.energysage.com/comparing-top-community-solar-states-minnesota-california-massachusetts-colorado/.

Table 11 – Community Solar Programs in Massachusetts

Source: https://www.solar-estimate.org/news/community-solar-massachusetts

Energy Company	*Community Solar Program*
Clearway Energy Group	Clearway Community Solar (formerly NRG Community Solar)
CleanChoice Energy	CleanChoice Energy Community Solar
Clean Energy Collective	Roofless Solar
CVE North America	Halo Solar
BlueWave Solar	BlueWave Community Solar

Community solar in Massachusetts is made available through the virtual net-metering rules, discussed above. In part because of these rules, there is some confusion as to what constitutes a community solar system. A database developed by NREL, lists 206 community solar programs in Massachusetts with a total capacity of 254 MW.[36] Many of these seem to be private systems that use virtual net metering to assign electricity production and possibly RECs to separate electricity accounts, in many cases condominiums.

As noted earlier, most community solar programs don't quality for ZNC zoning, because the RECs are typically retained by the community solar program or sold to the electric distribution company as a means to comply with state-mandated RPS requirements. Sometimes the RECs are sold separately in the open market. However, there are a few instances when community solar RECs are transferred to the customer. The SolarShare program by Sacramento Municipal Utility District (SMUD) was revised recently so that RECs are provided to the customer. Xcel Energy's Community Solar Garden program in Minnesota allows third party solar project operators to either retire the RECs on behalf of their customers or sell them to the utility for $20 to $30 per MWh.[37]

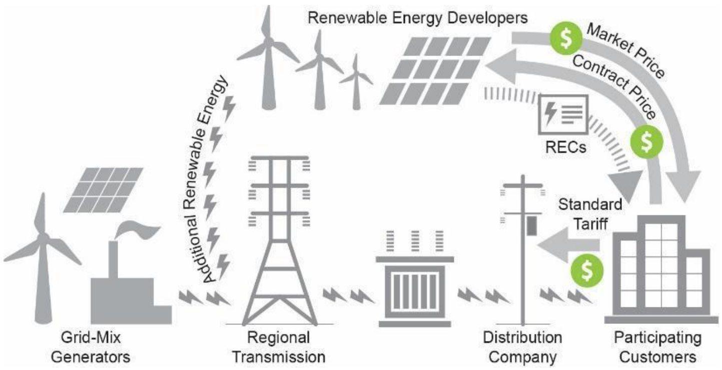
In Massachusetts, community solar is similar in many ways to self-owned off-site systems. In both cases, a single renewable energy system serves multiple buildings or customers and there is a direct credit to the electricity account. The difference is that self-owned off-site systems are *private* while community solar systems are open to the *public* and generally owned by a third party or in some cases the utility.

Virtual Power Purchase Agreements (vPPA)

Direct (or physical) power purchase agreements are a common way to finance and install on-site photovoltaic (PV) systems. Energy service providers install, own and operate the PV system which is located on a building owner's property. The building owner agrees to purchase power from the system for the term of the contract, usually 15 to 20 years according to a schedule of prices agreed to in the contract. The PV developer (or energy service provider) bears the cost and risks associated with construction and operation. The building owner agrees to buy the renewable power for the contract term,

[36] A publicly available community solar project list is available at https://data.nrel.gov/submissions/114.

[37] The Role of Renewable Energy Certificates in Community Solar, Andrea Romano, January 12, 2016, See https://www.navigantresearch.com/news-and-views/the-role-of-renewable-energy-certificates-in-community-solar.



but often does not get to claim the environmental benefits since many contracts assign RECs to the seller.

Virtual (or financial) power purchase agreements (PPAs) are a similar arrangement, except that the renewable energy system is not located on the building owner's property. Instead it is located in farm land, pastures, or rural land owned or leased by the renewable energy developer. While direct PPAs are almost exclusively PV systems, virtual PPAs more often are wind. Virtual PPAs are the financial instrument most commonly used by Google, Amazon and other large companies to acquire renewable energy to offset their operations. The buyer (customer) agrees to buy power from the renewable energy developer at a specified price schedule and period of time. In this way, they hedge price fluctuations of the energy market and assume more predictable utility expenses. If prices go up, they benefit; however, if prices go down, they end up paying more. These agreements are often called a "contract of differences".

Unlike direct PPAs, with virtual PPAs, the *RECs and environmental benefits are always assigned to the buyer*, so they qualify for ZNC zoning. The Rocky Mountain Institute Business Renewables Center developed a Term Sheet for negotiating virtual PPAs and this document makes it clear that the RECs and environmental benefits are assigned to the buyer, in contrast to the typical direct PPA. Since one of the motivations for companies like Google to enter into virtual PPA contracts is to claim the environmental benefits, having the RECs assigned to them is essential.

Scalability is a challenge with virtual PPAs. The minimum size for solar virtual PPAs is about 5 MW and the minimum size for wind PPAs is about 10 MW, but most vPPA deals are much larger.[38] A 5 MWh solar system would power approximately one million ft² of office space. Also, the counterparty to the renewable energy developer (purchaser of the vPPA) must have an excellent credit rating. The minimum renewable energy system sizes and need for credit worthiness make vPPAs an unlikely option for small developers or building owners. However, governmental entities, utilities or allied private parties could serve as the counterparty and sell or allocate shares to individual building owners, a process known as aggregation. In 2018, there were only about 27MWhrtual PPAs negotiated in the United States for a total of 23.5 million MWh. The average size of the deal was about 85,000 MWh.[39]

The scale issue can be addressed through aggregation. Companies or organizations can combine their electricity needs and negotiate together with renewable energy developers to achieve the necessary demand and to obtain better terms. Massachusetts Institute of Technology recently partnered with the Boston Medical Center and the Post Office Square Redevelopment Corporation. This partnership issued a request for proposals and signed a vPPA contract with a 60-MW solar project in North Carolina. In this case, MIT took the lead and more than two thirds of the solar production.[40]

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38 Per Blaine Collinson formerly with Edison Energy (Altenex).

39 Status and Trends in the Voluntary Market (2018 data), Jenny Heeter, slides presented in September 2019 at the Renewable Energy Markets Conference in San Diego. NREL Document 74862.pdf.

40 The MIT case study is documented in the *Climate Action Playbook* by Breakthrough Energy, February, 2021.

Proximity is a potential issue with virtual PPAs. Sometimes the location of the renewable energy system is located in a separate electric grid thousands of miles from the electric load it is offsetting. Many buyers of virtual PPAs prefer to enter agreements with renewable energy systems located close to their facilities or at least in the same electric grid or market. However, out-of-region vPPAs are allowed for ZNC zoning credit if they are located in states that have electric grid emissions greater than Massachusetts. For example Boston University signed a vPPA contract with a wind developer for a 48.6 MW project in South Dakota. A key consideration for BU was that the avoided carbon emissions for renewable energy in South Dakota are significantly higher than a similar wind farm in Massachusetts, since the carbon emission of the grid in South Dakota is greater than Massachusetts.

Another issue is that virtual PPAs are an agreement between an organization (often a corporation) and a renewable energy developer. They are not associated with a particular building permitted through ZNC zoning. This creates an accounting and record keeping challenge, which can be addressed through BERDO reporting. Transparent documentation is needed to assure that an adequate portion of the environmental benefits from a vPPA contract are assigned to the ZNC building for the given period of time and are not double counted. Tying the PPA to a particular building through the vPPA contract could be a challenge since the renewable energy developer is making a deal with a creditworthy counterparty for the duration of the contract. Renewable energy developers would be leery of a deal where the counterparty could change when the building is sold. This is not an issue with Boston's ZNC zoning requirements, because the new ZNC building owner could simply switch to another renewable energy procurement option and document the change through BERDO reporting.

In traditional (vertically organized) electricity markets where the utility owns generation, transmission and distribution (not applicable in Massachusetts), the utility will sometimes serve as the broker for virtual PPAs between renewable energy developers and their large customers.[41] This option is discussed below under utility renewable energy contracts.

Cost Considerations

The cost of the vPPA to the buyer depends on the terms of the contract and the future sales prices for renewable electricity in the market where the renewable energy system is located. With a virtual PPA, the buyer guarantees the renewable energy developer a minimum wholesale price for the electricity they sell into the market. This is the strike price. If the developer is able to sell at a price higher than the strike, the buyer benefits and receives the difference from the developer. If the developer sells at a price lower than the strike price, the vPPA buyer makes up the difference through a payment to the developer. Because of this feature, vPPAs are often called a "contract of differences". The actual electricity that the buyer receives at the facility is disconnected from the electricity generated by the counterparty in the vPPA, although it is usually the goal of the buyer to match the two.[42]

Cost data is not known for vPPAs, but in this case, program participants would still need to buy their electricity through a competitive supplier or EverSource. It is probably reasonable to assume a cost similar to green pricing programs which are in the range of $33 to $38 per MWh.

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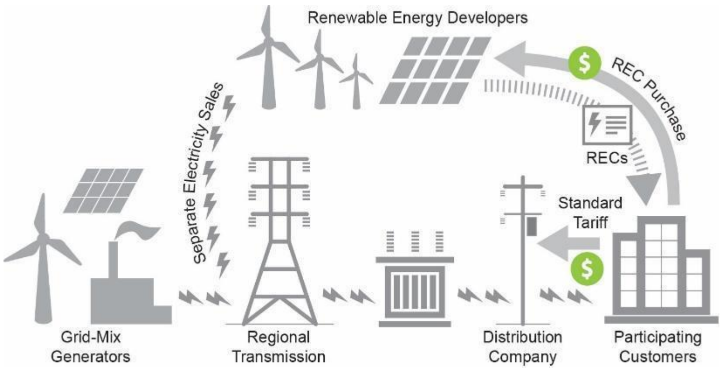
[41] See Lori Bird, et. al., Policies for Enabling Corporate Sourcing of Renewable Energy Internationally, A 21st Century Power Partnership Report, NREL/TP-6A50-68149, May 2017

[42] This structure causes some organizations, in particular financial institutions, to consider virtual PPAs in the same category as financial derivatives and require that they to be treated as speculative investments.

Unbundled RECs



Renewable energy certificates (RECs) represent the environmental attributes or benefits associated with renewable energy. With vPPAs and some community solar programs, RECs are used for tracking and verification of the renewable energy purchased, however, RECs can be separated from the underlying renewable energy they are associated with and sold into the open market, typically in increments of one MWh. The concept of RECs is international, but the term used varies in other countries. REC is used in the United States, Australia, India and other places. A variation is called an I-REC (the "I" standing for international). Europe uses the term Guarantees of Origin (GOs), Mexico uses the term Certificados de Energia Limpia (CELs), and the term Tradable Instruments for Global Renewables (TIGRs) is used in other areas. In some countries more than one designation is used.

RECs can be categorized in a number of ways according to the source of renewable energy (*type*), when the renewable energy was generated (*vintage*), where it was generated (*geography*), and when the generator was constructed (*age*). To approximate the benefit of on-site renewable energy, the source of the renewable energy should be new wind, solar or geothermal generators; production should occur in the same period of time of the building energy that is being offset, and the generator should be new and located in the same geographic area and electric grid of the complying building. As noted earlier, non-emitting Massachusetts Class I RECs are required for ZNC zoning. The market sets a higher price for RECs when more conditions or restrictions apply.

The purchase of unbundled RECs is perhaps the most flexible method of procuring off-site renewable energy. This option is discussed in the Massachusetts context in the July 11, 2018 report by BR+A Engineers. Unbundled RECs represent the largest share of voluntary renewable energy procurement in the United States. In 2018, 63.2 million RECs were sold representing 47% of all voluntary renewable energy procurement.[43] About 33 million of the 51 million unbundled RECs in 2017 (about two thirds) were generated in just three states: Texas, Oklahoma and Kansas. These were mostly generated by wind turbines

Forward purchase contracts may be structured so that the owner(s) of the ZNC building can buy an adequate number of RECs at a specified price for a minimum period of time, however, such a contract is not required for ZNC zoning, since it is flexible and enforced through BERDO reporting.

Cost Considerations

The price of unbundled RECs depends on whether they are Massachusetts Class I RECs or national unrestricted RECs. The price trend for Class I RECs is shown in Figure 4. This has been as high as $50/MWh between 2013 and 2015. The price dropped to around $5 for a brief time in late 2018, but the

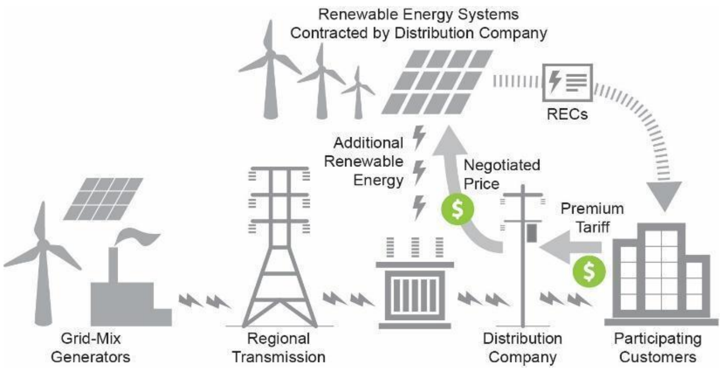
43 Status and Trends in the Voluntary Market (2018 data), Jenny Heeter, slides presented in September 2019 at the Renewable Energy Markets Conference in San Diego. NREL Document 74862.pdf.

price is now about $40/MWh. The five-year running average is in the range of $30/MWh. However, Class I solar RECs are selling for more than eight times general Class I RECs (see Figure 5).

Unrestricted national RECs which are mostly from wind in Texas and the Great Plains are currently selling at about $0.70/MWh. The price was as high as about $1.10/MWh in 2015 and as low as $0.40/MWh in 2016. The five-year running average is about equal to the current price of $0.70. These RECs do not qualify for ZNC zoning compliance.

In summary, the current price is about $40/MWh, but the five-year running average is about $30/MWh. Over the last five years, the price has been as high as $50/MWh and as low as $5/MWh. A broker fee or sales commission may result in a slight premium to the prices quoted above.

Green Pricing



Electric distribution companies, community choice aggregators, and competitive electricity suppliers often offer their customers 100% renewable energy from the grid. The Boston Community Choice Electricity program[44] (a CCA) provides an option for 100% renewable energy for its customers. Some of the competitive electricity suppliers also offer 100% renewable energy (see Table 5).

Durability is the principal issue with retail green tariffs. Most of the programs only require a 12-month commitment and 36 months is the longest commitment required by any of the existing programs. Green tariffs are generally voluntary and the customer (buyer) can opt out of the program on short notice and revert back to the standard offering. However, the ZNC zoning requirements will be enforced through BERDO reporting and building owners will be required to demonstrate participation in an acceptable program at the end of each reporting period. The ZNC zoning obligation is passed on to future owners in the event the property is sold.

In other states, some retail providers are addressing the durability issue by allowing customers can pre-pay the premium at the time of building construction.[45] This could possibly enable the premium to be financed from the capital improvement budget. Future building owners and/or tenants would receive 100% renewable energy, but pay according to the standard (default) tariff. Deed notations and/or covenants are other possible means of structuring a long-term commitment.[46] Committing to a single competitive supplier for the long-term may not be attractive to some building owners, but the ZNC zoning obligation is flexible and allows more competitive programs to be substituted in the future.

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[44] Green Municipal Aggregation: Community Choice Electricity Program (CCE) https://www.boston.gov/departments/environment/community-choice-electricity and https://communitychoiceboston.org/

[45] Sonoma Clean Power, a community choice aggregator serving Sonoma County, is exploring this option as a way to expedite the reconstruction of homes destroyed by the Tubbs fire in Santa Rosa and surrounding areas.

[46] The SMUD SolarShares program is technically a community solar program and it provides durability through a deed restriction.

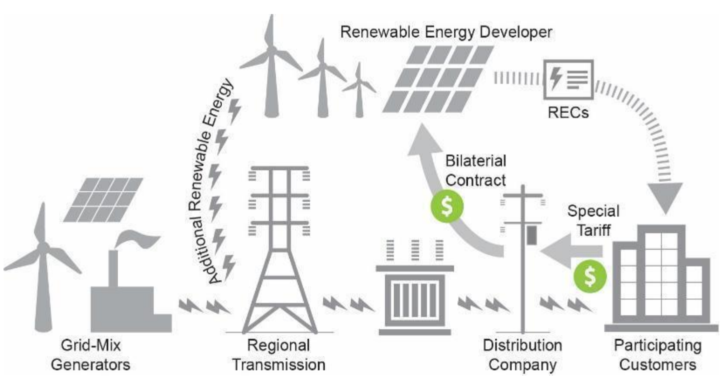
Being powered by 100% renewable energy will be attractive to tenants in multi-tenant buildings and building owners/developers can pass along the 100% renewable commitment to enable them to claim the use of renewable energy as part of their operations. This arrangement is sometimes referred to as a Green Lease.

Cost Considerations

In Massachusetts, the incremental price for green power depends on whether the electricity is backed by Massachusetts Class I RECs or national unrestricted RECs. The premium for 100% renewable energy from the Boston Community Choice Electricity program is $38/MWh. This is the same as the Green Energy Consumers green tariff which is based on with Massachusetts Class I wind RECs.[47] NREL reports that the typical premium for 100% green power is about $0.033/kWh ($33/MWh) which is in the same range as that reported by Green Energy Consumers.[48] The per-kWh cost for 100% renewable energy through the Boston Community Choice Electricity program is $148/MWh. The rate that complies with the minimum RPS requirements is $110/MWh so the premium is $38/MWh or $0.038/kWh, the same as the program offered by Green Energy Consumers.

As noted earlier, most competitive energy suppliers in Massachusetts currently back their green products with wind RECs from Texas and the Great Plains which do not qualify for credit through the ZNC zoning program. These are far less expensive (see Figure 6); the average premium is about $8/MWh ($0.008/kWh). A reasonable estimate for participating in green pricing programs is $38/MWh.

Utility Renewable Energy Contracts



Some utilities offer to procure renewable energy on behalf of large nonresidential customers through a one-off bilateral contract or other arrangement. In these cases, the utility moves the customer to a custom rate structure to reflect the costs of the renewable energy project and retires RECs on behalf of the customer in proportion to their electricity consumption. A key difference between utility renewable energy contracts and retail green tariffs is that customers may negotiate for a particular class of renewable energy generators, e.g. solar. For ZNC zoning qualification, only Massachusetts Class I generators are eligible.

These contracts are sometimes offered as an incentive for large companies to locate a data center or manufacturing plant to the area. In 2017, the NREL database on off-site renewable energy procurement lists just 15 customers for such contracts and the total renewable energy purchased was 2.78 million MWh or an average of 185,000 MWh per customer. NREL reported no utility renewable energy contracts in Massachusetts in 2017. These contracts are geographically concentrated: 60% of total sales were in

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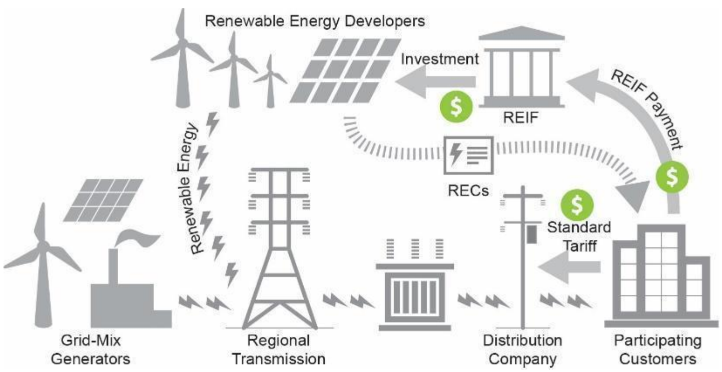
47 See See http://greenenergyconsumers.org/greenpowered/howswitchingworks#mix.

48 Status and Trends in the U.S. Voluntary Green Power Market (2017 Data), Eric O'Shaughnessy, Jenny Heeter, and Jenny Sauer, National Renewable Energy Laboratory, NREL/TP-6A20-72204, October 2018, Figure 9.

Iowa with the other 40% scattered between just seven states: Virginia, Nevada, North Carolina, Oklahoma, Nebraska, Georgia and Tennessee.

Renewable Energy Investment Fund



A Renewable Energy Investment Fund (REIF) is a monetary account set up to accept payment from building owners or developers who are unable or don't want to install on-site systems, engage in contracts for renewable energy procurement, or pass along the requirement to participate in renewable energy purchasing to their future tenants (i.e. any of the procurement options listed previously). Management of the fund can vary, but would likely be a local or provincial governmental entity, although utilities may also have a role, depending on local circumstances.

Low-income housing programs provide a precedent for REIFs. In communities with requirements for low-income housing, developers often have the option to either provide a certain percentage of low-income housing as part of their project or alternatively, they may contribute to a fund and the local housing authority would use to the money to build or contract for low-income housing on another site. Appendix C has examples of low-income housing programs that could provide a precedent for a REIF. Another parallel is the alternative compliance payment that utilities and competitive suppliers pay in the event that they fail to meet their RPS requirements for a certain period (see Table 3). The alternative compliance payment occurs at the end of a BERDO reporting period to true up renewable energy purchases with net electricity consumption, while the REIF payment could be structured as a one-time up-front payment, like contributions to low-income housing programs.

The managing entity for the REIF could use the money in a number of ways, but all of the options should meet the minimum requirements for off-site renewable energy described above:

8. The most direct use of the funds would be to construct or expand a PV system on behalf of the building owner and assign RECs (and perhaps electricity as well through the Massachusetts's virtual net metering program) to the ZNC complying building. In this case, the REIF would own, manage and operate the system(s).[49] Additionality would be achieved and if the system is located in the Boston area, it could provide educational and inspirational value. With this option (and with virtual net metering), the REIF program could function much like a community solar program where participants pay in advance through a REIF contribution for enough capacity to offset the complying building's energy use. System sizes would likely be larger than the 10-kW single-phase or 25 kW three-phase thresholds and the REIF would have to make an *Application for a Cap Allowance* in order to use virtual net-metering. At present there is about 80 MW of capacity remaining under the cap.

[49] The benefits of the federal investment tax credit would not apply to the city since it pays no federal taxes, but the system could be installed on city property through a direct power purchase agreement. However since many contracts assign the RECs to the seller (renewable energy developer) in direct PPAs, special terms would need to be negotiated.

9. Rather than directly owning the renewable energy system, a second alternative is for the REIF to contract with a third-party for the construction, operation and management of the renewable energy system. The third-party renewable energy developer would sell power into the grid through ISO New England, but the environmental attributes associated with the renewable energy, including RECs and/or carbon credits, would be assigned to REIF participants for a specific term. They would also transfer to the new property owner in the event of a sale.

   The contract with the third-party renewable energy developer could be structured in many ways, but one option would be through a vPPA (see earlier discussion). With this option, the REIF management could set special requirements, e.g. that the renewable energy generator be Massachusetts Class I. Through aggregation, the REIF would enable the vPPA option to work for small customers who may not qualify for a vPPA contract themselves because of the minimum purchase quantity or the need for an excellent credit rating. The REIF would basically serve as an aggregator and distribute the RECs and other benefits of the vPPA to each of the program participants. The REIF would likely need to be backed by the City, since the renewable energy developer would require a counterparty with excellent credit.

10. A third option is for the REIF to purchase unbundled RECs (Massachusetts Class I RECs) on behalf of program participants. Small businesses may find it difficult to locate a broker and directly buy unbundled RECs, and the REIF could make the process seamless for building owners and developers. Again, the program could be structured with a single upfront payment to cover the purchase of RECs for a specific period. REIF management could enter a forward contract to buy the RECs on behalf of all the program participants for the given duration.

If a one-time up-front payment is made to the REIF before building occupancy, the investment might be booked to the capital improvement budget and financed through the mortgage or other long-term financial instruments. The payment would be proportional to the amount of renewable energy needed to achieve compliance with the renewable energy procurement requirement. The renewable energy capacity for each program participant would be determined through energy performance modeling.

If the program is set up properly and effectively managed, it should provide near equivalency to the installation of on-site renewable energy systems in terms of impact and additionality. Contributions to the REIF would result in new renewable energy generation being added to the grid and operated for the long-term. The DOER guidelines for managing alternative compliance payments provide a precedent and the payment itself (see Table 3) could be a reference point for setting the REIF amount.

The REIF concept could also potentially include the funding of local emission reduction projects that benefit environmental justice populations in Boston and support community priorities. This would expand the use of REIF beyond just renewable energy and include projects like energy efficiency for low-income residents, among others. A similar expanded scope is being considered for the use of the Alternative Compliance Payments (ACP) for the proposed Building Emissions Performance Standard (BEPS) in the BERDO update. Additional equity and inclusion focused parameters could also be applied to the fund, such as the oversight of the fund being performed by a review board with community representatives (e.g. 2/3 community representatives is proposed under the BEPS fund referenced above).

Cost Considerations

The amount of money to be paid to the REIF should be adequate to cover the hard and soft costs of building new renewable energy systems (option 1), negotiating and buying a virtual PPA (option 2), or buying RECs (option 3). If option 1 is managed like a community solar program, then participants would have two benefits: an electricity credit to their utility bill as well the RECs and other renewable energy attributes. In essence, participants would be paying in advance for a given term of electricity (e.g. 15 years) along with the RECs. If the REIF can install a PV system for $1,430/kW[50] and if the system produces 1,425 kWh each year for each kW of capacity[51], the system would produce both electricity and RECs at an annualized cost of $0.092/kWh ($92/MWh) for a 15-year period (or longer).[52] Soft costs would likely increase the cost. These costs include both the electric energy and RECs and do not represent incremental costs.

Compliance Cost Summary

The cost of achieving compliance with each of the procurement methods depends on a number of factors. The cost of some options is fairly straightforward to assess, as the market has set a price, e.g. green pricing and unbundled RECs. The costs of on-site and self-owned off-site systems are a bit more complicated and depend on tax credits and the counterfactual. No data is available for utility contracts or virtual PPAs since these are not common in Massachusetts. Table 12 summarizes the range of costs that can be expected. The assumptions and procedures for developing these costs are discussed earlier.

Table 12 – Cost Comparisons for Procurement Options and Variations for Boston

Procurement Method	*Variation*	*Cost Range ($/MWh)*
On-Site and Self-Owned Off-Site	n.a.	$58.8 small systems with no tax credits, $31.4 small with tax credits $18.8 large systems with no tax credits, $4.5 large systems with tax credits
Community Solar	Up-Front Payment	Not available in Boston but probably similar to green pricing
	Subscription	Not available in Boston but probably similar to green pricing
Virtual PPA	MA Class I Generator	No data available but probably similar to green pricing
	Out of Region	No data available but probably similar to green pricing
Unbundled RECs	MA Class I required	$40 current, $30 five-year running average, $50 high, $5 low
Green Pricing (RECs)	MA Class I required	$33 to $38 based on current offerings and NREL estimates
Utility Contract	Bilateral Agreement	No data available
REIF	Local PV System	See self-owned and on-site systems.
	vPPA Investment	See vPPA
	Unbundled RECs	See unbundled RECs above

[50] This is the average of utility scale systems at $1,040/kW and building scale systems at $1,800/kW.

[51] This is the expected production of a solar PV system in the Boston area with a fixed azimuth and tilt (not tracking).

[52] This is based on a discount rate of 4.2% and a 15-year time horizon. Electricity production after the 15-year period is not considered but has value. However, for simplicity, maintenance and operation costs are not factored in.

There are many different ways for buildings to comply with the renewable energy procurement requirements. Various renewable energy procurement methods and combinations are available. Table 13 gives an estimated of the present value of compliance in dollars per square foot for offices, retail stores, schools, and multi-family residential. These estimates are based on the buildings being designed to the energy efficiency levels specified in ASHRAE Standard 90.1-2019 or the IECC 2021, but it is possible to design buildings that are more energy efficiency. The more energy efficient the building, the lower the compliance cost since less renewable energy needs to be installed or purchased. The estimates represent the premium for renewable energy and do not include the base cost for electricity.

Table 13 – Compliance Costs for Typical Buildings

		Office	Retail	School	Multi-family
		All-Electric Buildings			
	Electricity Use (kWh/ft^2-y)	8.62	15.23	11.50	13.79
Present Value Cost of Compliance ($/ft^2)	Minimum	3.59	6.34	4.79	5.75
	Average	4.25	7.51	5.68	6.80
	Maximum	5.56	9.82	7.42	8.89
		Mixed Fuel Buildlings			
	Electricity Use (kWh/ft^2-y)	6.35	9.46	8.49	8.07
Present Value Cost of Compliance ($/ft^2)	Minimum	2.64	3.94	3.54	3.36
	Average	3.13	4.67	4.19	3.98
	Maximum	4.09	6.10	5.48	5.20

The cost of compliance is a direct function of building electricity use as shown in Figure 8. Larger renewable energy systems are needed with greater electricity use. This provides a significant motivation to design buildings to be more energy efficiency.

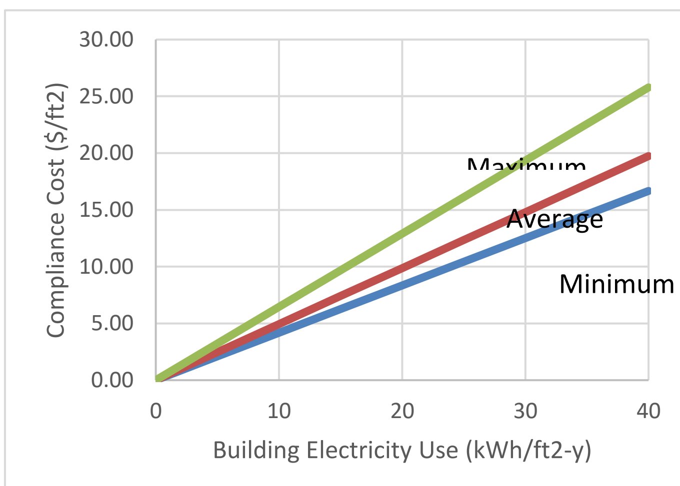


Figure 8 –Compliance Costs vs. Electricity Intensity

Affordable housing programs provide a precedent for the Renewable Energy Investment Fund. The following are examples. Other non-profit and non-governmental precedents also exist for renewable energy investment funds, and these could be further explored as models for developing investment selection and review processes.

Boston's Inclusionary Development Policy Fund

The administration of REIF funds could be modeled after Boston's existing Inclusionary Development Policy Fund, which collects contributions from market-rate housing developments with ten or more units and in need of zoning relief to support the creation of income-restricted housing. Inclusionary Development Policy Funds are used by the City of Boston Department of Neighborhood Development ("DND") to fund the creation of affordable/income restricted housing across Boston. The DND makes funds available to support affordable housing through Requests for Proposals. Proposals that meet the DND's underwriting policies and standards for accessibility, sustainability, good design, and community support are eligible to receive funding from the DND. The DND supports developers who receive funding throughout their projects and can help find eligible tenants for buildings.

Santa Fe's Affordable Housing Trust Fund:

"The Affordable Housing Trust Fund was set up by the City to act as a repository for development fees generated through the affordable housing program, as well as for program income funds that are paid back to the City. Another source of funding is revenue from land sales by the city. To supplement Community Development Block Grant (CDBG) funding, the trust fund was set up so that at least 51% of funds must be used for down payment assistance. Other prioritized activities include rental assistance for very low-income renters and real estate/infrastructure funding to support nonprofit development.

Every year, the City's Community Development Commission sets funding priorities and an Request for Proposals (RFP) is released that is commensurate with the CDBG funding schedule as described in the preceding section. In order to achieve efficiency, the CDC will consider the applications for funding from the Affordable Housing Trust Fund at the same time as CDBG funding requests."

Arlington's Affordable Housing Investment Fund:

Since its creation in 1988, the Affordable Housing Investment Fund has been Arlington County's main financing program for the development of affordable housing. The program has enabled the majority of the approximately 7,500 rental units approved throughout the County to help provide homes for low- and moderate-income households, including specialized housing for the elderly, the homeless, or persons with disabilities.

The Fund supports affordable housing development and preservation in Arlington by:

- Providing low-interest, subordinate loans for developers of affordable housing.
- Subsidizing renovations and upgrades to keep existing affordable housing safe and sustainable.
- Alleviating the dramatic loss of affordable housing units in multifamily properties.

Austin's Affordable Housing Density Bonus Programs

In Austin, affordable housing density bonus programs are neighborhood-specific, and some allow a fee-in-lieu option, wherein developers pay a fee per square foot of bonus area. The funds gathered from fees may be allocated toward creating affordable housing in the city or investing in the neighborhood of the development: funds gathered through Austin's Downtown Density Bonus feed Permanent Supportive Housing; funds gathered through the North Burnet Gateway density bonus program are invested within two miles of North Burnet Gateway boundaries; funds from the East Riverside Corridor density bonus program are paid into the Transit Area Housing Assistance Fund. Although no examples of a fee-in-lieu option for density bonus programs incentivizing energy efficiency or building electrification have been identified, these could be effectively modeled after the fee-in-lieu option. Using this model, Boston could allow neighborhoods a degree of self-determination in their use of REIF money.

Victoria, British Columbia

Victoria, B.C.'s policy takes a similar but slightly different approach to quantifying the value of increased density and requiring correlated financial contributions: "the City has identified a fixed rate target which will be sought for certain rezoning which result in bonus density. For all other rezoning resulting in bonus density, the City will seek an amenity contribution equivalent to 75% of the additional land value created by the rezoning, based on an economic analysis." This structure could be adapted to require developments that undergo rezoning resulting in bonus density to contribute to a fund supporting energy upgrades in the neighborhood or city.

Appendix D –Template for REIF and Administrative Body

Model Language: The City of Boston shall establish a Renewable Energy Investment Fund (REIF) to act as a repository for fees generated through the Renewable Energy Procurement Requirement and appoint a commission to oversee the administration and impact of the fund. The commission shall include members with expertise in renewable energy, urban development, socioeconomic equity/environmental justice, and investment. The commission shall meet annually to review the impact of current and prior investments, quantify the renewable energy added to the grid through REIF funds, review and revise if necessary the payment requirements, and set funding priorities for the next year.

Boston’s Inclusionary Development Policy (see Appendix A) provides a precedent for the authorization, by executive order or inclusion as a zoning article, for:

- Land use policy with long-term impact on ownership and operations
- Terms that are set during the land use permitting and are recorded with the deed to ensure future compliance
- City management of private development mitigation measures

Funds administered as part of a REIF must be managed effectively for long-term additionality and must ultimately contribute significantly to the proportional reduction of greenhouse gas emissions. Key considerations in the structure and administration of a REIF include clarity in purpose, oversight and accountability, and measurement of impact. The administrative authority responsible for the management of REIF funds would:

- Record allotment of funds,
- Quantify the impact from the investments with regard to additional renewable energy systems and reductions in greenhouse gas emissions,
- Periodically review and adjust the investments to ensure that REIF contributions are resulting in new renewable energy generation being added to the grid and operated for the long-term, and
- Verify that RECs are being retired on behalf of the complying buildings that have contributed to the REIF.

General Notes and Websites (not part of report)

Community Choice Aggregation

State statute enables CCAs. Cities with CCA include Melrose, Brookline, Lexington, and others. Brookline has an offer for 25% and 100% renewable energy. Lexington plans a 100% program if it is "economically feasible". Many other towns are working on CCAs: Acushnet, Attleboro, Carver, Dartmouth, Dedham, Dighton, Douglas, Dracut, Fairhaven, Fall River, Freetown, Marion, Mattapoiset, New Bedford, Northbridge, Norton, Plainville, Rehoboth, Seekonk, Somerset, Swansea, Westport, and Westford.

The website notes that Somerville and Cambridge are in the early stages, with a focus on buying clean energy, but it appears that Cambridge is well ahead of that reported at this website.

The following websites have additional information about CCA programs in Massachusetts.

- https://www.massclimateaction.org/community_aggregation
- **www.masscea.com**
- http://www.goodenergy.com/Community-Energy-Aggregation/massachusetts Good Energy is a broker that can work with customers to purchase renewable energy and/or RECs. It also works with cities to set up their CCA.
- https://www.peregrinegroup.com/municipal-aggregation/ Peregrine Energy Group is a consulting group and broker hired to set up the CCA for Cambridge, which is called the *Cambridge Community Electricity Program* (see details below).

Clean Energy Collective

The *EnergySage Community Solar Marketplace* is a DOE program to help homeowners find a company to install solar and to get quotes. Eversource is a partner and the website is tailored to the local utility. It can also be used to find community solar opportunities. See https://www.energysage.com/p/eversource/. You choose a state and the available programs will be displayed. For Massachusetts, two programs show up: Massachusetts SMART Community Solar (Clean Energy Collective) which serves Eversource east customers and Russel & Tolland (Ampion) that serves western Massachusetts. More detail is offered below and at https://cleanenergyco.com/rooflesssolar/mass/.

The website notes that "Clean Energy Collective (CEC) is a pioneer in the industry, establishing the country's first community-owned solar array in 2010. CEC has a significant presence in Massachusetts, having built the first array in 2014. Since then, we have built more than 45 projects in the state, representing nearly 85MW of community solar capacity and serving thousands of customers in the Bay State."

The big shortcoming is that customers do not get the RECs. The following note is provided under the graphic at the top of the website, "*By participating in this community solar program, you acknowledge and agree that you do not receive environmental attributes, green attributes, renewable energy credits, or tax incentives associated with the program, all of which shall be owned by CEC, the utility, or another third party*." The program can be used in either Eversource or National Grid territories. The program is billed as a way to save money on the electric bill, as opposed to paying a premium for the benefits of renewable energy. The program is open to all account holders of Eversource or National Grid. Residential customers must have a FICO score of 680 or better.

The following are some of the questions and answers posted to the website:

What are the advantages of RooflessSolar vs. rooftop solar panels?

RooflessSolar site locations are selected to allow the solar panels to orient towards the sun at the optimal angle, with less shade to maximize solar production and your savings. RooflessSolar projects provide up to a 20% performance enhancement over traditional rooftop solar systems. In addition, CEC constantly monitors facility performance and can quickly dispatch contractors to resolve any maintenance issues, if needed. **THE DISADVANTAGE, WHICH THEY DO NOT TOUT, IS THAT THE CUSTOMER DOES NOT GET THE RECS AND CAN MAKE NO CLAIM THAT THEY ARE USING RENEWABLE ENERGY.**

What impacts will community solar have on my community?

The economic benefits of these projects will be felt for years to come – including long-term leases with local landowners, millions of dollars of construction investment through utilizing local electricians, and other contracted specialists to maintain the solar facilities. And the program delivers long-term monetary savings that area businesses and residential customers will receive for 20 years! The sustainability impact will be felt as well, as each community solar customer is contributing to a lower-carbon future for Massachusetts. **EVERSOURCE AND NATIONAL GRID ARE ALREADY OBLIGATED TO MEET THEIR RPS REQUIREMENTS AND SELLING THE PROGRAM IS A WAY FOR THEM TO DO THIS. THE DENSITY BONUS NEEDS TO BE BASED ON HAVING ADDITIONAL IMPACT BEYOND WHAT IS ALREADY REQUIRED BY THE MASSACHUSETTS RPS.**

How large is the system I'm subscribing to?

Your system size will be customized to meet your energy needs. For example, a typical residential customer in your area may need a 9.20 kW ac system, based on a monthly electricity bill of $150.

You will be assigned a subscription size in kilowatts-AC based on your 12-month electric consumption history, and the details of your system size will be updated in your contract agreement.

Eversource Website Information

Click here. May need to log in. I created an account in order to access more information. The following information is taken directly from the website.

When am I eligible to receive net metering credits?

You will be eligible to receive net metering credits only after your unit is authorized to be online and you have provided:

- Evidence that you have received a Cap Allocation from the Administrator of the System of Assurance (see the MassACA website). Simplified systems (less than 10 kW AC single phase and less than or equal to 25 kW AC three phase) are exempt from the Cap Allocation requirement;
- A complete and accurate Schedule Z;

- For agricultural net metering facilities, a determination from the Commissioner of the Department of Agricultural Resources that a business is an agricultural business and that the net metering facility is operated as part of that business; and
- For anaerobic digestion net metering facilities, a determination from the Department of Energy Resources (DOER), in coordination with the Department of Environmental Protection (DEP), that the facility qualifies under DOER's regulations as a Class I renewable energy generating source pursuant to DOER's Renewable Portfolio Standards regulations.
- For net metering facilities seeking classification as a municipality or other governmental entity, a participant must file an application with the DPU. The application and instructions are available on the MassACA website. Once approved, the DPU will assign a public entity classification number.

For billing, what are the two types of Net Metering accounts?

There are two types of customers, Host and Beneficiary. Host customers may produce excess generation. Credits from this generation may be applied to the same account or allocated for the benefit of other customer accounts (via a Schedule Z form). **THIS IS REALLY INTERESTING. IT SUPPORTS DIRECTLY OWNED OFF-SITE SYSTEMS AND WOULD ALLOW JUST ABOUT ANYONE TO BECOME A COMMUNITY SOLAR SUPPLIER.**

Can I allocate to an Eversource gas account or an Eversource electric account in a different service territory?

No. Net metering credits can be allocated to other electric accounts within the service territory and ISO load zone of the Host Customer account consistent with Section 1.07 of the Net Metering Tariff. Net metering credits cannot be allocated across the company's Eastern and Western Massachusetts territories. **THE RENEWABLE ENERGY PROCUREMENT REQUIREMENT IS USED TO OFFSET GAS USE, BUT THIS WOULD PUT SOME LIMITS ON THAT. IF WE LIMIT THE DENSITY BONUS PROGRAM TO ALL-ELECTRIC BUILDINGS, THEN THIS ISSUE WOULD LIKELY GO AWAY.**

How is the total amount of the net metering credit calculated or determined?

In general, the net metering credit is calculated by multiplying excess generation (kWh) by the appropriate rate for each of the following charges:

1. Basic Service fixed charge;
2. Distribution charge;
3. Transmission charge;
4. Transition charge.

Applicability will vary based on the solar facilities application profile. More information can be found in the company's Net Metering Tariff. **SEE THE NET METERING RULES DOCUMENT IN THE RESOURCES DIRECTORY.** .

If I have a large credit balance due to net metering credits, can I receive a check?

No. Class I and Class II customers with large credit balances should complete a new Schedule Z form to allocate excess net metering credits to additional electric accounts.

Per the tariff: For any Billing Period that a Host Customer earns Net Metering Credits, the Distribution Company shall allocate Net Metering Credits by applying them to a designated Customer's account. The Distribution Company shall carry forward, from Billing Period to Billing Period, any remaining Net Metering Credit balance.

Can a customer close their account to cash out the net metering credits?

No. If a customer closes their account, the residual net metering credit will be used to offset net metering recovery surcharges for all customers. Alternatively, the customer may submit a final Schedule Z to allocate the credit balance to another account(s).

Can a customer partially cash out their credits?

No. However, Net Metering Credits may be cashed out to Class III Net Metering Facilities at the discretion of the company.

How many times may I submit a new Schedule Z?

A new schedule Z may be submitted twice in a calendar year.

Can I install a solar photovoltaic system at my home or business in the Boston area?

Certain areas of the Eversource electric distribution system in the City of Boston and the surrounding area may present challenges for interconnecting a solar PV system.

Eversource customers in this region, known as the Area Network, should be aware that while some locations may be able to accommodate a solar PV system interconnection, other locations may be less suitable.

Please read our Important Notice to Eversource Customers located in the Boston Area Network and Surrounding Regions for more information.

ARE ANY OF THE "AREA NETWORK" LOCATIONS IN CAMBRIDGE? SEE https://www.eversource.com/content/docs/default-source/builders-contractors/boston-area-solar.pdf?sfvrsn=7ad6ff62_4**. CAMBRIDGE IS PART OF THE "AREA NETWORK". THE WEBSITE STATES THE FOLLOWING, "IF YOU ARE A PROPERTY OWNER IN CAMBRIDGE, NEW BEDFORD, OR ONE OF THE BOSTON NEIGHBORHOODS LISTED BELOW, AND ARE INTERESTED IN INSTALLING A SOLAR PV SYSTEM, PLEASE CONTACT US BY EMAIL AT EMDG@EVERSOURCE.COM OR BY PHONE AT 1-800-340-9822, PRIOR TO BEGINNING YOUR PROJECT." THIS SHOULD BE ADDED TO THE EXCEPTIONS FOR THE MANDATORY SOLAR REQUIREMENT.**

How much of the credit will each Beneficiary receive?

Eversource requires the Host Customer to have an approved Schedule Z on file. The Beneficiaries and allocation percentages are designated on the Schedule Z form by the Host Customer. The Host customer bill will display the allocated credit amounts in the "Other Charges or Credits" section.

How Renewable Energy Credit Prices Are Set

https://www.energysage.com/alternative-energy-solutions/renewable-energy-credits-recs/renewable-energy-credit-prices/

Last updated 1/2/2019 The following information is taken from the website.

One REC ("renewable energy credit" or "renewable energy certificate") represents the generation of one megawatt-hour (MWh) of electricity from a renewable energy source. REC prices vary from state to state and depend on a variety of factors, including where you purchase your RECs.

States can be divided into "voluntary" and "compliance" REC markets. The price of RECs changes depending on your state's market structure. States with compliance markets have standards that require electrical utilities to generate a certain percent of their power from renewable resources, known as the Renewable Portfolio Standard (RPS).

Utilities in states with an RPS have to buy RECs if they don't generate enough renewable energy themselves, which increases REC prices in the state. States with voluntary markets typically have less expensive RECs, since there is less demand for them from utilities.

RECs are not necessarily tied to the actual delivery of electricity, and you can purchase them from anywhere in the United States. Outside suppliers sell RECs that come from new energy projects built within the past 12 years, so that you know you're supporting the construction of new renewable energy facilities. You can also often buy RECs through your electrical utility as part of what are called green power programs. Most green pricing premiums cost around 1 to 2 additional cents per kWh.

Cost of renewable energy certificates

States with compliance markets typically have to buy RECs within their region. The price of these RECs can vary greatly from state to state and year to year. According to the National Renewable Energy Laboratory (NREL), in 2011 the price of one REC in Ohio was a little under $35, and it fell to $8 by 2015. By comparison, prices in New England were below $20 in 2011, and climbed to between $45 and $50 in 2015.

RECs can be sold "bundled," or paired with electricity. Bundled RECs must be purchased locally, since the consumer needs to be able to buy the electricity from their local utility. Other RECs can be sold "unbundled," or separate from the renewable electricity they represent. Anyone can buy these RECs and, since there is often an oversupply of unbundled RECs, they are very inexpensive. In 2014 unbundled RECs cost less than $1 each.

Unbundled and bundled RECs offer a great deal of flexibility to a buyer. If price is the most important factor to you, unbundled RECs from anywhere in the country can be as cheap as $1 or less. If you want to support local energy, bundled RECs offer a way to buy electricity locally along with RECs.

Why buy RECs?

Buying RECs allows you to support the renewable energy market without having to install solar panels on your roof or invest in other more involved methods of generating renewable energy. Depending on what type of RECs you buy, you can help local renewable energy projects or even future projects that haven't yet been built.

When buying RECs, not all RECs are created equal

RECs always represent the renewable energy attributes of one MWh of electricity generated, but some RECs have more positive impact on the renewable energy market than others.

"Future RECs" are RECs that will be generated in the future, bought as an up-front purchase. These RECs are sold by new renewable energy facilities or facilities that have not yet been built. Buying future RECs helps to encourage new renewable energy generation, as they provide financial support to the builders of new facilities. The disadvantage to this approach is that the buyer cannot claim the renewable energy attributes of the RECs until they are actually generated. If a facility is not built or is destroyed after construction, consumers cannot claim those RECs—if you're looking into buying future RECs, consult with the seller first.

Additionally, some states rank RECs into different levels, or "tiers," depending on their generation source and environmental impact. This is typically done in states with Renewable Portfolio Standards (RPS), such as Maryland, Pennsylvania, and Massachusetts. Tier 1 RECs refer to RECs that have been newly generated and come from the cleanest renewable resources. Renewable resources such as biomass and hydropower generally fall into the two lower tiers—Tier 2 and Tier 3—although these classifications change from state to state.

SEIA General Information on Community Solar

https://www.seia.org/initiatives/community-solar

Community Solar Models

There are various ways that customers (or "subscribers") may participate and receive benefits from shared renewable energy. Successful models generally include a billing mechanism that allows subscribers to receive credit on their electricity bills for their share of the power produced. Here are a few:

Utility-Sponsored Model

Some utilities provide their customers with the option to purchase renewable energy from a shared facility. The utility owns the array, then sells or leases shares to customers. The customer may purchase a set amount of electricity at a fixed rate for a term, ranging from as short as a kilowatt-hour block to as long as 20 years. The rate, while typically slightly higher than the current retail rate, may provide protection and stability against rising rates for grid electricity. Utility models generally limit subscription to within their distribution territory.

On-bill Crediting

One shared renewable energy model involves enabling residents and business to invest in a portion of a local solar facility, and receive a credit on their electricity bills for their share of the power produced. Credits may be provided in the form of kwh offsets to the customer's consumption, or monetary credits to the customer's bill. Because of diverse state laws and regulations, the rate at which the energy is valued is dependent on geographical area.

Special Purpose Entity (SPE) Model

In this approach, individuals or companies join in a business enterprise to develop a community solar project. The business may design, construct, and own the facility, then work with the local utility to allocate benefits to subscribers. By using an SPE, organizations may be able to take advantage of incentives and tax credits that are unavailable to utilities. University Park Solar and the Clean Energy Collective are examples of this model.

Non-Profit "Buy a Brick" Model

In this model, donors contribute to a shared renewables installation owned by a charitable non-profit organization.

The non-profit Grid Alternatives is actively and successfully pursuing this model.

Notes from 5/1/2019 Meeting

Self-Owned is much like community solar. Keep community solar on the list. A building owner can hire a solar company to put solar on another site and the credit can accrue to the owner and his properties. This is an option for multi-property organizations like retail chains, real estate investment trusts, school districts, home owner associations, etc.

The schedule Z assigns cost to beneficiaries, but not the RECs. We need a similar process for assigning RECs. RECs default to the system owner/operator, but they can assign them to whoever.

In New England, RECs are tracked by NEPOOL GIS. See https://www.nepoolgis.com/ for details.

Frankel noted that cost effectiveness should be a consideration in evaluating off-site options. Seth responded that price should not be an important factor. A row will be added to the evaluation matrix o deal with this.

Navigant

The Role of Renewable Energy Certificates in Community Solar, Andrea Romano, January 12, 2016, https://www.navigantresearch.com/news-and-views/the-role-of-renewable-energy-certificates-in-community-solar

If their project share includes something less than a renewable energy certificate (REC)-bundled kilowatt-hour, how should the community solar program be marketed? Ever since the advent of RECs in the late 1990s, confusion has surrounded these questions, because according to widely held guidelines, electricity is only renewable if the RECs are included and retired.

Miscellaneous Text on RECs

Another issue with green retail tariffs is what qualifies as renewable energy. The types of renewable energy included in a retail provider's renewable portfolio vary considerably and is often defined by the Renewable Portfolio Standard (RPS) that is regionally applicable. These standards require investor owned and other utilities to secure a certain percentage of their electric power from renewable energy sources, but what counts as renewable energy varies in each state or jurisdiction. Wind, solar and geothermal sources are clearly renewable energy and are recognized as such in all programs. More controversial sources are biomass, large hydro-electric plants, and unbundled RECs. Biomass is only renewable if forest growth and expansion exceeds wood harvesting and clearing, which is often challenging to verify by the customer. These issues are addressed when green tariffs are backed by Massachusetts Class I RECs.

Hydro-electric plants are renewable energy sources driven by the evaporation and condensation of water, but it has been decades since new large-scale dams have been constructed. The best sites are already taken and potential new sites are likely to face significant opposition from land owners, environmentalists and other interest groups. For this reason, the RPS requirements in most states exclude large legacy hydro-electric plants from being considered renewable energy, but some states like New York, allow it. Additionality is the principal reason that policy makers choose to exclude large hydro. The purpose of the RPS requirements is to encourage utilities to invest in or purchase *new* renewable energy, not take credit for large legacy hydro-electric plants that already exist.

There are a number of issues related to RECs that are discussed in more detail below. The renewable energy portfolio that backs up most green retail tariffs includes purchases of unbundled RECs. Like biomass and hydro-electric power, each state and each RPS ruling is different in the way unbundled RECs can be counted toward meeting the RPS requirement.[53] The issues associated with unbundled RECs (see below) trickle down to the renewable energy portfolios that contain them.

But the issue of additionality goes beyond large legacy hydro-electric plants. Any long-term commitment to purchase green energy should result in *new* renewable energy generating capacity being installed. Whether or not green tariffs achieve additionality will depend on a number of factors.

In California, all retail electric providers have to report renewable content and portfolio emissions factors separately for each offering, but this requirement may not apply in all jurisdictions. This prevents renewable energy sold through 100% renewable energy programs to be double counted in the standard offering, but as noted earlier, the RPS requirements vary considerably by state.[54] If the accounting is separate for each offering, there is less chance that retail providers will blur the lines between their default portfolio and special renewable energy offerings or green tariffs.

In summary, there are many issues with green tariffs as an alternative to on-site renewable energy: difficulty in structuring a long-term commitment, debatable sources of renewable energy, and uncertainty about whether additionality is achieved.

On-Site Natural Gas or Fuel Oil Consumption 6/2/2021

The approach is to require an annual ACP payment for each unit of natural gas or fuel oil that is consumed at the building. The ACP payment would be established for non-compliance with the renewable electricity procurement requirement. One basis of the payment would be the price of Massachusetts Class I RECs, which are now running about $40/MWh.

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[53] California for instance has "buckets" of renewable energy sources. The first Bucket, and the preferred method, is renewable energy systems that sell power directly to the California ISO. At least 75% of the renewable energy must come from this bucket. The second bucket is renewable energy that is "firmed and shaped", e.g. variable solar energy is supplemented and augmented with conventional sources. Unbundled RECs represent the third bucket and cannot exceed 10%.

[54] The National Conference of State Legislatures reports that 29 states have adopted renewable portfolio standards. The requirement can apply only to investor-owned utilities (IOUs), but many states also include municipalities and electric cooperatives (Munis and Coops). The various state programs are summarized at the NC Clean energy Technology Center.

Here is the rationale. Installing new renewable energy in the ISO New England area will avoid 1,024 lb of CO2e emissions for each MWh produced. Burning a MWh of natural gas at the building will result in 681 lb/MWh (19.75 lb/therm). Burning a MWh of fuel oil at the building will result in 715 lb/MWh (29.13 lb/gal). These data are from 189.1-2020 and IgCC-2021.

If the ACP payment is $40/MWh, the cost for avoiding a lb of carbon is $0.039/lb ($86/mton), ($40/MWh)*(MWh/1024 lb). The ACP payment to offset a therm of natural gas is ($0.039/lb)*(19.75 lb/therm) or $0.77/therm. The ACP payment to offset a gallon of fuel oil is ($0.039/lb)*(29.13 lb/gal) or $1.14/gal.

Last month fuel oil in Massachusetts was running about $2.83/gal, so the ACP would represent a 40% premium. In 2020, the average price of natural gas was $1.41/therm, so the ACP would represent a 55% premium.

We should discuss this. It looks a lot like a carbon tax, which may be good or bad, depending on the political climate.