District of Columbia Comprehensive Energy Plan

DRAFT

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Developed for:

DEPARTMENT OF ENERGY & ENVIRONMENT
GOVERNMENT OF THE DISTRICT OF COLUMBIA

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EXECUTIVE SUMMARY

A Long-Term Energy Transformation

This Comprehensive Energy Plan (CEP) is the District of Columbia's five-year roadmap for achieving its long-term target of reducing greenhouse gas (GHG) emissions by 50% by the year 2032, and by at least 80% by 2050. To achieve these ambitious targets, the District must pursue a range of innovative and aggressive actions. As described in Chapter 2, District-wide energy use has already decreased over the past decade, thanks in part to Federal and District Government policies and private sector initiatives. GHG emissions have also declined, largely attributable to a reduction in the number of coal-fired power plants that supply the District with electricity. However, significant challenges to achieving the District's 2032 and 2050 GHG targets remain.

The District has also set two additional, related targets of cutting citywide energy use by 50%, and increasing the use of renewable energy to make up 50% of the District's energy supply by 2032. To explore how the District might meet its GHG and other its other existing targets, a consultant team created a citywide energy and emissions model to help identify where emissions reductions must occur. The model projected future energy use and GHG emissions and simulated the impacts different actions could have on reducing energy and emissions between 2017 and 2032. The outcomes of the model simulations form the basis for the set of recommended actions presented in this CEP.

The CEP organizes these recommendations into three sections that correspond to the major components of the District's energy system:

- **Buildings**, including specific actions for both new construction and existing buildings, plus cross-cutting actions (Chapter 3).
- **Energy Supply**, including actions to both increase the supply of clean and renewable energy, and to modernize the District's electricity system (Chapter 4).
- **Transportation**, including actions designed to transition passenger vehicles from conventional petroleum drivetrains to zero-emission electric drivetrains (Chapter 5).

Each section provides a pathway to achieving the District's targets and presents a full suite of climate and energy policies necessary to achieve them. However, the CEP does not provide details on program design or specific policy language for each action. Below, the key actions necessary for achieving the targets are outlined. A full list of all recommended CEP actions is presented at the end of the Executive Summary.

Buildings

New Construction

To achieve their GHG targets, the District must move quickly toward the implementation of a net-zero energy building code that focuses on shifting buildings away from the use of fossil fuels (e.g., natural gas, coal, oil). To drive the successful implementation of such a building code, the District will need to provide incentives, education and training, and demonstrate leadership to build public support. Significantly higher energy performance in new building construction is projected to help the District avoid 5.1% (423,000 tCO_2e) of the GHG emissions projected in 2032 under the business-as-usual (BAU) scenario.

Existing Buildings

While net-zero energy codes will shift new construction away from fossil fuels, the vast majority of buildings that will be in operation in 2032 exist today. The District must therefore also retrofit a significant portion of its existing building stock to increase its efficiency and reduce reliance on fossil fuels. Retrofits of this scale will require the ongoing management of a well-financed, data-driven, and strategically-targeted program. By retrofitting one in five buildings to achieve a 30% reduction in energy use, the District is projected to avoid 5.6% (462,000 tCO_2e) of GHG emissions projected in 2032 under the BAU scenario.

Energy Supply System

Clean and Renewable Energy Supply

To achieve their GHG targets, the District must increase the proportion of renewable energy derived from sources located within the District. To do so, the District must focus primarily on designing their Renewable Portfolio Standard (RPS) to require an increasing proportion of renewable energy and reducing the number of Renewable Energy Credits and Alternative Compliance Pathways that can be used to comply with it. This must be joined by new RPS legislation that requires 100% of the District's electricity to be supplied from renewable sources by no later than 2050.

In addition to these changes to the RPS, the District must also replace the current Standard Offer Service with a renewable energy power purchase agreement, develop neighborhood energy and solar proliferation strategies, and take steps to improve the adoption and installation of solar panels and other renewable energy technologies.

Electricity System Modernization

A zero-emissions energy system requires a modernized electricity system with a grid capable of integrating high levels of zero-emission distributed energy resources (DER). Such a modernized electricity system will allow for a substantial increase in the quantity of electricity generated within the District, and for the economic benefits of new local generation to be fully realized. This shift will require the development of regulatory frameworks, market structures, and utility models that support a shift toward high levels of DER and facilitate distributed (e.g., peer-to-peer) transactions. A modernized electricity system will also

require grid efficiency and management capabilities to improve grid reliability and resilience, and reduce the ongoing, long-term investments in delivery and generation infrastructure.

The CEP includes a number of specific actions for the District to revise the way electricity generation and other grid investments are evaluated, and drive planning efforts to focus on higher levels of DER integration. Research and regulatory and legislative changes will be required to reduce barriers to DER integration, improve understanding of the District's energy supply and demand, and demonstrate the value of a modernized electricity system.

Transportation

Electric Vehicle Readiness and Adoption

Deep GHG emissions reductions from the transportation sector will be required to meet the District's 2032 and 2050 GHG reduction targets. This must include a shift in mode share towards an increased use of public transit, cycling, and walking, a reduction in emissions from fleets, and the transition of the passenger vehicle stock to efficient and zero-emission electric vehicles. As the District has already begun to make efforts to shift mode share and is currently exploring methods to reduce emissions from fleets, the recommendations in this CEP focus on transitioning passenger vehicles to zero-emission electric vehicles. To accelerate this transition to zero-emission vehicles, the District must focus primarily on policies and actions that support both electric vehicle readiness and adoption, including the construction of the infrastructure necessary to support electric vehicle adoption. This includes increasing the number of vehicle charging opportunities, improving consumer understanding and confidence in electric vehicles, improving the affordability and availability of electric vehicles in the District, and increasing the use of electric vehicles in car-sharing fleets.

An Effective Plan for the District

Implemented together, the actions recommended in the CEP will result in a reduction in the District's GHG emissions of up to 55.9% by 2032 (relative to the 2006 baseline). As success in some areas of the CEP will depend heavily on success in others, the implementation of the CEP actions should be done in a coordinated and strategic manner. Table 1 below demonstrates how the recommended policies and programs will transform the District's energy system, drive deep and sustained GHG reductions, and continue to position the District as a leader in climate change mitigation.

A key uncertainty in achieving the level of emissions reduction outlined by the CEP is how electricity suppliers will comply with the Renewable Portfolio Standard (RPS). The District's RPS currently requires a minimum portion of electricity supplied to District consumers to be generated by renewable sources (e.g., wind, solar), but offers suppliers three compliance pathways: (1) procure new renewable energy generation; (2) purchase and retire renewable energy credits (RECs); and (3) make alternative compliance payments (ACPs). All three pathways support renewable energy generation; however, only the first can reliably lead to GHG reductions that can be attributed to the District. Where RECs or ACPs are used to

comply with the RPS, the GHG reductions achieved by the District by 2032 will therefore be less than 55.9%. This topic is discussed in more detail in Chapter 2.

Table 1. Summary of principal GHG reduction actions

GHG Reduction Wedge	GHGs Reduced from 2032 BAU (tCO_2e)	Percent GHGs Reduced from Total 2032 BAU*
CAFE Standard	473,000	5.7%
Mode Share Change	524,000	6.3%
Electric Vehicle Adoption	34,000	0.4%
New Construction Actions	423,000	5.1%
Existing Building Actions	462,000	5.6%
Neighborhood-Scale Energy	30,000	0.4%
PPA for Standard Offer Service	636,000	7.7%
Renewable Portfolio Standard	1,044,000**	12.6%**
RPS Local Solar Requirement	178,000**	2.2%%**

All figures based on site energy use.

**This column measures the percentage reduction in total GHG emissions that a single action area drives relative to the total GHG emissions in 2032 under the BAU scenario. For example, New Construction Actions result in GHG emissions reductions that decrease total District-wide 2032 GHG emissions by 5.1%.*

***The GHG reductions assume electricity suppliers only use new renewable energy to comply with the RPS.*

While the actions outlined in the CEP will achieve the District's GHG targets, they will not achieve the District's energy use reduction or renewable energy utilization targets. The consultant team determined during the modeling process that achieving all three targets in unison will prove very difficult, if not impossible. Through a collaborative process with representatives from the Department of Energy and Environment, the project team decided to prioritize the GHG reduction target. By establishing GHG reductions as the overarching focus, the CEP aims to provide the District with a prioritization of the investments and resources necessary to achieve energy system decarbonization and successfully mitigate climate change. The energy use and renewable energy targets remain priorities for the District, and the CEP includes actions focused both on energy use reductions and renewable energy increases.

A Plan That Evolves

Finally, the CEP is intended to be a living document that will continuously be revised to incorporate new insights and information as technology improves, knowledge develops, and new issues arise. The actions proposed in the CEP are intended to align with other major plans in the District, including the *Sustainable DC Plan* (2012)*, moveDC Plan* (2014), and the forthcoming *Climate Ready DC Plan* (2016). The District is also investigating carbon pricing, clean energy and efficiency financing, microgrids, and vehicle fleet emissions reductions, among other topics. The CEP reflects the District's latest research on these topics at the time of publication, with the expectation that new insights will continue to develop after publication.

A full list of CEP actions

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1 INTRODUCTION

1.1 Facilitating an Energy Transformation

Cities around the world have started to implement a range of plans and strategies to reduce greenhouse gas (GHG) emissions and combat the risks and threats associated with climate change. The District of Columbia (the District) is a leader in this effort and has already begun to reduce GHG emissions and prepare for climate change impacts through the development of the *Sustainable DC Plan*, *moveDC Plan,* and *Climate Ready DC Plan*.[1]

However, in order to successfully mitigate the impacts of climate change, the District must effect a broader transformation in the way energy is produced, delivered, and used across the city. Because GHG emissions associated with fossil fuel combustion can continue to warm the climate for several hundred years after their release,[2] fossil fuels will eventually have to be completely eliminated from the energy supply system. This process is often described as decarbonization.

To this end, this Comprehensive Energy Plan (CEP) provides a five-year roadmap that would put the District on a trajectory towards dramatically decarbonizing its energy system, and presents a longer-term path towards the District's 2032 targets. The CEP does not provide details on program design or specific policy language for each action, although design considerations and recommendations are provided in some cases. The development of this CEP was guided by the concept of market transformation as a way of understanding the key components required to drive lasting change (Figure 1). Market transformation requires the integration of five elements:

1. Alignment of climate- and energy-related targets.
2. Development of data and information systems to track the District's progress toward its targets.
3. Establishment of strong regulations for energy production and consumption.
4. Provision of incentives to facilitate the adoption of necessary behaviors and actions.
5. Design of engagement and education programs to increase market awareness, consumer demand, and skills development.

The term energy system here refers to all dimensions of energy use in the District, including all fuel or electricity consumed by buildings, in transportation, or by the energy transmission and distribution system itself. A system-wide transformation requires measures that shift both energy supply delivery *and* use, supported by enabling actions that facilitate and encourage broader system change. By focusing on a complete energy transition, this CEP aims to build on the District's existing goals and targets to form a

[1] *Sustainable DC Plan*, http://sustainable.dc.gov/
moveDC Plan, http://www.wemovedc.org/
Climate Ready DC Plan, http://www.sustainabledc.org/climatereadydc/

[2] Hansen J, Kharecha P, Sato M, Masson-Delmotte V, Ackerman F, Beerling DJ, et al. (2013) Assessing 'Dangerous Climate Change': Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature. PLoS ONE 8(12): e81648. doi:10.1371/journal.pone.0081648

complete vision of the strategies and actions necessary to meet the District's long-term climate and energy targets (Box 1). This CEP also provides an important resource and educational tool to raise awareness among policymakers and the general public about the critical energy and climate challenges currently facing the District.

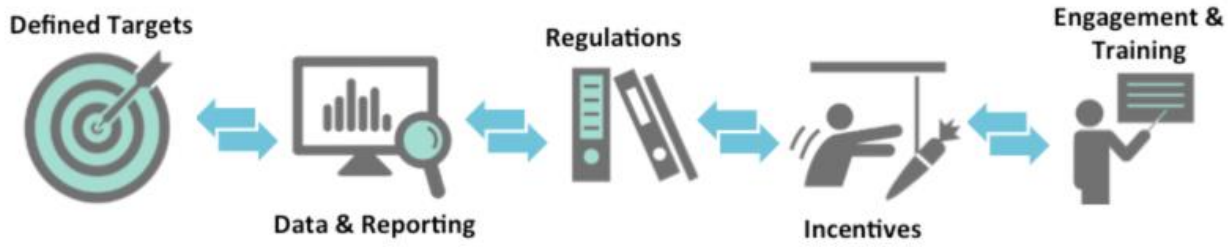


Figure 1. Components of an Energy Market Transformation

Box 1. The District's climate and energy targets

- A reduction in GHG emissions by 50% by 2032, and 80% by 2050, relative to 2006 levels.
- A reduction in District-wide energy use by 50% by 2032, relative to 2012 levels.
- An increase in the use of renewable energy to make up 50% of the District's energy supply by 2032.[3,4]

1.2 Focus on GHG Reductions

While the CEP directly addresses the District's existing climate and energy targets (Box 1), achieving them in unison will prove very difficult, if not impossible. Conversely, reductions in energy use and increases in renewable energy will not necessarily lower GHG emissions. For example, efforts to reduce energy use alone can result in remaining energy still depending significantly on GHG-intensive fuel sources, such as natural gas. Similarly, increases in renewable energy utilization may satisfy incremental demand, rather than replacing existing demand. In both cases, there may only a limited impact on GHG emissions, or no impact at all. Therefore, an explicit emphasis on GHG reductions is necessary to ensure actions taken by the District ultimately achieve the GHG emissions reduction targets. By establishing GHG reductions as the overarching focus, the CEP aims to provide the District with a prioritization of the investments and resources necessary to achieve energy system decarbonization and successfully mitigate climate change. The energy use and renewable energy targets remain priorities for the District, and the CEP includes actions focused both on energy use reductions and renewable energy increases. Future work may look for additional opportunities to achieve these targets.

[3] The District of Columbia, 2012, Sustainable DC Plan (pp.10-11), http://sustainable.DCgov/sites/default/files/dc/sites/sustainable/page_content/attachments/DCS-008%20Report%20508.3j.pdf

[4] District Department of Energy & Environment, Climate Action Planning, http://doee.DCgov/service/climate-action-planning

That said, the five-year timeline of the CEP is a brief period of time in the span of an energy system that is rapidly changing. The District must continue to engage with key stakeholders to ensure the relevance and responsiveness of the CEP, to allow for the integration of new technologies, and to respond to changing fuel prices and market conditions. This level of responsiveness requires ongoing and active examination of the District's energy system to ensure policies and programs are taking advantage of new opportunities and overcoming new challenges. To effectively mitigate climate change, any investments in fossil fuel-based energy sources or infrastructure must be completely eliminated. The District took a key first step in this direction in June 2016, with the announcement of its full divestment of fossil fuels from the District Government's pension fund for government workers.[5] Many similar steps are required.

1.3 A Set of Recommendations

The recommended actions presented in the CEP are ambitious, and their collective impact will be significant. While they have been designed for implementation over the next five years, they will influence District policy, planning, program design, and decision-making processes long into the future. Each action was thoughtfully developed using a comprehensive process of consultation and engagement that included the following activities:

- An initial engagement session with District Government representatives and stakeholders.
- A review of existing District climate and energy plans, actions, and priorities.
- A review and analysis of District-wide energy and emissions data.
- A collaborative two-day workshop with District Government representatives.
- Ongoing engagement and discussions with District Government representatives and consultants.
- A review of best practices in other leading jurisdictions.

To help evaluate the potential impact of different actions in relation to the decarbonization of the energy system, a citywide energy and emissions model was developed and applied to the District (for additional detail, see Chapter 2). A baseline of current energy use and emissions was established to determine principal sources of District emissions by sector and by fuel type. This was followed by a process in which a range of policy scenarios were simulated. These simulations were conducted in collaboration with District Government representatives to identify the scale of overall action necessary to reach the District's targets, and the most realistic set of actions that could be implemented.

The resulting set of recommended actions are broken into the major components of the District's energy system:

1. **Buildings**, including specific actions for new construction and existing buildings, as well as cross-cutting building actions (Chapter 3).
2. **Energy Supply**, including actions to both increase the supply of clean and renewable energy, and to modernize the District's electricity system (Chapter 4).

[5] D.C. Pension Fund Divests From Fossil Fuels, http://www.washingtoncitypaper.com/news/city-desk/blog/20781868/dc-pension-fund-divests-from-fossil-fuels

3. **Transportation**, including actions designed to transition passenger vehicles from conventional petroleum drivetrains to zero-emission electric drivetrains (Chapter 5).

Each corresponding section of the CEP outlines the current status of that particular component and presents a selection of recommendations that draw on existing District policy and programming. Recommendations are cross-referenced between sections as appropriate (e.g. where clean and renewable energy actions may depend on electricity system modernization actions). The CEP uses the acronyms below, along with an action number, to designate recommendations from the different sections:

- **NC** – New Construction (e.g., NC.1, NC.2).
- **EB** – Existing Buildings.
- **CCB** – Cross-Cutting Building Actions.
- **CRE** – Clean and Renewable Energy.
- **ESM** – Electricity System Modernization.
- **EV** – Electric Vehicle Readiness and Adoption.

The recommended actions provided in the CEP are intended to be implemented as a unified package. Certain actions set the preconditions necessary to achieve others, such as the gathering of information necessary to develop and implement a particular strategy. Other actions provide co-benefits that support the achievement of a number of actions, such as the development of industry capacity to understand new technologies or approaches. The actions provided in the CEP should, therefore, be adopted together to equip the District with the full roster of programs, policies, tools, data, information, and capabilities necessary to achieve the targets. A coordinated and strategic implementation is essential to success.

1.4 Funding the Transformation

Transforming the District's energy system from a largely fossil fuel-based system to one that is supplied by almost no fossil fuels requires continued government investment and the support of policymakers, stakeholders, and the public. Reliable and consistent financial structures and funding sources are critical to achieving widespread market change. The CEP requires a large, stable, and accessible pool of funds to drive unprecedented levels of private investment in renewable energy and energy efficiency. Two principal approaches to funding the District's energy transformation should be explored in coordination with the recommendations provided in the CEP: 1) establishment of a green bank and 2) carbon pricing.

The first approach to funding the District's energy transition is the creation of a green bank**.** Green banks are typically public or quasi-public entities that leverage private sector capital to increase the overall level of investment in renewable, low-carbon energy. The creation of a green bank is essential to meeting the District's targets, as the investments required to carry out the actions outlined in the CEP will far exceed what the District Government alone can provide. As an illustration, DOEE reported that a total of $1.5 billion was required to meet the District's former requirements for solar energy generation.[6] As the

[6] District of Columbia Green Bank Recommendations & Implementation Plan, District Department of Energy & Environment, Prepared by the Coalition for Green Capital, June 27, 2016

District has now doubled its requirements for solar energy generation, even greater investment will be needed.

The value and importance of a green bank has been echoed by DOEE's Single Family and Small Multifamily Working Group in its August 2016 report, *Green Residential Solutions – Recommendations from the Single Family Small Multifamily Green Building Working Group*.[7] Green banks have proven to be a crucial model in providing much-needed funding for the many dimensions of energy transition, while providing additional benefits for consumers, businesses, and investors. These include:

- Improved leveraging of private sector investment per public dollar spent.
- Continued financing of public grants with a lower public funding burden.
- Lower energy bills through efficiency and renewable energy.
- Job growth in the local economy through clean energy investments.
- Streamlining existing programs without having to consolidate program administration.
- Improved efficiency of government programs by coordinating green bank activities with other agencies to maximize program value.

The establishment of a green bank should be a top priority for the District. The DOEE-commissioned *District of Columbia Green Bank Technical Report* provides a comprehensive analysis of a green bank's role in financing renewable energy, energy efficiency, and related infrastructure projects in the District.[8] Specific recommendations provided in the green bank report align with several of the recommendations in Chapters 3 to 5 (Box 2).

To effectively drive the levels of investment required to achieve the District's emissions reduction targets, the green bank should offer a portfolio of financing solutions that address both renewable energy and energy efficiency market needs. These solutions include:

- Off-the-shelf commercial property assessed clean energy (PACE) financing to accelerate renewable energy usage.
- On-bill financing to open the energy efficiency market to renters.
- Low-to-moderate income whole-home solutions with alternative underwriting options.
- Standard offer loan loss reserve to drive residential lending.
- Comprehensive community solar solutions, including rooftop aggregation, to increase solar access.
- Aggregation of solar renewable energy credits to overcome inefficiency. [9]

[7] http://doee.dc.gov/service/green-buildings

[8] Prepared for DOEE by the Coalition for Green Capital, August 3, 2016.

[9] For more details on these, see the *District of Columbia Green Bank Technical Report*.

Box 2: Principal recommendations for the development of a green bank from *District of Columbia Green Bank Technical Report*

- Pass legislation to establish the green bank as a new quasi-public, wholly-owned nonprofit corporation of the District Government that sits between the government and markets.
- Establish a separate Board of Directors appointed by the Mayor and Council of the District of Columbia.
- Capitalize the green bank with $100 million of public money over time and from a number of sources (including appropriations, Exelon-Pepco merger funds, and increased SETF ratepayer funds) to animate approximately $500 million in private investment.
- Provide an ongoing stream of dedicated public funding to a green bank on an annual basis.
- Give the green bank the ability to issue bonds under various structures.
- Borrow administrative staff from DOEE to initiate the green bank, then hire a team of dedicated staff to operate it.
- Use the green bank to provide a portfolio of financing and market-based solutions that target renewable energy, energy efficiency, and low- to zero-emission transportation.
- Target specific funds to low-to-moderate income individuals and combine these funds with other instruments (e.g., on-bill financing).

In particular, deep green retrofit incentives are critical to achieving the high retrofit rates required in the CEP and should be based on the analysis summarized in *Greening the District of Columbia: Incentives and Policies to Achieve Deep Green Building Construction and Renovations* (Appendix).[10] Some of these recommendations have already been integrated into Chapter 4.

Carbon pricing provides an additional funding mechanism and offers other benefits in fostering a market transformation. Carbon pricing can play a valuable role in shifting consumer, business, and government decision-making toward low- and zero-emission options. By setting a price on carbon, jurisdictions like the District can send a strong economic signal to the market to reduce GHG emissions. Two major approaches to carbon pricing include emissions trading systems and carbon taxation. In the former, a total cap on GHG emissions sets a limit to the quantity of emissions that can be released by individual industries or businesses. Those who exceed their GHG limit would be required to purchase additional allowances from those who have not. In the latter, a tax is set on the carbon content of different fuels. While the appropriateness of the precise mechanism depends on the jurisdiction in question, some form of carbon pricing will help drive down emissions in the District, particularly in the building sector. The Department of Energy and Environment (DOEE) is currently investigating the potential role and design of carbon pricing.

[10] This report is currently undergoing review by DOEE and will be available to the public in the near future.

1.5 A Living Document

Finally, it should be noted that the CEP is a living document intended to be revised to continuously incorporate new insights and information as knowledge develops and new issues arise. Alongside the CEP, the District Government has commissioned several other studies to support climate and energy policy and program development. These include:

- The design and creation of a green bank.[11]
- The design and implementation of effective deep green retrofit financing. [12]
- The role of carbon pricing and its potential implementation.[13]
- The role of microgrids.[14]
- The reduction of GHG emissions from government and commercial vehicle fleets.[15]
- The sustainability performance of single -family and small multifamily buildings. [16] and
- The District's successful adaptation to the impacts of climate change.[17]

The authors of the CEP reviewed the studies above to avoid potential duplication and align recommendations. Select results from the studies on deep green retrofit financing and the sustainability performance of single-family and small multifamily buildings have already been incorporated into this report, while other recommendations may be incorporated at a later date. It is important the District take into consideration the specifics of these parallel studies as well in order to develop a complete and detailed understanding of the policies, programs, and other actions required to achieve the long-term climate and energy targets.

[11] *District of Columbia Green Bank Technical Report*, prepared by the Coalition for Green Capital for DOEE, August 3, 2016.

[12] *Greening the District of Columbia: Incentives and Policies to Achieve Deep Green Building Construction and Renovations*, commissioned by DOEE and completed by Capital E in 2016.

[13] Forthcoming.

[14] Forthcoming.

[15] Forthcoming.

[16] *Green Residential Solutions – Recommendations from the Single Family Small Multifamily Green Building Working Group*, June 2016.

[17] *Climate Ready DC Plan*

2 TRANSITIONING TO A LOW-CARBON DISTRICT

2.1 The District's Energy Use and Emissions Profile

To identify the set of essential actions required for the decarbonization of the District's energy system, it is necessary to understand the District's current energy and emissions profile. Since the establishment of the 2006 GHG emissions baseline, accurate energy use and GHG emissions data have been collected and calculated for five nonconsecutive years: 2006, 2009, 2010, 2011, and 2012. While there are gaps in the data, the baselines derived provide a sufficient understanding of the key sources of emissions in the District today. The primary sources of energy use and GHG emissions across the District are categorized and explained by fuel type and by sector below. These sources indicate key elements that require the District's attention to achieve the GHG reduction targets. As energy use and GHG emissions data are unavailable for 2007 and 2008, they have been estimated in the figures below by assuming a linear annual change between the years 2006 and 2009.

2.1.1 District Energy Use in 2012

Figure 2 summarizes the trend in energy used in the District between 2006 and 2012 by fuel type. All reported energy and GHG emissions figures throughout the CEP are reported based on site energy use based on building energy data from DOEE and to align with the District's GHG inventories.[18] As you can see, the District used approximately 85 billion kBtu of energy in 2012, down from 100 billion kBtu in 2006. Three main activities were found to make up the vast majority of energy consumption: electricity use in the building and transportation sectors; natural gas use in the building sector; and gasoline consumed by vehicles. In 2012, electricity accounted for approximately 43% of all energy used in the District, while natural gas and gasoline accounted for 28% and 25%, respectively. Also, while gasoline is sourced from a variety of companies, the majority of electricity and natural gas is supplied to the District by two utilities. Therefore, the electric utility *Pepco* and the natural gas provider *Washington Gas* are important stakeholders in a strategy that successfully achieves the District's long-term climate and energy targets.

When the fuel sources are broken out by sector, it is clear the primary uses of energy are attributable to the electricity, natural gas, fuel oil, and kerosene used by buildings, which together account for approximately 73% of the energy consumed in 2012. The remaining 27% can be attributed to gasoline, diesel, and a small amount of electricity consumed for transportation, including passenger vehicles, corporate and government fleets, freight, and mass transit.

[18] Site energy use is the amount of heat and electricity consumed by a building as reflected in utility bills, whereas source energy accounts for the total amount of raw fuel required to operate a building. Source energy in incorporates all transmission, delivery, and production losses. Description from https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager/understand-metrics/difference

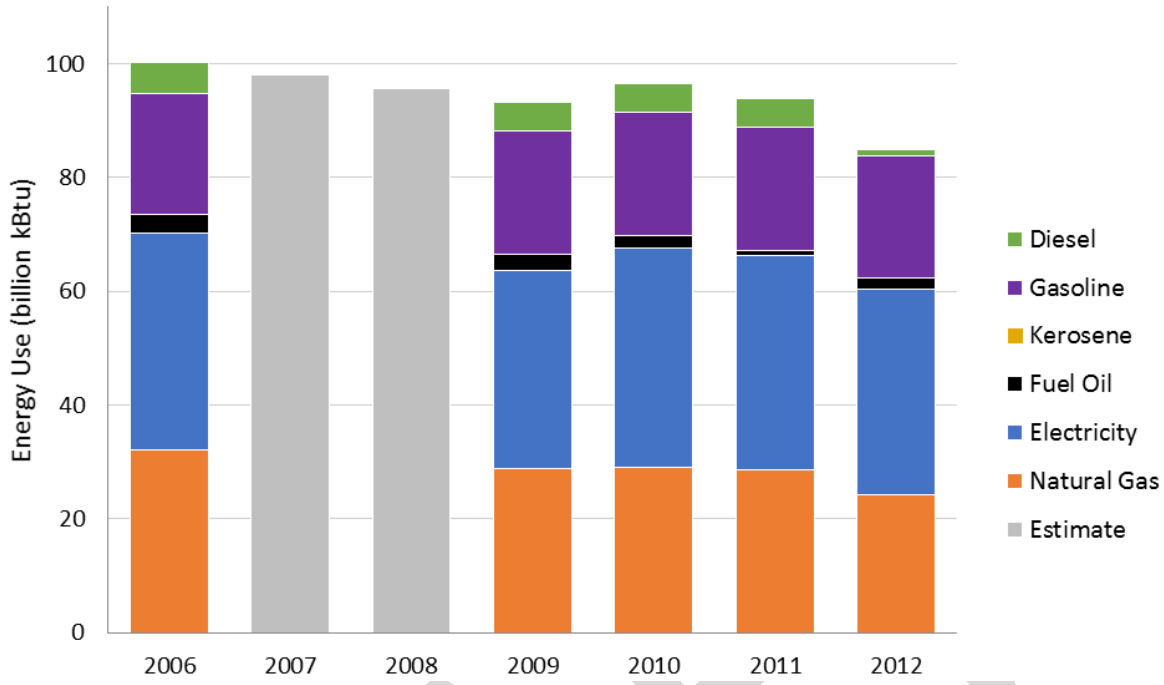


Figure 2. Site energy use by fuel type, 2006 to 2012.

2.1.2 GHG Emissions in 2012

An analysis of the District's GHG emissions illustrates that the relative contributions from the building, transportation, and waste sectors to the District's overall emissions profile is similar to that of other large, dense cities, such as New York and Boston. In 2012, buildings represented the most significant contributor to climate change, accounting for 76% of the District's total GHG emissions. The transportation sector emitted comparatively little, accounting for approximately 21% of the District's GHG emissions. This imbalance between the building and transportation sectors does not indicate the inefficiency of the District's buildings, but rather a transportation sector that generates much fewer carbon emissions than the national average, the result of a combination of high levels of mass transit use and highly walkable and cyclist-friendly neighborhoods. The remaining 3% of the District's emissions are derived from solid waste. Though solid waste is not considered in the CEP, the District should continue to target this sector for emissions reductions whenever possible.

In an analysis by fuel type, electricity use was the largest contributor to total District-wide GHG emissions in 2012 at 60% (Figure 3). Recall that reported GHG emissions are based on site energy use. When combined with natural gas at 15% of total GHG emissions, this indicates that a shift from fossil fuel-based electricity sources to the use of GHG emissions-free electricity will be a key dimension of decarbonization.

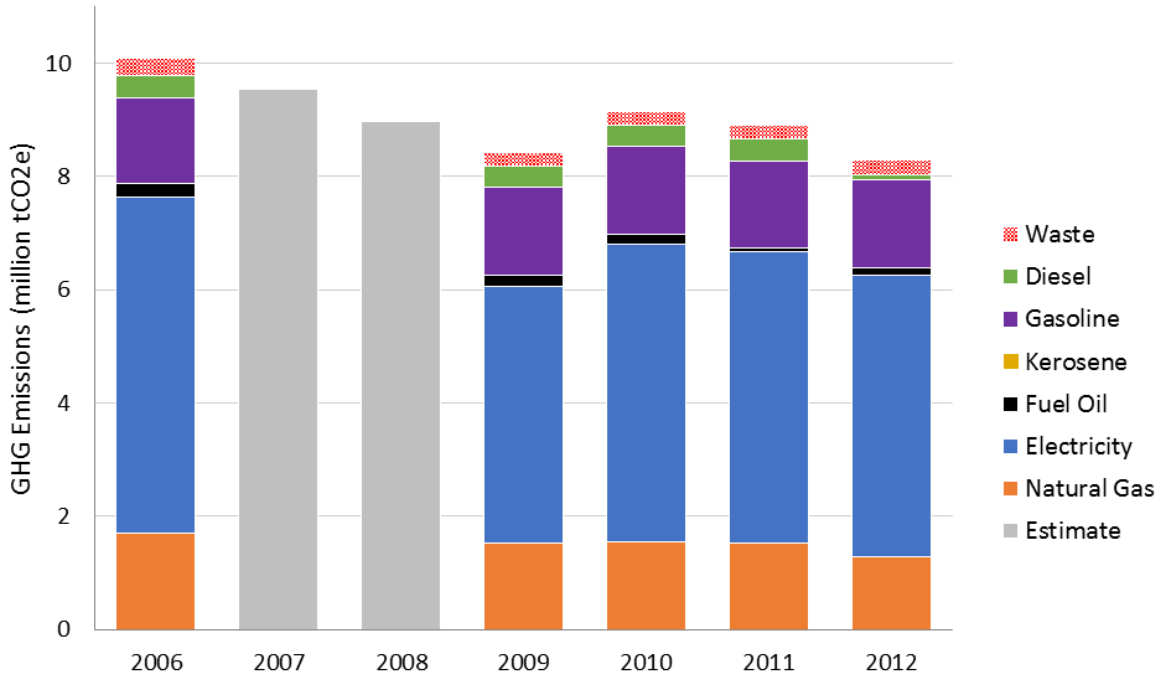


Figure 3. GHG emissions by fuel type based on site energy use, plus waste, 2006 to 2012.

At 19%, gasoline was the second largest contributor to GHG emissions in 2012. To reduce these levels, the District will need to facilitate a significant transition to zero-emission vehicles in the transportation sector, in addition to replacing vehicle demand with transit, walking, and cycling.

The District's total emissions dropped by 23% between 2006 and 2012. This decline can be attributed in part to the decreasing greenhouse gas intensity of the electric grid as coal power plants are retired and replaced with natural gas plants and renewable energy sources. This progressive cleaning of the grid is largely outside of the District's control; however, the District's Renewable Portfolio Standard (RPS), in combination with the RPS requirements of neighboring states, have also had some impact. The decline can also be attributed to an adjustment in the way diesel consumption is calculated, which resulted in a significant decline in the total estimated diesel consumption.[19] Meanwhile, GHG emissions from natural gas have stayed relatively constant, with annual variations driven by weather and associated temperatures (e.g., colder versus milder winters).

2.2 Modeled Impacts of Recommended Actions

By establishing a baseline of the District's energy use and emissions, it is possible to project the reductions in GHG emissions, decreases in energy use, and increases in renewable energy required to accomplish the District's targets. As noted in Chapter 1, the consultant team developed a citywide energy and emissions model to assess the impact of different actions on the overall process of decarbonization. In this section,

[19] Sourced from note in DOEE's GHG Summary Table file.

the results of this model are presented to demonstrate the effect of each group of actions in comparison to a business-as-usual emissions scenario. It should be noted that the model used here is not intended to predict the District's actual emissions to 2032, but was instead designed to inform the selection and prioritization of different options. The model was also designed to allow the District to continue to revisit the recommendations of the CEP as conditions change.

2.2.1 Model Data and Assumptions

All data used in the model was initially sourced from District-specific datasets; where District-specific data was unavailable, data was gathered from sources across the northeast or, where necessary, using national figures. The model itself is separated into three interrelated sectors: Buildings (including both New Construction and Existing Buildings), Transportation, and Energy Supply.

2.2.1.1 Buildings

In the building sector, energy and emissions projections are based on square footage; energy use intensities (energy use per square foot of floor area per year, or EUI); fuel mix (electricity, natural gas, fuel oil); projected development rates; and policy assumptions related to energy use reductions, new code and retrofit adoption rates, and year of implementation. Building sector projections are based on District-specific EUIs by sector, which are, in turn, based on data from the District's Energy Benchmarking and Disclosure Program and the Energy Information Administration's 2012 Commercial Building Energy Consumption Survey.[20] From these data points, two groups of actions are captured in the model:

New Construction Actions: The model assumes that the District Government will follow a phased approach to net zero energy code adoption. Residential buildings that are less than 10,000 square feet are assumed to meet a net-zero code in 2020. All other residential and commercial buildings are assumed to meet a net-zero code in 2026. This assumes that new codes will impact the energy performance of new buildings three years after code adoption to account for design, permitting, and construction time. The actions recommended in Sections 3.1 and 3.3 support the District's transition to these codes.

Existing Building Actions: The model also assumes that deep energy retrofits will achieve an average of 30% energy use reductions across 15% of the building stock between 2020 and 2032, with shallower retrofits of 15% energy use reductions across 3% of the building stock between 2017 and 2019. The actions recommended in Sections 3.2 and 3.3 support the District in achieving these retrofit rates and energy use reductions.

2.2.1.2 Energy Supply

Changes to the energy supply sector are based on assumptions about policy-driven changes that shift the electricity supply to renewable sources and increase energy thermal and electric energy supplied from neighborhood energy systems. Of these, two assumptions about GHG reductions from the District's electricity supply require further explanation:

[20] http://www.eia.gov/consumption/commercial/data/2012/

First, the CEP model simulates the GHG reduction impact of the District's Renewable Portfolio Standard (RPS), which requires that 50% of the electricity supplied to the District come from renewable sources by 2032, including 5% from local solar systems.[21] The RPS plays a vital role in achieving the District's 2032 GHG reduction target. However, the exact level of GHG reductions that can be achieved through the implementation of the RPS remains uncertain. The reason for this uncertainty stems from the RPS's compliance pathways and the requirements of ICLEI's *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions*, the industry-standard GHG accounting protocol used by the District.[22]

As discussed in further detail in Chapter 4, the District's RPS allows electricity suppliers to comply with the requirements using a combination of three approaches:

1. Directly sourcing renewable energy and supplying it to District consumers,
2. Purchasing renewable energy credits (RECs) if enough renewable energy cannot be sourced, or solar renewable energy credits (SRECs) for the local solar requirement.
3. Making alternative compliance payments (ACPs) to the District based on the portion of the RPS requirement the utility cannot satisfy with renewable energy or RECs and SRECs.

As noted above, ICLEI's *Protocol* does not allow for the use of RECs in accounting for GHG emission reductions, while ACPs represent financial contributions that do not directly lead to new renewable energy generation or GHG reductions, which is a requirement for ICLEI's GHG accounting. As a result, the amount of GHG reductions that the District can achieve by 2032 will significantly depend on how electricity suppliers comply with the RPS. Under a 50% RPS, the District will achieve GHG reductions between 43.8% (if suppliers meet the standard using *only* RECs and ACPs) and 55.9% (if suppliers meet the standard using *only* renewable energy). The District Government uses ACPs to fund renewable energy programs, so the ACPs could conceivably result in GHG emissions reductions above the 43.8% noted above.

Second, as noted in Section 2.1.2, a 23% reduction in GHG emissions was observed between 2006 and 2012, due in part to the decommissioning of coal-fired power plants. The U.S. Environmental Protection Agency's *Clean Power Plan* (CPP), if implemented, will likely result in a continuation of this 'cleaning' of the grid; however, it does not apply directly to the District as there are no fossil fuel power plants located within the District's borders.[23] While the District may benefit from the actions taken by other states under the CPP, its own RPS will drive GHG emissions reductions roughly equivalent to what would be achieved through the CPP. To avoid double counting these emissions reductions, the impacts of the CPP has not been included in the modeled projections. As such, four key actions relevant to energy supply are captured in the model:

Neighborhood-Scale Energy: The model assumes that five neighborhood-scale energy systems are installed between 2020 and 2028. [24] These systems are powered by wastewater thermal resources

[21] Renewable Portfolio Standard Expansion Amendment Act of 2016. 2015 Quarterly State of the Market Report for PJM: January through March, p.248, http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2015/2015q1-som-pjm-sec8.pdf

[22] ICLEI's U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, http://www.ghgprotocol.org/city-accounting

[23] FACT SHEET: Clean Power Plan Framework, https://www.epa.gov/cleanpowerplan/fact-sheet-clean-power-plan-framework

[24] Neighborhood-scale energy systems are also commonly referred to as district energy systems.

identified by DC Water and total 37 MW. Actions CRE.7 and CRE.8 are designed to support the development of these systems.

Power Purchase Agreement for Standard Offer Service: Second, the model assumes the District Government will sign a power purchase agreement (PPA) with one or more energy suppliers to provide renewable for 80% of the Standard Offer Service (SOS) beginning in 2018, with the remainder met by the spot market. The SOS is the electricity purchased for those District ratepayers who do not choose a competitive supplier for their electricity. The SOS currently provides approximately 24% of the District's electricity.[25] To be conservative, this is assumed to decrease by 10% to 21.6% due to SOS customers switching to alternative electricity providers with the adoption of the renewable energy PPA (Action CRE.2).

Renewable Portfolio Standard: The RPS accounts for the maximum impact of the District's 2032 requirement of 45% renewable electricity supplied from outside the District. The actual impact of the RPS will depend on how electricity suppliers decide to comply.

Renewable Portfolio Standard Local Solar Requirement: The RPS local solar requirement accounts for the maximum impact of the RPS requirement that 5% of electricity supplied in the District must come from local solar systems. As with the RPS above, the actual impact depends on how electricity suppliers comply with the solar requirement.

2.2.1.3 Transportation

Finally, energy and emissions in the transportation sector are determined using estimates of vehicle miles traveled; vehicle fuel efficiencies; fuel GHG intensities; a breakdown of use by mode of transportation; and rates of electric vehicle uptake. Three primary sets of actions relevant to the transportation sector were included into the model:

Corporate Average Fuel Economy (CAFE) Standard: The CAFE standard is a federal fuel efficiency and GHG emissions standard that is applied to light duty (i.e., passenger) vehicles. While this regulation is outside of the control of the District, it has a significant impact on GHG emissions from transportation.

Mode Share Change: The model assumes the District will achieve its 2032 mode share target of 50% transit, 25% walking and biking, and 25% driving, as set out in the *Sustainable DC Plan*. The actions required to achieve these reductions are not covered by the CEP, as mode share is the focus of the *moveDC Plan*.

Electric Vehicle Adoption: The model assumes that 30% of new vehicles sold in 2032 will be electric vehicles, up from less than 1% in 2015.

2.2.2 Achieving the District's 2032 Targets

The model demonstrates that when implemented together, the CEP actions recommended in Chapters 3 to 5. can achieve the District's 2032 GHG reduction target. These actions will not, however, achieve the District's 2032 energy use reduction nor renewable energy utilization targets. During the energy and

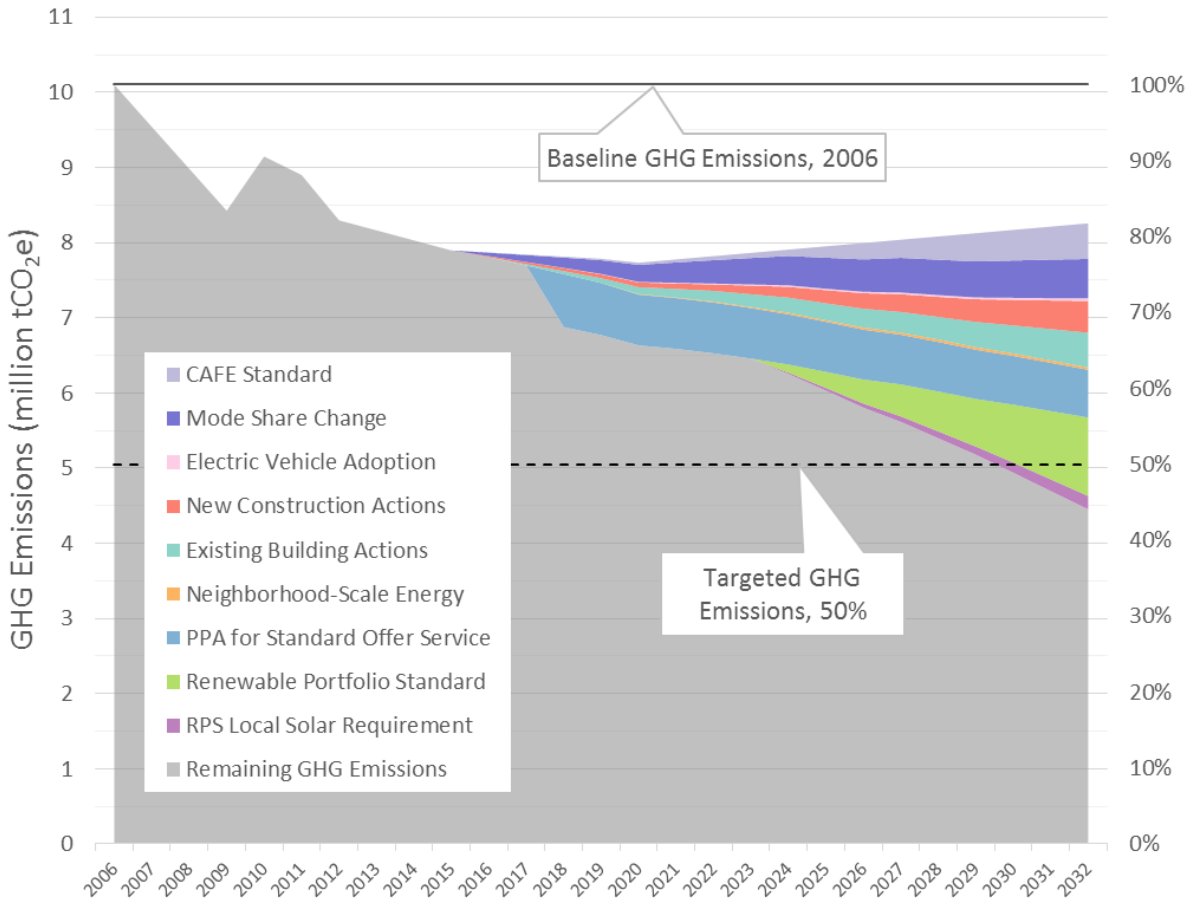
[25] Correspondence with DOEE staff on Aug 1, 2016.

emissions modeling process, the consultant team discovered the relative difficulty of achieving the District's energy use reduction and renewable energy utilization targets, and particularly of achieving all three targets simultaneously. A key reason for this is that GHG emissions reductions can be achieved both through improving energy performance and decarbonizing energy sources. Conversely, energy use is generally unaffected by actions focused on decarbonizing energy sources.[26] The consultant team presented this finding to representatives of DOEE during a collaborative engagement session, along with the assumptions underlying the model, and the group collectively decided to prioritize the GHG reduction target over the other targets in the CEP. As noted in the Introduction, prioritizing GHG emissions reductions allows the District to focus its limited resources on the target that has the most direct impact on climate change, and thus offers the greatest opportunity to avoid significant climate impacts.

2.2.2.1 Achievable GHG Emissions Reductions

The model demonstrates that when implemented together, the actions recommended in the CEP will achieve up to a 55.9% reduction in GHG emissions relative to 2006. As discussed in section 2.2.1.2 above, projected GHG reductions depend significantly on how electricity suppliers comply with the RPS. GHG emissions reductions may be as low as 43.8% below 2006 levels if suppliers comply with the RPS using only RECs, SRECs, and ACPs. Figure 4 presents projected GHG reductions achieved by actions in different sectors (assuming the maximum possible reductions from the RPS), while Table 1 summarizes the total GHG emissions avoided in 2032 in metric tons of carbon dioxide equivalent (tCO_2e) and the percent of total emissions avoided compared to the business-as-usual scenario. Though the District's targets are measured against a 2006 baseline, the implementation of the CEP's actions is assumed to begin at the end of 2016.

[26] Energy use reductions can in some cases be achieved through decarbonizing energy sources. For example, if using source instead of site energy, energy consumptions may be reduced by decarbonization actions that shift electricity generation from centralized fossil fuel generators far outside the District to renewable energy sources closer to the District.



**Based on site energy use. Historical data is the same as that presented in section 2.1. Acronyms: CAFE Standard = Corporate Average Fuel Economy Standard; PPA = power purchase agreement; RPS = Renewable Portfolio Standard.*

Table 1. Summary of GHG reduction action wedges.

GHG Reduction Wedge	GHGs Reduced from 2032 BAU (tCO_2e)	Percent GHGs Reduced from Total 2032 BAU*
CAFE Standard	473,000	5.7%
Mode Share Change	524,000	6.3%
Electric Vehicle Adoption	34,000	0.4%
New Construction Actions	423,000	5.1%
Existing Building Actions	462,000	5.6%
Neighborhood-Scale Energy	30,000	0.4%
PPA for Standard Offer Service	636,000	7.7%
Renewable Portfolio Standard	1,044,000**	12.6%**
RPS Local Solar Requirement	178,000**	2.2%%**

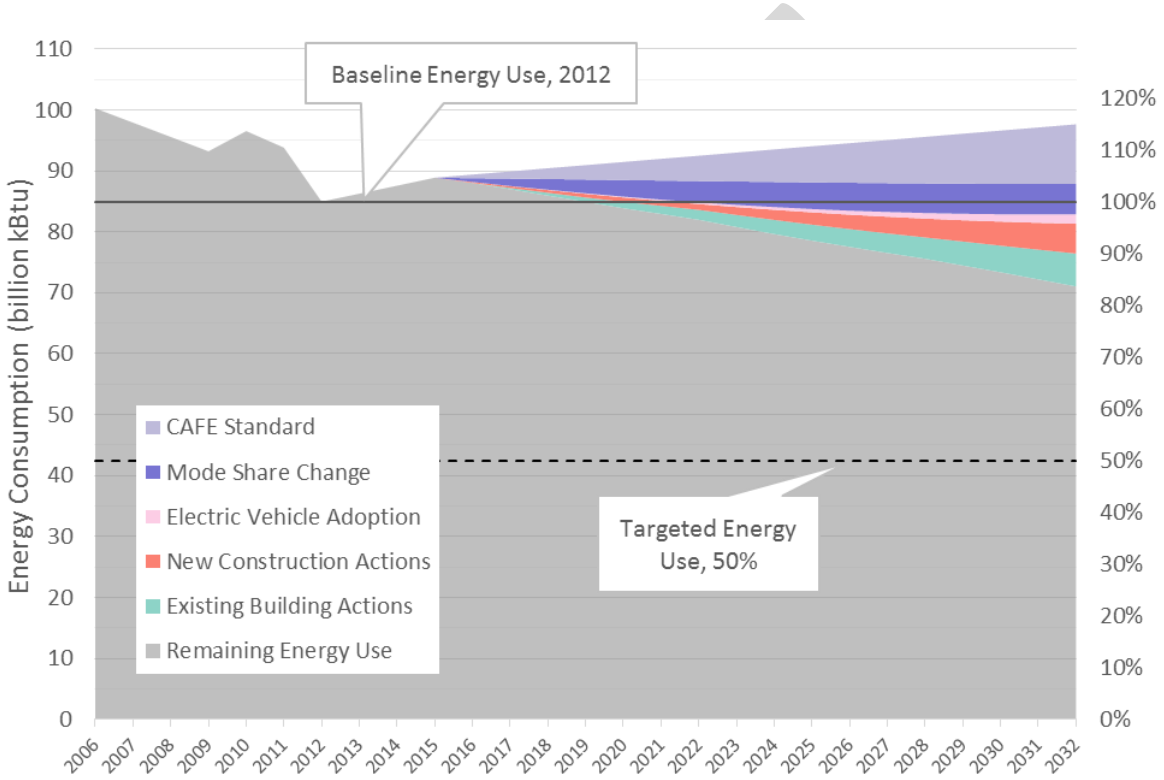
All figures based on site energy use.

**This column measures the percentage reduction in total GHG emissions that a single action area drives relative to the total GHG emissions in 2032 under the BAU scenario. For example, New Construction Actions result in GHG emissions reductions that decrease total District-wide 2032 GHG emissions by 5.1%.*

***The GHG reductions assume electricity suppliers only use new renewable energy to comply with the RPS.*

2.2.2.2 Achievable Energy Use Reductions

In addition to a decrease in GHG emissions, the results of the model simulation indicate an anticipated decline in energy use of 16.4% relative to the District's 2012 baseline. Figure 5 presents these projected energy use reductions according to different groups of actions, while Table 2 summarizes the total energy use that will be avoided in 2032 in British thermal units (Btu) and a measure of the energy use avoided compared to the business-as-usual scenario in 2032. Note that the renewable energy wedges from Figure 4 and Table 1 do not appear in Table 2, as they do not reduce energy use but only shift the source of that energy.



** Historical data is the same as that presented in section 2.1. CAFE Standard = Corporate Average Fuel Economy Standard*

Figure 5. Projected Site Energy Use Reductions from Recommended Actions

Table 2. Summary of site energy use reduction action wedges.

Energy Use Reduction Wedge	Site Energy Use Reduced from 2032 BAU (million kBtu)	Percent Site Energy Use Reduced from Total 2032 BAU*
CAFE Standard	9,792	10.0%
Mode Share Change	4,935	5.1%
Electric Vehicle Adoption	1,573	1.6%
New Construction Actions	4,899	5.0%
Existing Building Actions	5,394	5.5%

**This column measures the percentage reduction in total GHG emissions that a single action area drives relative to the total GHG emissions in 2032 under the BAU scenario.*

2.2.2.3 Achievable Increases in Renewable Energy

The model also estimates the proportion of renewable energy that will make up the District's total energy supply in 2032. Unlike the District's GHG reduction and energy use reduction targets, the renewable energy target will shift according to the total quantity of energy used in the District. This means that the total amount of renewable energy required to achieve the target will decrease as the District achieves deeper energy use reductions. Figure 6 presents the proportion of renewable energy that will contribute to the District's total energy use, while the renewable energy generation required to achieve these targets is summarized in Table 3.

As with GHG reductions, the percentage of energy supplied by renewable sources depends significantly on how regulated electricity suppliers comply with the RPS. The current RPS requires that 50% of electricity come from renewable sources by 2032, including 5% from local solar systems. If electricity suppliers comply with this requirement only by supplying renewable electricity to the District, 32% of the District's total energy use in 2032 will come from renewable sources. If electricity suppliers use *only* RECs and ACPs to comply with the RPS, only 12% of the District's total energy use in 2032 will come from renewable sources. Both of these situations are unlikely, and the actual achieved renewable energy utilization will fall somewhere between 12% and 32%. Where it falls will depend significantly on steps the District takes to drive electricity suppliers to comply by supplying renewable electricity.

Table 3. Summary of renewable energy utilization and estimated supply requirements.

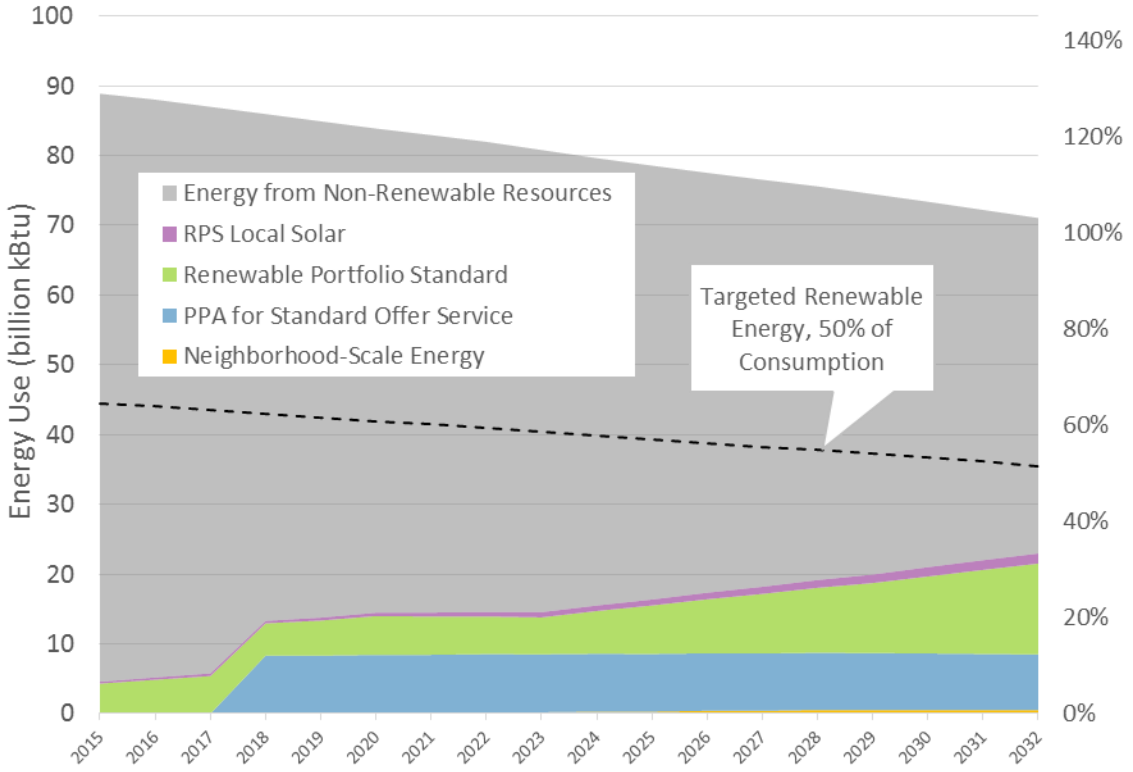
Renewable Energy Utilization Wedge	Renewable energy utilized in 2032		Estimated generation capacity required in 2032 (MW) *
	million kBtu	percent of total energy use	
Neighborhood-Scale Energy	524	0.7%	37
PPA for Standard Offer Service	7,971	11.2%	580 - 1,490
Renewable Portfolio Standard	13,020	18.3%	947 - 2,434
RPS Local Solar Requirement	1,447	2.0%	372

Based on site energy use.

**Required generation capacities are based on assumptions about capacity factors: 47.4% for neighborhood energy wastewater thermal,[27] a low of 17.9% (utility-scale solar photovoltaic) to a high of 46.0% (offshore wind) for RPS outside the District, and 13.0% for solar rooftop photovoltaic within the District.[28]*

[27] DC ENERGIZED, DC Water's Energy Opportunities, DRAFT 2-11-2016, unreleased as of March 21, 2016.

[28] GDS Associates for the District Department of the Environment, Renewable Energy Technologies Potential for the District of Columbia, 2013



** RPS = Renewable Portfolio Standard*

Figure 6. Projected Utilization of Renewable Energy as a Result of Recommended Actions

3 BUILDINGS

In this chapter, recommendations are provided in three interrelated sections: New Construction (Section 3.1), Existing Buildings (Section 3.2), and Cross-Cutting Building Actions (Section 3.3) that apply to both new and existing buildings. At the end of the chapter, each set of recommendations is summarized by an individual roadmap that can be used by the District to guide their implementation over the five-year span of the CEP, as well as future actions through 2032.

3.1 New Construction

3.1.1 Policy and Targets Overview

The District's new construction sector is an area in which rapid reductions in carbon emissions are both necessary and feasible. Today, new designs and technologies are able to provide superior occupant services while using substantially less energy than a building built to typical North American building codes.[29] The construction of these high-performance buildings will be critical to ensuring high performance of buildings for the duration of their useful life, which can extend several decades.

This section presents a number of recommendations for the active promotion, construction and support of high-performance buildings across the District. While the number of high-performance buildings in the District of Columbia is currently small, awareness of their benefits is spreading. Developers are increasingly drawn to energy efficiency, renewable energy, improved thermal comfort, better daylighting, higher worker productivity, and more resilient performance during power outages. [30,31] - By upgrading building codes, providing financial support, and offering educational and training opportunities for the design and construction industries, the District Government can move toward the achievement of a low-carbon built environment.

3.1.1.1 High Performance Buildings Characteristics

Across the U.S., the number of high-performance buildings is growing. Thirty-nine buildings across the U.S. have achieved the International Living Future Institute's (ILFI) Net-Zero Energy Building certification, including a six-story Class A office building and a production townhome community. Another 350 buildings have registered to achieve the same level of performance and are now in various stages of development.[32] The New Buildings Institute's (NBI) *Getting to Zero* database includes approximately 140 net-zero or net-zero ready commercial and multifamily buildings, while the Net-Zero Energy Coalition has documented several thousand potential, and 21 verified, net-zero energy homes.[33,34]

[29] Throughout this document, "codes" refers to "energy, building, and construction codes."

[30] Judith Heervagen, Impact of Workplace Daylight Exposure on Sleep, Physical Activity, and Quality of Life,

[31] Alex Wilson, *Resilient Design: Smarter Building for a Turbulent Future*, Environmental Building News, March 2012.

[32] ILFI website, data obtained May 25, 2016.

[33] http://newbuildings.org/resource/getting-to-zero-database/

[34] http://netzeroenergycoalition.com/zero-energy-case-studies/

These high-performance buildings share a remarkably consistent set of design and technological characteristics,[35] including:

- High-quality building envelopes with average insulation values twice those required by North American building codes, as well as detailed performance-tested air barriers.
- High-performance windows that reduce cooling demand in the summer and minimize heat loss in the winter.
- Partially passive heating and ventilation systems that reduce the need to use energy-intensive active systems.
- Heat pump-based heating and cooling systems that offer energy-efficient alternatives to conventional heating and cooling systems.
- Hydronic distribution systems for heating and cooling.
- Heat recovery systems that minimize heat loss through ventilation systems.
- Daylighting strategies that reduce the need for electric lighting.
- Energy efficient LED lighting.
- Variable speed drives and pumps that vary ventilation and heating/cooling distribution speeds to provide optimal levels of heating, cooling and ventilation.
- Active monitoring and engagement with user loads.
- Easily accessible, transparent energy use data.
- Active attention to actual building energy usage on the part of building managers.

While these technologies and designs are generally not the norm in new construction, they are well tested and understood. What is most innovative about high performance buildings is that they consolidate in an integrated fashion the full array of technologies and strategies under one roof.

3.1.1.2 Market Development and Adoption

While the number of these high performance buildings is growing, several barriers to their widespread adoption still exist, both within the District and elsewhere in the U.S. It is often assumed that cost is the primary driver towards market acceptance of technology change within the built environment. However, the reality is that many factors influence the adoption of new, innovative models of building design and construction. Some of these factors include the following.

Market uptake of new, but proven, technology**:** Many high performance building technologies have moved beyond the prototype stage and have been certified by the relevant federal Occupational Safety and Health Administration's Nationally Recognized Testing Laboratory. Technologies and systems such as those listed above are widely available in the U.S. marketplace. However, they have not yet become a standard part of the building and construction industry in many cities.

Technical know-how by building specialists**:** Another reason for low uptake rates is the lack of familiarity with newer building technologies among engineers and architects. As in other major cities working to improve building energy performance, there are a handful of firms in the District with direct experience

[35] Liljequist, B., 2016, The Power of Zero, Learning from the World's Leading Net Zero energy Buildings.

in these advanced buildings, which enables their construction locally. However, many firms have little experience in working with high performance building technologies.

Knowledge and understanding**:** As in the case of building specialists, there is a dearth of knowledge about high performance buildings among building industry members, such as property managers, building owners, and developers. As such, while developers may be interested in pursuing high performance projects, a lack of understanding of, or comfort with, the options available may prevent them from acting on their interest.

Delays in the spread of innovation: The delay between the introduction of an innovative technology and its widespread adoption by the mass market typically lasts several years. This is a well-known pattern of innovation diffusion in which a small number of early adopters accept an innovation long before it becomes popular. However, through the establishment of communication channels, an innovation can more quickly become a mainstream product. When their benefits are marketed effectively, a higher level of demand for high performance buildings can be created. This demand can in turn create a competitive environment, accelerating innovations further and reducing costs.

Demonstration buildings**:** The ability to see and experience a local, successful example of a high performance building greatly accelerates the spread of building innovations and shifts the market toward acceptance. Of the hundreds of examples of high performance buildings that can be found across the country, a few are located in the District. For example, Dunbar High School boasts a solar array, the District's largest ground-source heat pump, and the highest score achieved in the U.S. Green Building Council's LEED for Schools-NC certification program to date.[36] The construction of other similar buildings will help increase the visibility and uptake of high performance buildings.

Collaboration: The history of innovation is filled with communities of people evolving innovation together. The District currently has an assortment of high performance building leaders, but bringing them together in a more cohesive way would greatly accelerate the uptake of high-performance building technologies.

Cost: At the end of the day, costs matter. The cost increase between typical and cutting-edge high performance buildings runs from 3% to 10%.[37] A study conducted within the District has indicated that the cost premium for highly energy efficient buildings is approximately 1% to 12%, depending on building type, with a return on investment ranging from 5% to 12%.[38] Achieving net-zero energy performance increases the estimated cost premium to 5% to 19%, with a return on investment of up to nearly 38%, depending on the use of available tax and renewable energy credits. However, this cost differential is largely the result of a pricing system based on customized, non-standard fabrication and design. If the elements of high performance buildings were more commonly used, the cost differential would become negligible.

[36] U.S. Green Building Council, 2015, http://www.usgbc.org/articles/reaching-new-heights-dunbar-highest-scoring-leed-schools-nc-project-date

[37] Matthiesen, L., The Power of Zero: Cost Study, 2014, Integral Group

[38] Net Zero and Living Building Challenge Financial Study: A Cost Comparison Report for Buildings in the District of Columbia, 2013, http://doee.dc.gov/sites/default/files/dc/sites/ddoe/service_content/attachments/20140411_Net%20%20Zero%20and%20Living%20Building%20Challenge%20Study_FINAL.pdf

3.1.1.3 District Action

The recommendations presented below seek to address the limitations noted above. The District has already made several moves to improve the energy performance of its buildings through various changes to its laws and building codes. The history of green building policy in the District began with the *DC Green Building Act* of 2006, which requires all new and major renovations of commercial private buildings 50,000 square feet and larger, and all public or publically financed commercial projects and multifamily buildings 10,000 square feet and larger to be LEED certified. In 2014, the District adopted one of the country's greenest building codes by approving the 2013 *DC Green Construction Code*, based on the 2012 edition of the *International Green Construction Code*, and the 2013 *DC Energy Conservation Code*, based on the 2012 edition of the *International Energy Conservation Code*. The *DC Green Construction Code* requirements apply to all commercial construction projects 10,000 square feet and larger, and all residential projects 10,000 square feet and larger and four stories or higher. However, there remains much to be done to improve the energy efficiency of new buildings and transition the District's buildings to high-performance, low-carbon standards.

3.1.2 Recommended Actions

3.1.2.1 Update Building and Energy Codes

NC.1 Establish a path to the phased adoption of net-zero codes between 2020 and 2026

Action: Use the 2016-17 and 2020 code updates to establish a pathway toward net-zero energy performance in all residential and commercial buildings over the next ten years, starting with the new construction single family and small multifamily buildings in 2020.

Relevance: Building codes represent the single-most powerful tool cities can use to require higher levels of building performance from the design and construction industry. In general, codes tend to increase in stringency using small percentage improvements that occur at regular intervals. For example, ASHRAE's 90.1 building standard has been adopted by several cities and states across the U.S. as a basis for their building codes, and is updated every three years. ASHRAE also recently created the ASHRAE Standard 189.1-2014, which supplements 90.1 with a higher performance green building standard. Provisions in this code offer an excellent resource for the implementation of more aggressive improvements.

To achieve the District's emission reduction targets, more immediate and substantial progress in the evolution of the building code will be required. This includes the need to push building code requirements toward net-zero energy performance to ensure its energy and GHG emissions targets are met and to maintain its position on the leading edge of green building code development. The update of the latest code cycle is expected to occur in 2017, while another code amendment is scheduled for 2020. These amendments offer key near-term opportunities for the District to move building requirements toward net-zero levels of performance.

Details: While it may be premature for the District to implement net-zero energy levels of performance for all building types with the 2016-17 code cycle, the District should begin to undertake a coordinated and multifaceted effort to build a foundation for and pathway toward a complete set of net-zero building codes by 2026.

Recommendations for the 2016-17 Update: For the current code update, the District should implement an increase in energy code requirements typical of a three-year cycle. However, these should be joined by tactical requirements that take advantage of current incentives and support more significant changes as early as 2020. Specific areas the District should explore include:

- The adoption of a requirement for continuous exterior insulation. This requirement should be coupled with advanced fresh-air ventilation requirements to ensure good indoor air quality.
- The adoption of a requirement for windows with U values equivalent to the top 25% in class, based on an exploration of the selection of windows currently available in the DC marketplace.
- The adoption of an alternate compliance path for high-performance buildings, such as net zero, Passive House, and Living Building Challenge. Such a code should also be used as a basis for awarding financial and permitting incentives.
- Submetering of major systems, including plug loads (pending feasibility and value analysis).
- Submetering of tenant spaces.

Specific requirements for commercial and residential buildings should also be explored. For *commercial buildings*, the District Government should:

- Adopt ASHRAE Standard 90.1-2013 and chapter seven of ASHRAE 189.1-2014.
- Adopt the energy efficiency requirements of the alternative renewables pathway in ASHRAE Standard 189.1-2014 Sections 7.4.1.1.2 and 7.4.3.1.
- Require the use of photovoltaic panels throughout all flat roof areas, except those needed for skylights, vents, HVAC equipment, and other sustainable improvements such as green roofs.
- Adopt a commercial air leakage performance sealing requirement, similar to the requirement for residential buildings in the 2013 code update.

For *residential buildings*, the District Government should:

- Adopt a requirement for the use of mini-split ductless heat pumps as the primary heating source in residential buildings using electric resistance heating above 2 kW of installed capacity, as has been required by the State of Washington.
- Create a Green Construction Code for single-family and small multifamily buildings (less than four stories or 10,000 square feet) that include measures similar to those included in the other existing District green codes.
- Offer alternative compliance paths for third-party standard pathways, such as LEED for Homes, Enterprise Green Communities, Passive House, and Living Building Challenge.[39] and,
- Continue to mandate air performance sealing, and add any supplemental requirements determined appropriate based on experience implementing the 2012 code.

[39] Based on recommendations from DOEE's Single Family and Small Multifamily Working Group.

Recommendations for the 2020 Update: For the 2020 code cycle, the District Government should push a much stronger update that drives all buildings toward net-zero energy performance by 2026.

For *single-family and small multifamily residential buildings* (<10,000 square feet), the District Government should adopt a net-zero energy code for new construction in 2020, and require all substantial renovations to be net-zero by 2026.[40]

For *commercial and large multifamily buildings*, the 2020 code update should mandate a series of prescriptive measures that begin to shift the sector toward net-zero energy performance and net-zero energy codes for all buildings. While this can be adopted as late as 2026, the District Government should investigate the feasibility of moving to a net-zero code even sooner. The 2020 code update should include (but not be limited to) the following prescriptive measures.

- Minimum Insulation: R-40 walls, R-60 roof
- Minimum Windows: U=0.22
- Minimum air leakage rate: 1.0 ACH @ 50 Pascals
- Ventilation: rate and locations per ASHRAE using heat recovery and dedicated outdoor air systems, solar electric preheat
- Heating and cooling: reverse cycle chillers, high-performance air source heat pumps, with VRF or hydronic distribution, with carbon dioxide (CO_2) mandated as compression gas
- Lighting density: 0.3 W/ft^2
- A minimum daylighting of all occupied spaces
- Occupant and operator energy monitoring system and reduction strategy
- Minimum appliance standard: best in class ENERGY STAR®
- Hot water: heat pump-based system and solar hot water

In addition to these performance requirements, the District should also include minimum requirements for post-occupancy performance, including minimum energy use intensity (EUI) performance requirements. This will allow the District Government to regulate the occupancy phase and ensure all loads are addressed while enabling the separation of responsibility between developer and occupant/operator. The District may wish to use the ILFI's Living Building Challenge (LBC) or Net-Zero Energy Building (NZEB) certification, which requires a third-party auditor to certify net-zero energy performance.

Finally, depending on the stringency of the 2020 code requirements, the District should adjust its code update cycle to ensure that no further code updates will be made for five years following the adoption of net-zero code requirements. This will increase the palatability of the change, as it will reduce the constant disruption of shorter code cycles.

[40] Based on recommendations from DOEE's Single Family and Small Multifamily Working Group.

Next Steps:

- Implement increased energy performance recommendations during the 2016-17 code update.
- In 2017, analyze the feasibility of moving toward net-zero single-family and small multifamily residential codes during the 2020 update.
- In 2017 and 2018, conduct stakeholder engagement and analysis focused on determining a pathway to net-zero codes across all buildings by 2026, with an objective to adopt net-zero codes earlier.

3.1.2.2 Provide Incentives

NC.2 Provide a net-zero energy incentive package

Action: Offer a major incentive package that drives a steady market shift toward the construction of net-zero energy buildings.[41]

Relevance: Increasing the proportion of high efficiency, net-zero energy buildings is critical to achieving deep GHG and energy use reductions in the buildings sector. To shift the market in this way, the District Government must provide an attractive package of incentives that drive different choices and behaviors. - Designed and implemented effectively, these incentives can drive a steady shift over the next few years toward the types of buildings the District Government will need to require in the near future. By promoting high-performance buildings thru incentives in the short term, the District will provide an aspirational symbol for developers, building owners, designers, and contractors both in and outside of the city.

Details: To shift the building market, substantial incentives are needed to capture the attention of mainstream developers, especially during periods of fast-paced construction. An effective incentive package should consist of three coordinated components.[42]

Property Tax Abatements**:** First and most importantly, the District Government should create a pilot program to provide property tax abatements for buildings that meet net-zero energy standards. These tax abatements should be based on the actual building energy performance rather than the performance it was initially designed to achieve. Tax abatements should cover up to 75% of any cost premium associated with a building operating at the prescribed net-zero energy performance, not including the cost of renewables (which are already heavily incentivized). To create an initial cadre of net-zero energy - buildings, the District Government should initially limit the program to 20 projects. After this initial phase, the District Government should evaluate the effectiveness of the program and adjust the level of incentives provided accordingly.

Accelerated Permitting**:** Second, the District Government should provide an accelerated permitting pathway for net-zero energy projects. This pathway should simplify the permitting process and reduce

[41] This recommendation is based on *Greening the District of Columbia: Incentives and Policies to Achieve Deep Green Building Construction and Renovations*, a report prepared for the District of Columbia Department of Energy and Environment by Capital E in 2016. The report provides additional details and information on both new construction and existing building incentives that can support the building performance and retrofit success required to achieve the District's 2032 GHG goal.

[42] Additional details on each aspect of this recommendation can be found in the report *Greening the District of Columbia: Incentives and Policies to Achieve Deep Green Building Construction and Renovations* in Appendix .

DOEE and DCRA permitting time. This program will require support from upper-level leadership, as well as a set of dedicated staff for its operation. Wherever possible, a front of queue system should be used to ensure expedited process.

FAR increases**:** Third, the District Government should grant floor area ratio (FAR) increases for buildings that target net-zero energy standards.[43] The applicability of this incentive will depend in part on a building lot's zoning, in that buildings in DC's downtown core are subject to federal restrictions on building height.

While the incentives above may apply more specifically to commercial and large multifamily buildings, the District Government can offer similar incentives to single-family and small multifamily buildings (less than 10,000 square feet). These should include expedited permitting and waived fees for buildings that meet designated performance requirements, such as International Living Future Institute's Net-Zero Energy Building Certification or Passive House Certification with solar.[44]

Next Steps:

- Use the remainder of 2016 and early 2017 to design the specific incentives identified above, and then implement the property tax abatement, accelerated permitting pathways, and floor area ratio bonuses in 2017 in conjunction with the updated construction codes.

3.1.2.3 Leadership and Catalyzing Change

NC.3 Issue a net-zero energy innovation request to the Federal Government

Action: Lobby the Federal Government to adopt the same level of building energy performance as the District Government.

Relevance: The District Government has no jurisdiction over Federal Government buildings, making it impossible to require them to achieve any specific level of performance. However, the District has a unique opportunity to influence the Federal Government as a result of both their co-location and the special relationship between the two jurisdictions. While District Government legislation is subject to Congressional approval, the relationship can be two-way, allowing ideas and inspiration to move from the District to the Federal Government and vice-versa.

Furthermore, Executive Orders issued by President Obama have put the Federal Government on track to require net-zero levels of performance in all newly constructed buildings during the next decade (where feasible).[45,46] The U.S. Department of Energy has also taken a leadership role in energy innovation in supporting the development of high-performance buildings. As such, there is an opportunity for the District to encourage the Federal Government to construct new buildings that meet a net-zero energy level of performance. Especially where they are particularly prominent, these high-performance buildings will help to accelerate similar development within the District while providing examples for the rest of the country.

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[43] Floor area ratio (FAR) is total floor area divided by total lot area.

[44] Based on recommendations from DOEE's Single Family and Small Multifamily Working Group.

[45] Executive Order 13693 -- Planning for Federal Sustainability in the Next Decade, 2015, https://www.whitehouse.gov/the-press-office/2015/03/19/executive-order-planning-federal-sustainability-next-decade

[46] Executive Order 13514 -- Focused on Federal Leadership in Environmental, Energy, and Economic Performance, 2009, https://www.whitehouse.gov/the-press-office/president-obama-signs-executive-order-focused-federal-leadership-environmental-ener

Details: To encourage the Federal Government to achieve the same level of energy performance required by the District Government, a request should be issued by resolution of the DC Council. Testimony to Congressional committees will help educate and raise awareness among the industry and broader public, and can help to push the discourse forward. A focus should also be placed on the contribution of such an initiative to the creation of a healthy, innovative economy, as well as an increase in green collar, well-paying, middle-class jobs.

Next Steps:

- In 2016, adopt a resolution to challenge the Federal Government to adopt the same standards for government buildings as those adopted by the District Government.

3.1.3 New Construction Roadmap

		The Five-Year CEP					Projected Path to 2032 Climate and Energy Targets										
New Construction	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Update Building and Energy Codes																	
NC.1 Establish a path to the phased adoption of net-zero codes between 2020 and 2026																	
Provide Incentives																	
NC.2 Provide a net-zero energy incentive package																	
Leadership and Catalyzing Change																	
NC.3 Issue a net-zero energy innovation request to the Federal Government																	

Legend	
Planning, Research, and Program and Policy Development	
Plan or Program Implementation	
Policy or Regulation Implementation	
Pilot Project	
Program Evaluation	

3.2 Existing Buildings

3.2.1 Policy and Targets Overview

Existing buildings consume more energy in the United States than any other sector, accounting for approximately 40 quadrillion BTUs of energy, or over 41% of all the energy used in the country.[47] The dense urban makeup of the District of Columbia means that buildings account for an even higher portion of energy use and emissions. In 2014, District buildings consumed approximately 15 million MMBtu of on-site energy, 70% of which was electricity use.[48] Approximately 74% of GHG emissions in the District result from the operation of these buildings, the majority of which are non-residential.[49] The District will meet the energy and emissions climate targets only by pursuing actions and programs that target existing buildings, especially commercial buildings.[50]

The District already leads by example in this area by tracking and publishing fifteen-minute interval data for all Department of General Services (DGS) buildings via the BuildSmartDC program.[51] This leadership shows accountability for District Government performance and underscores both the importance and value of managing building performance in real-time.[52] However, more can be done to improve the energy and emissions performance of existing buildings in the District. This section provides recommendations to help the reduce energy consumption and improve energy efficiency in the built environment. Recommendations both build off existing District activities and propose new and novel initiatives.

3.2.2 Building Energy Benchmarking in the District of Columbia

The District made a significant effort to reduce energy use and emissions from the existing building sector in 2008 with its approval of the Clean and Affordable Energy Act (CAEA). The CAEA requires large privately-owned commercial and multifamily buildings and all publicly-owned buildings to report their energy consumption in a process called energy benchmarking. Building performance information is then entered into the Environmental Protection Agency's (EPA) ENERGY STAR® program as a way of comparing building energy use across multiple building types and multiple states. For key building types, a score from 1-100 can be issued to demonstrate a given building's performance relative to others in its class (e.g., office, retail, hospital, etc.). Because the score adjusts for the actual use of a building, a building with very intensive uses and thus high energy intensity (e.g., data centers or buildings with 24-hour operations) can

[47] This is based on source energy use numbers from the U.S. Department of Energy, Energy Information Administration, http://www.eia.gov/tools/faqs/faq.cfm?id=86&t=1.

[48] The final benchmarking dataset incorporate herein refers to the NYU CUSP dataset of 2014 "cleansed" data.

[49] Green Building Report for the District of Columbia, 2012, http://doee.DCgov/sites/default/files/dc/sites/ddoe/publication/attachments/20140113_Green%20Building%20Report%202012_FINAL.pdf, p.9.

[50] Sustainable DC Plan, 2012

[51] BuildSmartDC, http://www.buildsmartDCcom/

[52] With respect to District buildings, DGS should report annual energy consumption, energy savings, carbon emissions and progress against goals publicly in a standard format year-over-year for increased visibility and accountability.

still receive a relatively high score. Buildings that achieve a minimum score of 75 are recognized for their high performance via the ENERGY STAR® certification program.

Beyond simply reporting their benchmarking data, the Act also requires buildings' benchmarking results to be publicly disclosed. In 2010, public buildings over 10,000 square feet were required to benchmark and report their data, followed by private buildings over 100,000 square feet in 2013, and buildings over 50,000 square feet by 2014.[53]

Not all buildings are required to benchmark their performance, as certain categories of buildings are exempt from the ordinance. These include buildings that share a tax lot but do not share energy consumption (separately metered), and special cases where an exemption has been requested by the owner. Single-family residential spaces are also exempt; however, DOEE facilitated a Single Family and Small Multifamily Working Group to explore alternative ways of engaging this sector. Finally, federal government buildings, foreign embassies and international inter-governmental organizations (IGO) are not covered. That said, federal facilities are required to benchmark and disclose energy performance under the Federal Energy Independence and Security Act of 2007 (EISA 2007). Executive Order 13693 additionally requires federal buildings to "[conform], where feasible, to city energy performance benchmarking and reporting requirements." It is also worth noting that over 70 embassies in the District have signed a sustainability pledge with the District to share energy performance data with DOEE. However, very few have done so to date.[54,55] As such, an update to the District's ordinance to include federal buildings could be effective in compelling federal government to report.[56,57,58]

The potential of this dataset is broad. Analyses can be conducted for both portfolios of buildings across the District as well as individual buildings. Comparisons across buildings of different size, type, age, or zip code allow for the identification of broad trends in energy usage. Trends can also be identified using factors such as market type, parking area, and fuel source in order to understand typical building characteristics within the District and how they come to affect energy consumption. To help improve the accuracy and thus usefulness of the dataset even further, the Department of Energy and Environment (DOEE) has offered a grant to New York University's Center for Urban Science and Progress.[59] The Center's research resulted in a preliminary strategy for data cleaning that merges disparate datasets, removes duplicate entries, identifies and removes significant outliers, and removes entries that lack critical pieces

[53] District of Columbia Department of Energy & Environment, 2011, Clean and Affordable Energy Act of 2008, http://doee.DCgov/publication/clean-and-affordable-energy-act-2008. D.C. Official Code 6-1451.03(c); 20 DCRMR 3513.

[54] U.S. Government Printing Office, Energy Independence and Security Act of 2007, http://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf.

[55] Diplomatic Mission and International Institutions Environmental Performance, Climate and Sustainability Pledge, http://sustainable.DCgov/page/diplomatic-mission-and-international-institutions-environmental-performance-climate-and

[56] U.S. Government Printing Office, Energy Independence and Security Act of 2007, http://www.gpo.gov/fdsys/pkg/BILLS-110hr6enr/pdf/BILLS-110hr6enr.pdf.

[57] Diplomatic Mission and International Institutions Environmental Performance, Climate and Sustainability Pledge, http://sustainable.DCgov/page/diplomatic-mission-and-international-institutions-environmental-performance-climate-and

[58] Executive Order 13693 – Planning for Federal Sustainability in the Next Decade. March 19, 2015. Section(3)(a)(i)(G). https://www.whitehouse.gov/the-press-office/2015/03/19/executive-order-planning-federal-sustainability-next-decade

[59] Kontokosta, C. et. al. Benchmarking and Data Quality Analysis of Energy Disclosure Data for Washington, DC New York University Center for Urban Science and Progress. October 28, 2015. Internal copy provided by the District Department of Energy and Environment.

of data. These resulting datasets have been used to guide the recommendations and analysis in this chapter.

3.2.2.1 Savings Potential in the District's Existing Building Stock

The District's benchmarking dataset shows that, in many ways the District is doing comparatively well in terms of building energy use. To begin, the average ENERGY STAR® score for District Office buildings of 72 sits well above the national average of 63.[60] The District has also been ranked as first in the nation for the number of ENERGY STAR® certified buildings in 2015 and 2016, and has been among the top five cities since 2009.[61] However, as buildings are only eligible for ENERYSTAR® certification once they hit a score of 75, there is still room to improve energy performance even in the District's relatively advanced commercial building stock.

Further, several other sectors have lower average ENERGY STAR® scores than the national average. For example, the District's average score for the hotel sector is 43, while the national average rests at 50.[62] Scores for Multifamily Housing (i.e., buildings with 20 or more units) were released by ENERGY STAR® for the first time in 2015; as a result, similar metrics of comparison for this sector will be accessible in future years. Insights such as these are and will continue to be important tools for understanding how best to allocate funding for energy efficiency outreach and programming, and target policy efforts toward the most efficient outcomes. Additional details on the recommended uses of this and other datasets, as well as other policy and programming options, are presented below.

It should also be noted that additional actions relevant to existing buildings can be found in Section 3.3, which includes actions targeting the entire building sector. Some recommendations from DOEE's Single Family and Small Multifamily Working Group have been included below, while others can be found in the Group's forthcoming report. The District Government should review and consider these recommendations in addition to those below.

3.2.3 Recommended Actions

3.2.3.1 Expand DCSEU Operations

EB.1 Increase operating budget for the DCSEU

Action: Increase the funding provided to the DC Sustainable Energy Utility.

Relevance: Alongside the District's energy benchmarking ordinance, the approval of the 2008 CAEA saw the creation of the DC Sustainable Energy Utility (DCSEU). The DCSEU began operating in March 2011 using funding from the Sustainable Energy Trust Fund (SETF), in turn, financed by an electric and gas rate surcharge to utility customers in the District. Under the CAEA, the DCSEU is responsible for:

- Reducing per-capita energy consumption.

[60] Energy Use in Offices, part of EPA's Data Trends Series, http://www.energystar.gov/sites/default/files/tools/DataTrends_Office_20150129.pdf

[61] U.S. EPA. ENERGY STAR Top Cities, 2016 and Past Rankings. https://www.energystar.gov/buildings/top_cities_past_rankings

[62] Energy Use in Hotels, part of EPA's Data Trends Series, https://www.energystar.gov/sites/default/files/tools/DataTrends_Hotel_20150129.pdf

- Increasing renewable energy generating capacity.
- Improving the energy efficiency of low income housing.
- Increasing the number of green collar jobs. 63

The DCSEU now has over five years of operational experience in the deployment of energy efficiency programs to the tens of thousands of District customers. However, funding levels for the DCSEU fall short of its peers. To bring funding in line with similar leading-edge efficiency programs in the U.S. and help achieve District's emissions reduction targets, the District should increase the funding it receives from the SETF.

Details: The SETF currently collects approximately $21 million annually, most of which is used to fund the DCSEU programs. However, two major issues are limiting the total amount of funding that is made available. First, the SETF surcharge has been fixed at $0.014 per therm consumed of natural gas and $0.0015 per kWh consumed of electricity.[64] When converted to standard units (MMBtu), these surcharges reflect a significant gap between what is charged for the consumption of natural gas ($0.14 per MMBtu of natural gas) and what is charged for electricity ($0.44 per MMBtu of electricity) – a difference of approximately 30%. Second, as District-wide energy use drops, the funds collected by the SETF will decrease as well, limiting the work the DCSEU will be able to undertake.

As a part of 2013's annual evaluation, measurement and verification process of the DCSEU's programs, consulting firm TetraTech analyzed the funding that would be required in order for the DCSEU to achieve its maximum performance targets in electricity and natural gas savings. Their report indicated a need for a budget of approximately $29 million, including $20 million for electricity programming and $9 million for natural gas.[65] It also noted that as the low hanging fruit of low/no cost measure are completed, incremental savings will require more expensive measures to achieve, such as capital improvements and deep retrofits. This negative feedback loop has led other jurisdictions with more established Demand-Side Management programs to increase their surcharge over time. A similar approach taken by the District Government will ensure the continued funding necessary for the successful operation of the DCSEU.

Next Steps:

- In 2017, adjust the SETF rates for electricity and natural gas to better align with a funding allocation that allows the DCSEU to operate at the leading edge of energy efficiency programs in the country. The adjusted rate should account for the shortfall required to achieve current goals, additional funding needed to achieve more aggressive goals, and the diminishing returns this funding will achieve over time.

EB.2 Increase the DCSEU's access to building energy performance data

Action: Improve the DCSEU's access to building energy information to allow them to target buildings with the highest potential for energy savings.

[63] DC Sustainably Energy Utility, About the DCSEU, https://www.dcseu.com/about-dcseu

[64] NC Clean Energy Technology Center Database of State Incentives for Renewable Energy (DSIRE), Sustainable Energy Trust Fund, http://programs.dsireusa.org/system/program/detail/108

[65] TetraTech. Department of Energy and Environment Verification of the District of Columbia Sustainable Energy Utility FY14 Annual Evaluation Report for the Performance Benchmarks. September 30, 2015. Unpublished. Page 2-8.

Relevance: The DCSEU's services are offered on a largely first-come, first-served basis, with little effort to target specific customers. However, the DCSEU's effectiveness could be vastly improved by targeting those buildings with the greatest potential for energy efficiency improvements. Doing so will require the DCSEU access to existing building energy consumption data at various levels of granularity, combined into a single user-friendly platform with information accessible in an actionable format. Understanding the characteristics and performance of the building stock will allow the DCSEU to target programs effectively and engage building owners and managers directly. As a part of this effort, the District should provide the DCSEU with the most current and accurate information available on the building stock and its energy performance on an ongoing basis.

Details: Several sources of data would assist the DCSEU in improving the effectiveness of its programs and services.

Utility information: As an independent organization, the DCSEU cannot access building energy consumption data directly from District utilities, nor does it have access to the metering configuration of District buildings. Such information would provide important insight into both the quantity of energy consumed by different buildings, as well as the way in which this energy is divided among individual customers (e.g., master-metered vs. tenant-metered). A requirement for District utilities Pepco and Washington Gas to share such data directly with the DCSEU would enhance its overall effectiveness in targeting the highest-potential energy savings projects.

Benchmarking data: DOEE already provides detailed benchmarking data to the DCSEU, which provides a snapshot of the annual energy performance and different characteristics of the District's built stock. While this data is useful, benchmarking data collected and shared on a monthly basis would allow further insight into building energy consumption under different climatic conditions, system loads, and operating characteristics. Understanding buildings' baseload performance may also indicate their potential for lighting or other building upgrades. In order to collect monthly data from Portfolio Manager, District Government staff should continue to work with their counterparts from other cities to help program staff at the U.S. EPA to overcome any technical hurdles associated with the transfer of monthly, rather than annual, energy consumption data.[66]

Metering data: In addition to benchmarking data, the Public Service Commission should also grant the DCSEU access to real-time utility data. A similar program has already been established in *Efficiency Vermont*, in which Account Managers are given access to (smart) meter information for homes and businesses that are utility customers.[67] Account Managers can use this information to conduct aggregate analyses, identify trends, customize savings recommendations, and improve their outreach practices. Access to such data would similarly help the DCSEU to verify actual energy savings following an energy-saving action or retrofit, increasing the accuracy of annual metrics. Access to smart meter data will also dramatically expand the sophistication with which the DCSEU can analyze and target the building sector.

[66] An alternate path forward would be using the EPA Portfolio Manager Web Services option rather than changing the granularity of information sent through the Reporting Template. Using Web Services would require a regulatory change to the District's rulemaking, which includes provisions that ordinance-subject building owners must submit District Benchmark Results and Compliance Report to the District, via the District Benchmark Reporting Template.

[67] Efficiency Vermont's Privacy Policy, https://www.efficiencyvermont.com/about/privacy-policy#What

Supplemental data: Under the current benchmarking ordinance, the District collects general building information (i.e., street address, year built, size, occupancy), property use data (i.e., gross floor area and operating characteristics), and energy and water performance data. However, more detailed building system and construction data would allow the DCSEU to better target buildings with high energy savings potential. An example of this kind of approach can be found in New York City's *Retrofit Accelerator program*, which offers no-cost, independent and building-specific technical assistance and advisory services on energy and water efficiency for building owners and operators. The *Retrofit Accelerator* targets high-savings potential buildings using a combination public and non-public datasets collected under Local Law 84 (for energy and water benchmarking) and Local Law 87 (for energy audits and retro-commissioning). The combination of these datasets allows *Accelerator* staff to identify building and contact high priority buildings to connect decision makers with resources to aid in efficiency planning and upgrades.

Green Building Act data: Finally, the Department of Consumer and Regulatory Affairs' (DCRA) Green Building Act dataset should be merged with energy benchmarking data, and subsequently shared with the DCSEU. The DCRA dataset includes ENERGY STAR® Target Finder scores based on the modeled energy performance of new construction and major renovations of large publicly- and privately-owned buildings. Combining this dataset with benchmarking data would link modeled energy performance at building or project design with actual energy performance over the course of building operations. However, mapping these datasets together would require the District to develop building-specific identification numbers to be used across agencies. To date, DOEE has been unable to match its benchmarking dataset with any datasets maintained by DCRA due to a misalignment in building identification numbers.

Next Steps:

- In 2017, develop a standard building identification number to be used across the District Government to allow building-specific information to be consolidated into a single resource. Once established, share these existing datasets across agencies for use in efficiency program development, using put nondisclosure agreements where necessary.
- In 2017, grant the DCSEU access to applicable datasets and direct the DCSEU to consolidate those datasets into one streamlined CRM program by 2018, including the SEED Platform and available contractor software systems. Share access should be shared with District Government agencies who work in the existing building space. Use case and workflow evaluation and security considerations for access and permissions for any data shared across agencies.
- Starting in 2017, work with the EPA to access monthly as well as annual energy data.
- Immediately work with the DCSEU, Washington Gas, PEPCO, and Public Service Commission to investigate the feasibility of granting access to real-time, granular interval energy consumption information of utility customers to the DCSEU, under strong non-disclosure requirements.

EB.3 Increase DCSEU flexibility

Action: Increase the ability of the DCSEU to target expanded target saving areas.

Relevance: In order to assist the District in achieving its emissions reduction targets, the DCSEU will need to target new energy savings areas. This will require an increase in the DCSEU's flexibility and in the type of offerings that it can provide.

Details: The DCSEU should be given access to any potential tool that maximizes the achievement of their targets at the lowest practical cost. Recommendations for the development and use of specific tools are listed below.

Operational energy management: Operational improvements to building performance include changes to building operational hours, adjustments to equipment settings, maintenance of systems and technologies, installation of sensors for lighting and thermostats, and real-time energy management. Since a verifiable standard for measuring the quantity and persistence of savings from these activities has not yet been adopted, operational energy management is not currently incentivized by the DCSEU.

The DCSEU should investigate the market for these and other kinds of operational improvements in the District with an aim toward understanding the current and potential market size. Similar investigations have led to operational energy management programs in other jurisdictions, including California, Minnesota, Chicago, Massachusetts, Maryland and New York. In the event that market conditions are similar, the District should consider adopting an appropriate methodology for estimating the persistence of savings in commercial and residential buildings. Best practices for the evaluation, measurement and verification (EM&V) of savings should be incorporated into the DCSEU's incentive program, including training and education for building operators on the use of submetering.

Coordination with other District Government agencies, instrumentalities and service providers: To improve the efficiency of its programs and services, the DCSEU should coordinate and work with other entities that share its goals. Specific entities include District Government agencies, instrumentalities, and administrators such as a DC PACE, as well as any future green bank (see Section 1.4). The DCSEU should be incentivized to cooperate, not compete with these agencies and service providers.

Projects with potential savings of over a year: Demand side management programs in states such as New York, Oregon, Vermont and New Jersey recognize that the potential return on investment in energy efficiency is greatest before and during building design.[68] To allow the DCSEU to address long-term projects with timelines greater than a single year, the process through which the management of the DCSEU is contracted out must be improved. During the 2016 request for proposal (RFP) process, the management of the DCSEU took a step in the right direction by extending the base contract period from one to five years, and including a five year renewal option.[69] However, additional changes are needed to properly incentivize the DCSEU to seek deeper, longer-term energy savings.

[68] For example, see new construction programs in New York (www.nyserda.ny.gov/All-Programs/Programs/New-Construction-Program) and Oregon (https://energytrust.org/commercial/construction-renovation-improvements/).

[69] RFP No. DOEE-2016-R-0002 For District of Columbia Sustainable Energy Utility Contractor, February 19, 2016, http://doee.DCgov/sites/default/files/dc/sites/ddoe/publication/attachments/DCSEU%20RFP_DOEE-2016-R-0002_FINAL.pdf

To this end, the District Government should credit the DCSEU for work and energy saving achieved through the life of its programs. This should include a direction to work with potential contractors from the very beginning of the new construction process by helping them to set goals, develop an RFP, and select a design team. The DCSEU should then work with design and construction teams from conceptual design through building delivery to maximize energy savings. Such changes will encourage the DCSEU to undertake projects that produce savings over several years, or projects that only produce savings beyond the first year of program implementation (e.g., new construction). This will increase the number, type and cost-effectiveness of projects that the DCSEU can undertake.

Code compliance: The DCSEU should assist DOEE, DCRA, the Green Building Advisory Council and the Construction Code Coordinating Board in developing and implementing building code improvements. The DCSEU should also design outreach and incentive programs for building owners, designers, and contractors with an eye to laying the foundation for future building code improvements.

In order to incentivize such investments, the DCSEU should be credited for a portion of any energy savings attributable to the adoption of energy-saving building code improvements, as is the case in Arizona utilities.[70,71] To maximize the energy savings realized from building code improvements, the DCSEU should invest resources in training, outreach, technical assistance, design assistance, marketing, explanatory materials, and other efforts to increase compliance with building codes. As codes become more ambitious, the DCSEU should receive credit for bringing poor performing buildings up to code. As the District has no history of crediting a Demand-Side Management administrator for code-related energy savings, enabling legislation may be required.

Fuel-agnostic energy savings: When the DCSEU was created, it was intended to be a nimble, flexible institution that would seek the greatest energy and emissions savings for ratepayers with as few limitations as possible and without regard to fuel source. As such, the original CAEA did not require the DCSEU to track electric and natural gas savings separately; these requirements were later added during the drafting of the DCSEU RFP. Eliminating these requirements would remove an impediment to whole system strategies (e.g., passive solar design) for which costs and savings must be arbitrarily allocated between electric and gas. This would also free the DCSEU to pursue strategies more in line with the District's commitment to reduce its GHG emissions by 80% by 2050. Achieving this level of savings will require the District to seize all opportunities to minimize fossil fuel consumption. For example, large-scale switching of electric systems to natural gas might yield short-term savings, but would be counter to long-term carbon reduction targets.

Minimize impediments to market responsiveness: As noted above, the DCSEU was intended to be entrepreneurial, flexible, and responsive to the market in ways that have generally proven difficult for government agencies and traditional utilities. The goal was, and remains, to establish an innovative body that can experiment and make calculated bets by trying new approaches and maximizing energy savings

[70] *Attributing Building Energy Code Savings to Energy Efficiency Programs*, developed by the Northeast Energy Efficiency Partnerships (NEEP) Evaluation, Measurement and Verification (EM&V) Forum; the Institute for Market Transformation (IMT); and IEE, an institute of the Edison Foundation, February 27, 2013, http://www.imt.org/news/the-current/leveraging-building-energy-codes-to-maximize-energy-savings

[71] Other jurisdictions, such as California, also provide utilities attribution for energy code adoption, but the Arizona model is most appropriate for a small jurisdiction like the District.

and benefits to ratepayers and residents at the lowest practical cost. To achieve this goal, steps should be taken to minimize paperwork and impediments; some examples include the following:

- The DCSEU is currently subject to a performance contract for SETF-funded work. In the event that DOEE provides additional funds to the DCSEU's budget, those funds should also be subject to performance requirements, while the DCSEU should handle any aspects of program design. Certainty in the size and timing of any additional funding will improve their impact, as will the flexibility to incorporate them into longer-term planning. Any adjustment to the DCSEU's performance goals made in connection with the provision of new resources to the DCSEU should account for this significant impact.
- The DCSEU should be able to pursue a portfolio of strategies that it deems most likely to deliver on its mandated goals, and make quick course corrections in response to market conditions and feedback.
- The DCSEU should also be subject to a streamlined EM&V process, comparable with those in other jurisdictions. This streamlining should include a random sampling of professional installations rather than inspection and review of 100% of installations.
- To minimize the costs for building owners to participate in its programs, the DCSEU should minimize paperwork and inspection to a level below that in Maryland and to the level of national best practices.

In short, the DCSEU and the District should work to streamline processes, eliminate bureaucracy and paperwork, and allow the DCSEU to operate as the truly flexible and nimble organization intended in the original CAEA.

Market transformation: Finally, the DCSEU contract should be structured so the DCSEU is encouraged to continue to engage in a full range of market transformation activities, including green leasing and training for brokers, appraisers, and other real estate professionals.

Next Steps:

- In 2017, direct the DCSEU to investigate the market penetration of operational energy management. If findings indicate a cost-effective opportunity to further incentivize operational energy management, direct the DCSEU to conduct a best practice review of other jurisdictions' approaches to estimating the persistence of savings, and any standard EM&V methods that can be deployed in the District.
- Once a five-year contract is awarded for the management of the DCSEU, credit the DCSEU for any multi-year savings and include these savings numbers in cumulative performance reviews conducted by DOEE.
- As the District adopts more ambitious energy and green codes, revise the DCSEU incentive and performance structure to allow credit for their participation in code compliance activities. This may require a legislative update.

- Ensure future DCSEU contracts can:
    - Pursue fuel-neutral goals are aligned with the District's decarbonization targets
    - Avoid separately tracking spending between electricity and natural gas programs
    - Avoid the need for prior approval for programs or course corrections
    - Last a minimum of five years without interruption across fiscal periods
    - Receive a monthly pre-payment or draw, or else receive stable and predictable payments without interruption for routine processing
- Subject the DCSEU to a streamlined trust-but-verify EM&V regime to minimize paperwork and bureaucracy. Use random sampling in place of 100% inspection and review processes and allow the DCSEU to use census tract data for income verification where appropriate. To the extent practical, implement these changes under the current DCSEU contract.

EB.4 Provide the incentives necessary to operate a District-wide deep energy retrofit program

Action: Improve the uptake of deep building energy retrofits by providing resources, training, and incentives.[72]

Relevance: A deep energy retrofit is a building-specific, whole-building analysis designed to identify points in the building lifecycle where investments in energy efficiency can achieve the highest return. These are often multi-year or ongoing efforts that require both operating and capital investments and that can achieve up to 50% reduction in energy consumption over time.[73]

While deep retrofits can generate significant cost savings for building owners and operators, they also require a considerable investment of time, money, and other resources that can make them unattractive. To overcome these barriers and drive the scale of retrofits necessary to achieve the District's GHG reduction targets, the District must invest in a set of incentives that make these added efforts worthwhile. These programs require financial investments by the District Government itself. However, a cost-benefit analysis has indicated that both the direct and indirect benefits of incentivizing net-zero and/or net-positive energy buildings outweigh the costs over a ten year period (see pp. 37-49 of Appendix).[74]

Details: To improve the uptake of deep energy retrofits, the District should shift to a system of pay-for-performance incentives, in which incentives are contingent on the actual measured performance of the building. Experiences in the District, as well as several other states, indicate that shifting to this form of energy efficiency programs can make retrofit programs both less expensive to operate and more effective in driving reductions (see Appendix).[75]

These incentives should also be set up in such a way that incentives are non-linear, in that greater energy savings are rewarded with greater financial incentives. In this way, a building that achieves a 50% reduction in energy consumption can receive a significantly larger package of incentives than a building

[72] Aspects of this recommendation are based on *Greening the District of Columbia: Incentives and Policies to Achieve Deep Green Building Construction and Renovations*, a report prepared for the District of Columbia Department of Energy and Environment by Capital E in 2016. The report provides additional details and information on both new construction and existing building incentives that can support the building performance and retrofit success required to achieve the District's 2032 GHG goal.

[73] Rocky Mountain Institute. "Deep Energy Retrofit 101". http://www.rmi.org/retrofit_depot_101 Accessed May 2016.

[74] This report is currently undergoing review by DOEE and will be available to the public in the near future.

[75] This report is currently undergoing review by DOEE and will be available to the public in the near future.

that achieves only a 25% reduction in energy consumption. Incentives should be made available for residential, commercial, and institutional buildings, and be implemented in a transparent manner.

Next Steps:

- Use the remainder of 2016 and early 2017 to design the specific incentives identified above.
- Work with the DCSEU to implement a package of incentives targeting deep energy use reductions by 2018.

EB.5 Coordinate and centrally track District efficiency and finance programs

Action: Coordinate existing Demand-Side Management (DSM) incentive and financing programs to ensure that incentives and benefits are tracked together and aligned.

Relevance: In order to streamline and consolidate the District's energy efficiency-related programs, disparate programs should be functionally coordinated to align their benefits and incentives.

Details: The DCSEU should closely coordinate with and support a new green bank (see Section 1.4), expanded property assessed clean energy (PACE) financing (see Action EB.10), as well as all other DSM incentive and financing programs (such as those discussed in Action NC.2). The DCSEU should additionally receive a credit for a portion of the energy savings, green jobs and other benefits that these programs generate. This will functionally align separate initiatives' incentives; however, a unified branding should also be developed to encourage the public to perceive them as a cohesive package.

Next Steps:

- In 2017, evaluate strategies for consolidating DSM incentive and financing programs to ensure that all associated programs are either aligned under one organization or closely coordinated to allow their incentives and benefits to work together.

3.2.3.2 Policy and Program Recommendations to Increase Energy Efficiency in Existing Buildings

EB.6 Lead by example in municipal operations

Action: Lead by example by implementing an aggressive deep energy retrofit program, followed by a net-zero retrofit program across the municipal building stock.

Relevance: As discussed in Action EB.4, deep energy retrofits are building-specific, whole-building analyses designed to identify points in the building lifecycle where investments in energy efficiency can achieve the highest return. While the particular savings that can be achieved are highly dependent on the particular building in question, the District can lead by example in undertaking the process for its building stock, with targets for energy savings to guide their efforts.

The District has already led by example by complying with its own benchmarking ordinance and going further in publishing fifteen-minute interval data for all DGS buildings through the BuildSmartDC program. This type of leadership underscores the importance and value of such actions and demonstrates a broader proof-of-concept for the building industry. The District should extend this leadership beyond energy disclosure to lead by example in reducing its building energy consumption via a deep energy retrofit program, followed by a net-zero retrofit program.

Details: An aggressive municipal building retrofit program should be phased-in over time, beginning with a deep energy retrofit process that spans 15% of District Government-owned buildings. The ultimate goal of the program should be a net-zero level of energy consumption across the District Government-owned building stock. However, it should be noted that circumstances will vary by building and may not be cost-effective or feasible for every District Government-owned building. Following the initial sweep of deep energy retrofits, the District should then initiate net-zero retrofits across an additional 5%, phasing in additional buildings over time.

In targeting these retrofit rates, and pushing the private sector to significantly improve building energy performance, the District Government can learn from and work with the U.S. General Services Administration in at least three ways:[76]

- Identify specific leasing preferences related to GHG emissions, energy performance, and other sustainability issues.
- Incorporate the social cost of carbon into building-related decision-making.
- Use combined purchasing power to provide market signals to suppliers to offer low, zero, or negative carbon products.

Next Steps:

- Implement a deep energy retrofit program on 15% of the municipal building stock (by square footage) between 2017 and 2020, prioritizing those buildings whose core systems and equipment are likely nearing the end of their useful life. Target an average of 30% energy use reductions from these retrofits.
- Implement a leadership-focused net-zero retrofit program across 5% of the municipal building stock between 2022 and 2024.
- Between 2024 and 2032, retrofit 16% of the municipal building stock to be net zero.

EB.7 Implement a Building Energy Performance Standard

Action: Implement a Building Energy Performance Standard. Options should include mandatory building audits, retrocommissioning, and/or minimum energy performance standards for existing buildings.

Relevance: While the District's benchmarking policy has provided useful access to information on the building stock, next-generation policies require building owners to take action, either by contracting an auditor to review building systems and operations against a certain standard or by requiring system upgrades.

Details: Building Energy Performance Standards (BEPS) establish mandatory building energy audits and/or retro-commissioning that either require and/or motivate building owners (and in certain cases tenants) to invest in the energy efficiency of their buildings. Such a policy would both reduce emissions associated with the built environment and provide the District with a more detailed understanding of building system characteristics, allowing for greater efficiency in program design and implementation.

[76] Adapted from *Greening the District of Columbia: Incentives and Policies to Achieve Deep Green Building Construction and Renovations*, a report prepared for the District of Columbia Department of Energy and Environment by Capital E in 2016.

The BEPS outlined by the BEPS Task Force would be among the first of its kind in local jurisdictions, and would apply to all buildings covered by the benchmarking ordinance.[77,78] The ENERGY STAR® score for buildings was suggested as a metric for evaluating building performance, as it is already used in the District's benchmarking program, and includes important considerations for occupancy, weather, and building use that help to normalize building scores for more fair comparison across peer groups.

While the BEPS Task Force did not include a precise recommendation for the ENERGY STAR® threshold, an examination of the benchmarking data suggests that an appropriate threshold for the District's highly efficient office sector should be a minimum ENERGY STAR® certification of 75. For additional building types subject to the ENERGY STAR® scoring system, the threshold should be 50—the national median. Building types without a means of scoring in ENERGY STAR® should either be exempt or use the national median for the property type in question.

If building owners do not meet the performance standard, alternate compliance paths can include one or more of the following:[79]

- Energy audits: An audit is a detailed assessment of how a building could improve its energy performance through upgrading or retrofitting its energy systems. Under the BEPS proposed by the BEPS Task Force, an ASHRAE Level II audit (or higher) would be required, with the findings submitted to the District. This additional data collection would enable the District to further enhance efficiency targeting, following the model of NYC's Retrofit Accelerator.[80]
- Retrocommissioning: Retrocommissioning is a systematic process wherein the existing base building systems (including the HVAC system, electrical and lighting systems, and building envelope) are thoroughly evaluated and optimized to ensure that they are running properly. Typical retrocommissioning measures include recalibrating sensors and controls, and cleaning and repairing existing equipment; they do not include capital-intensive improvements such as the installation of new, more-efficient equipment. Studies have identified retrocommissioning as one of the most cost-effective procedures to increase the energy efficiency of existing buildings and have estimated that improved operations can deliver half of the reasonably available savings from energy efficiency for a portfolio of buildings.[81]
- Certification of building operators: An extraordinary amount of energy is wasted when building operators do not know how to operate building systems efficiently or maintain them properly. A relatively inexpensive solution is to offer training in the operation and maintenance of relevant building systems. A building operator training and certification program prepares building operators to efficiently operate and properly maintain building energy systems.

[77] Sustainable DC Mayor's Order, Building Energy Performance Standards Task Force, December 10, 2014, http://www.sustainableDCorg/wp-content/uploads/2014/12/10-Building-Energy-Performance-Standards.pdf.

[78] Sustainable DC Mayor's Order. Building Energy Performance Standards Task Force. December 10, 2014, pp.23-27, http://www.sustainableDCorg/wp-content/uploads/2014/12/10-Building-Energy-Performance-Standards.pdf.

[79] The recommendations also included "disclosure of interval energy use." This report recommends that the District pursue a path to obtain interval energy use for all subject buildings via the utilities, similar to the Efficiency Vermont model. Further detail is available in section EB.2.

[80] NYC Retrofit Accelerator, https://retrofitaccelerator.cityofnewyork.us/

[81] Brian Merrill, "Operational Improvements Can Double Energy Efficiency Savings in Commercial Buildings," BusinessWire, February 6, 2013, http://eon.businesswire.com/news/eon/20130206005560/en/FirstFuel/Energy-Efficiency/Operational-Improvements (accessed April 15, 2013).

- Significant performance improvements: For poor performing buildings that may not be able to achieve the requisite BEPS threshold, a significant improvement from past performance can be deemed as complying with the BEPS ordinance for that five-year compliance cycle. The District should investigate an appropriate improvement threshold percentage improvement for these buildings.

If a building does not achieve the minimum BEPS threshold during the five-year compliance cycle, they can be allowed to make improvements through an established plan (either via deep-retrofit or incremental changes), or pay an alternate compliance fee. Revenue from the fee should be funneled through the DCSEU toward incentives for improvements in other buildings.

With a self-reported dataset, third-party data quality verification will be paramount to ensuring that the data accurately reflect building characteristics and performance. In order for the data to be used to drive and inform policies and programs, accurate data and public confidence in the accuracy of data are crucial. This includes the need to ensure that data reports are complete, accurate, and timely – a considerable task given the number of reports that are already processed by DOEE. Data quality verification may be contracted to a third-party firm (either by DOEE or by building owners themselves), or verification may be done in-house by DOEE with dedicated funding for staff time spent on inspections and correspondence. Either option will require a continued investment of dedicated funding.

As an alternative to the BEPS Task Force's BEPS strategy, the Los Angeles Existing Building Energy and Water Efficiency Program may provide an example for implementing multiple next-generation policies, including performance requirements. Under the proposed program, buildings over 10,000 square feet are subject to annual benchmarking, which are published via the Los Angeles Department of Building and Safety (LADBS) public database. Once every five years, building owners choose to either undertake a prescriptive path (i.e., retrocommissioning and energy/water audit) or a performance path (i.e., LEED certification, ENERGY STAR® certification, water audit, and reduction targets for energy and water use intensity) to further improve energy and water performance.[82] Another example policy can be found in New York City's Local Law 88 and its requirements for lighting upgrades in large buildings.[83]

Next Steps:

- Evaluate the following BEPS design details: minimum ENERGY STAR® score thresholds to use, building types to include, appropriate EUI for each building type, how to set code-based energy targets, enforcement procedures, and possible exemptions.
- Design and implement an aggressive BEPS policy for public and private buildings in the District. Implement BEPS by 2018 and ensure District Government buildings lead by example.

EB.8 Drive energy efficiency at tenant build-out

Action: Provide incentives to encourage efficiency improvements upon tenant turnover and build-out.

[82] Los Angeles Existing Buildings Stakeholder Group. Final Workshop, July 28, 2015, https://laexistingbuildings.files.wordpress.com/2015/01/150728_final-workshop.pdf

[83] New York City Mayor's Office of Sustainability, Local Law 88, http://www.nyc.gov/html/gbee/html/plan/ll88.shtml.

Relevance: Lighting, controls, certain HVAC systems, and tenant-owned equipment (e.g., office/IT equipment, commercial kitchens) are routinely replaced at tenant turnover, and less frequently replaced at lease renewal. Many commercial tenant spaces, including office and retail, turn over an average of once every seven years. This makes tenant turnover a key opportunity to improve efficiency.

Details: A multi-pronged strategy for maximizing efficiency gains during this unique window of opportunity should be implemented, with a particular consideration of programs specifically designed to incentivize energy efficiency improvements at tenant build-out. Such programs could be modeled on successful programs in other states (e.g., Massachusetts). These should be simple, streamlined and predictable to help minimize costs and delays. Time is a key consideration at tenant build-out when both landlords and tenants are eager to complete the process as quickly as possible.

Incentives should include simple set payments (e.g., $0.30 per square foot) for pre-determined packages for each major commercial tenant type (e.g., specific lighting densities for office, retail, etc.) that push energy efficiency well below code-permitted levels. As energy modeling can take long periods of time and can be costly, energy models should not be a requirement for the receipt of incentives.

Similarly, the DCRA should offer expedited permitting for tenant build-outs that exceed building code requirements. Packages should be updated to require higher levels of efficiency at least as often as the District updates its building energy codes. Unlike the expedited permitting written into the District's Green Building Act of 2006, the DCRA should not be required to provide permits during a specific time period (e.g., 30 days). Rather, the DCRA should simply move recipients of expedited permitting to the front of the line. The DCSEU should also be encouraged to continue to work with the DCRA to achieve improved compliance with building energy codes at tenant build-out, a time when code compliance tends to be relatively low. Submetered tenants are significantly more likely to focus on efficiency at build-out – see Action CCB.1 for additional detail.

Lastly, the U.S. EPA is required by law to launch a new rating system in 2020: ENERGY STAR® for Tenants. The District and the DCSEU should recognize, train, market, and provide incentives to drive early tenant adoption of this new system as a cornerstone of tenant awareness and action to improve efficiency.

Next Steps:

- In 2018, begin to offer incentives for pre-determined packages of improvements through the DCSEU, as well as expedited permitting for tenant build-outs that include planned packages of equipment that exceed code.
- Recognize, train, market, and incentivize early tenant adoption of EPA's 2020: ENERGY STAR® for Tenants initiative upon its launch.

EB.9 Encourage the adoption of green leases through education and training

Action: Encourage building owners and tenants to adopt green leases by providing stakeholder training, education, and recognition programs.

Relevance: Green leasing, or energy-aligned leasing, is the practice of realigning the financial incentives of the landlord and tenant to support energy or sustainability goals in the lease documents. These leases are designed to overcome the principal-agent problem, whereby landlords and tenants are dis-

incentivized to undertake energy efficiency upgrades in a building, as neither realizes the full benefit of the upgrades.

Details: In a recent study, the Institute for Market Transformation (IMT) estimated that green leases could reduce energy consumption in U.S. office buildings by between 11% and 22%, reducing nationwide utility expenditures by commercial buildings by as much as $0.51 per square foot. The potential savings for the U.S. market for leased offices ranges from $1.7 billion to $3.3 billion in annual cost savings.[84]

The District should provide education and resources for stakeholders who are able to influence the formation of these kinds of green leases, including brokers, lawyers, and commercial real estate companies, as well as building owners and tenants. This can be done via the facilitation of round-table discussions, or through the provision of training. The District should additionally recognize those leaders in the industry who participate in green leasing. The Green Lease Leaders program run by IMT and the DOE already recognizes these organizations; the District can encourage building owners and tenants to participate, and can provide recognition to those who do.

Next Steps:

- In 2016, offer a form of recognition for leading market participants who prioritize green leasing through a program such as the Green Lease Leaders.
- In mid-2018, provide education and resources around green leasing to brokers, lawyers, commercial real estate companies, tenants and owners.

EB.10 Enhance the District's Property Assessed Clean Energy program with a residential offering

Action: Expand the District's existing Property Assessed Clean Energy (PACE) financing program to include the residential building market.

Relevance: PACE is a financing structure that allows for cost-saving measures to be funded by a special property tax assessment.[85] Building owners can apply to the PACE program to secure 100% financing for qualifying energy efficiency retrofits and renewable energy investments (and other types of projects).[86] Terms of repayment can be up to 20 years (much longer than conventional financing) and remains with the property when it is sold. As such, PACE offers property owners the opportunity to immediately improve a property's cash flows through an energy-focused investment. This makes PACE an attractive and effective financing mechanism that can increase the private investment necessary to achieve the District's 2032 climate and energy targets.

Details: The District's current PACE program serves only commercial building owners, including some multifamily buildings. Expanding PACE to serve the entire residential market will increase the number of property owners that can access this financing program, and thus the proportion of the District's energy use and GHG emissions that can be targeted with lower cost renewable energy and energy efficiency

[84] Feierman, Andrew. What's in a Green Lease? Measuring the Potential Impact of Green Leases in the U.S. Office Sector. Institute for Market Transformation. May 2015. http://www.imt.org/uploads/resources/files/Green_Lease_Impact_Potential.pdf

[85] DC PACE Commercial, http://doee.dc.gov/service/dc-pace-commercial.

[86] For details, see http://urbaningenuity.com/dc-pace.

actions in the residential sector. DOEE's Single-Family and Small Multifamily Working Group identified a set of recommendations for a residential PACE program:

- Coordinate with major financial institutions to overcome barriers related to subordinated debt.[87]
- Create an interest buy-down program for low- and moderate-income households to enhance utility savings.
- Partner with the DCSEU to create greater value to residential customers.
- Create market demand through a strong marketing and outreach strategy, led by DOEE and a residential PACE administrator, in partnership with the District's financial and real estate community to create a pipeline of projects. [88]

Furthermore, the Working Group recommended that the District follow the residential PACE guidance released by the U.S. Department of Housing and Urban Development's (HUD) Federal Housing Administration (FHA) in July, 2016.[89] The new FHA guidance is the first signal of support for PACE at the federal level and aligns with the District's current PACE program. The guidance provides is intended to take the perceived risk out of this investment mechanism, thereby significantly increasing the availability of affordable clean energy financing to homeowners.

Next Steps:

- Expand the current PACE program to cover all residential building owners in 2017.

EB.11 Develop a virtual energy audit program

Action: Establish a virtual energy audit program covering all building types in the District.

Relevance: Energy audits are a critical tool to understanding a building's current energy performance and opportunities for improvement. To meet its GHG reduction targets, the District will be required to retrofit a large portion of the existing building stock. As such, it is critical for the District to find ways to conduct audits on all of the city's buildings in a short period of time with a small amount of funding.

Details: There are two types of energy audits: traditional and virtual. A traditional energy audit requires the physical presence of a trained building analyst (e.g., engineer) and the associated time and resources to conduct the audit. This approach provides the greatest opportunity for a building owner to identify issues and opportunities, but is also more costly. A virtual energy audit is a streamlined version of the traditional energy audit that uses energy and other building data, but does not require a trained building analyst on-site to check building systems and identify issues and opportunities, and is thus much less expensive.

One example of a virtual energy audit program can be found in Chicago. Energy Impact Illinois' *EnCompass* is an online tool developed via a collaboration of the Department of Energy, the Chicago Metropolitan

[87] Subordinated debt is debt that ranks below other loans and securities with regard to claims on assets or earnings. In the case of borrower default, creditors who own subordinated debt will not be paid until more senior debtholders are paid in full.

[88] Green Residential Solutions – Recommendations from the Single Family Small Multifamily Green Building Working Group, June 2016.

[89] Available at http://portal.hud.gov/hudportal/documents/huddoc?id=16-11ml.pdf.

Agency for Planning, and the private sector.[90] The tool uses existing ENERGY STAR® or Energy Information Administration benchmarking data to extrapolate broad trends in retrofit needs and opportunities in large scale residential and office buildings.[91] By filling out a survey on building characteristics and components, building owners are provided a customized list of high value energy conservation measures and their potential impact on energy performance.

For substantially less effort and time, a virtual energy audit allows building owners to identify most of the key insights that a traditional audit would deliver. It can quickly focus on key issues that drive poor energy performance, allowing more time and resources to be spent actually addressing identified issues. They make energy audits accessible to a wider set of building owners that cannot afford or would not invest in traditional audits. Virtual audits can also be used to set the stage for a more focused in-person review of certain building systems that appear to be underperforming. As such, virtual energy audits represent a powerful tool for the District to use in achieving the retrofit rates necessary to achieve its climate and energy targets.

The District should establish a virtual energy audit program that is available and attractive to all building types. For such a program to be successful, the following aspects are required:

- Full cooperation from local utilities to access utility data.
- Safeguards to ensure data confidentiality.
- Pairing with recommendations for energy (and other) efficiency measures.
- A one-stop shop for homeowners that pairs audit recommendations with funding and incentives to make physical building improvements (see Action CCB.3).
- Easy availability to targeted customers (e.g., small business owners, homeowners, renters).
- Opt-In integration with regional multiple listing service website MRIS (for residential users).[92]

Next Steps:

- Obtain approval for the use of customer utility data in a virtual energy audit program and develop agreements with utilities to access this data in 2017.
- Secure funding, then commission an organization to develop and manage an online virtual energy audit program by the end of 2017.
- Aim to provide audit results to property owners in 2018.

[90] http://encompass.energyimpactillinois.org/

[91] Energy Information Administration date comes from the Commercial Buildings Energy Consumption Survey (CBECS).

[92] www.mris.com

3.2.4 Existing Buildings Roadmap

		The Five-Year CEP					Projected Path to 2032 Climate and Energy Targets										
Existing Buildings	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Expand DCSEU Operations																	
EB.1 Increase operating budget for the DCSEU																	
EB.2 Increase the DCSEU's access to building energy performance data																	
EB.3 Increase DCSEU flexibility																	
EB.4 Provide the incentives necessary to operate a District-wide deep energy retrofit program																	
EB.5 Coordinate and centrally track District efficiency and finance programs																	
Policy and Program Recommendations to Increase Energy Efficiency in Existing Buildings																	
EB.6 Lead by example in municipal operations																	
EB.7 Implement a Building Energy Performance Standard																	
EB.8 Drive energy efficiency at tenant build-out																	
EB.9 Encourage the adoption of green leases through education and training																	
EB.10 Enhance the District's Property Assessed Clean Energy program with a residential offering																	
EB.11 Develop a virtual energy audit program																	

Legend	
Planning, Research, and Program and Policy Development	
Plan or Program Implementation	
Policy or Regulation Implementation	
Pilot Project	
Program Evaluation	

3.3 Cross-Cutting Building Actions

In addition to the actions above, the District should take steps to support energy use and GHG emissions reductions across the overall building sector. The actions recommended below target both New Construction and Existing Buildings.

3.3.1 Recommended Actions

3.3.1.1 Policy and Program Recommendations

CCB.1 Increase code compliance in all buildings through Smart Code Enforcement

Action: Increase code compliance in both new and existing buildings through Smart Code Enforcement.

Relevance: While increasingly stringent building codes are being adopted across several U.S. states and cities, current code compliance rates in many municipalities remain low. This is often attributed to either a lack of sufficient resources or its relatively low priority among property managers. However, a well-designed program to improve compliance rates can be implemented without legislation at little or no cost, so long as there is a strong commitment from the local code department.

Fortunately, DCRA has demonstrated this commitment and made great progress in enforcing the District's energy codes in recent years through Smart Code Enforcement. DCRA's achievements in improving energy code compliance were recognized when it was awarded a Standard Bearer's award by IMT and the International Code Council in 2015. However, to achieve and maintain the building performance required to achieve the District's 2032 targets, an increase in staff numbers and the implementation of specific targets for compliance are needed to continue improving the success of the program.

Details: To improve code compliance in new and existing buildings, the District Government should assess current code enforcement procedures and compliance rates, and revamp current procedures accordingly to achieve a specific compliance target by a certain date.[93] Additional enforcement staff will be required to meet new compliance targets. The District Government should also require inspectors of single family and small multifamily residential buildings (<10,000 square feet) to be licensed by the American Society of Home Inspectors (ASHI) or equivalent.[94]

Next Steps:

- In early 2017, undertake a code compliance study to understand the nature of code compliance in the District. This should be designed in such a way that the results can be shared publicly.
- By 2019, develop and deploy a training curriculum on codes and code compliance through the DCSEU to complement the training already being offered by DCRA and the DCSEU. This should be continually updated as codes are adopted and ambitious targets are set on an ongoing basis.

[93] Typically, compliance targets are set at 90% because the 2009 American Recovery and Reinvestment Act (ARRA) legislation required states to develop plans to achieve 90% compliance with the energy codes by 2017 in order to receive energy funding.

[94] From DOEE's Single Family and Small Multifamily Working Group.

CCB.2 Incentivize and require submetering

Action: Phase in submetering requirements for new construction and major renovations into District Government building codes. Incentivize submetering in existing buildings via the DCSEU. Change District laws and regulations to allow residential building owners to submeter residential tenants for the purpose of directly billing for energy use.

Relevance: The energy used by tenants within their spaces can amount to up to 50% of the energy consumed in typical commercial office buildings.[95,96] In commercial, multi-tenant buildings with a single or master meter, tenants are typically charged on a per-square-foot basis, and have limited or no visibility on their actual energy consumption. A recent U.S. DOE report highlighted the importance of submetering in reducing market barriers such as poor information availability and misaligned incentives between tenants and landlords.[97] Submetering these spaces and requiring building owners to inform tenants about their energy consumption gives tenants the information they need to track and reduce consumption.

While submetering alone does not reduce energy consumption, it is an important step in providing visibility into tenant- and system-level energy consumption in a building, and allowing market actors to make informed operational and capital investment decisions. Research by commercial real estate practitioners indicates that submetering tenant spaces can contribute to reducing building energy costs by more than 20%. Residential submetering is also important to allow residents to capture the benefits of more efficient behavior and appliances.

It should be noted that this action can be particularly sensitive—and important—for affordable housing. As buildings increase in their efficiency toward net-zero energy levels of performance, developers of affordable housing must be able to provide a reduced utility allowance and proportionally increase the rent. However, the District should ensure that the net level of affordability for the tenant remains the same.

Details: The District should take several steps to phase in incentives and later requirements related to submetering to secure the energy saving-benefits of submetering. The following sequence will ensure that adequate infrastructure is in place and that owners will have sufficient time to prepare for and respond to requirements.

First, submetering should be added to the list of equipment that the DCSEU is able to incentivize. Currently, standard rebates are only available for certain types of equipment, such as lighting, HVAC, refrigeration, and food service, among others. In order to reduce the upfront cost of installing submeters, incentives should be expanded to potentially include hardware and installation costs for installing submeters. In addition, the DCSEU should provide training to building contractors, designers, and operators on the purpose, installation and use of submeters to promote energy efficiency. As discussed in Action EB.3, the DCSEU must receive credit for the savings associated with the installation and operation

[95] Base building systems such as heating and cooling, common area lighting, and elevator operations make up the other portion of commercial building energy use.

[96] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. Energy Efficiency in Separate Tenant Spaces – A Feasibility Study. April 2016. http://energy.gov/sites/prod/files/2016/04/f30/DOE%20-%20Energy%20Efficiency%20in%20Separate%20Tenant%20Spaces_0.pdf (p.1)

[97] Ibid.

of submeters and any associated equipment. Alongside incentivizing submetering in existing buildings, the District's building codes should also include submetering requirements for new construction and renovation. This will ensure that all newly constructed and renovated spaces will be submetered, and will phase-in submetering over time with the construction and renovation cycle.

Once a broader market share for submetering is established (i.e., a minimum of 10 years), the District should investigate a submetering policy similar to New York City's Local Law 88. Along with requirements for lighting upgrades in large non-residential buildings, LL88 includes a provision that requires non-residential building owners to install electric submeters for their non-residential tenants, providing monthly energy statements to those tenants.[98]

The District of Columbia Code §34-1552 *et seq.* already requires the Commission to announce rules and standards for building owners of *nonresidential* buildings to install submetering infrastructure for the purposes of billing tenants for their share of energy consumption.[99] By omission, residential units are not included in this code. In order to realize the energy-saving benefits of submetering in residential spaces, the District Government should therefore legalize the practice of submetering in residential buildings. For rent-controlled buildings, the District Government should work with tenants and landlords to devise and pass legislation to enact a fair and streamlined system of automatically lowering rents when tenants begin to assume utility costs previously born by the landlord.

Next Steps:

- Immediately require the DCSEU to revise their incentive offerings to include submeters as qualifying equipment, and offer submetering training to building contractors, designers and operators within the District as part of its educational curriculum.
- As part of the next building code update, require submetering at new construction and major renovations, and include the latest national model codes and standards.
- By 2018, direct the Public Service Commission to change its regulations to allow for submetering and billing in residential spaces, and include requirements for tenant spaces to be submetered.
- By 2020, enact a new law that requires tenant spaces in all large new buildings to be submetered or separately metered.
- Ultimately, pursue a submetering requirement in all buildings.

CCB.3 Develop a centralized online platform for residential energy efficiency programs

Action: Create a centralized online platform to provide information on and access to residential energy efficiency programs. Provide resources and information on program offerings, available incentives and financing, and any other useful information for residents, multifamily building owners, and developers.

Relevance: The purpose of this recommendation is to provide educational and informational resources to facilitate the process of accessing and paying for energy efficiency improvements. The District already offers several incentives and programs to make residential energy efficiency actions more accessible and affordable, with additional actions recommended in the CEP. A central resource that provides information

[98] New York City Mayor's Office of Sustainability, Local Law 88, http://www.nyc.gov/html/gbee/html/plan/ll88.shtml.

[99] National Conference of State Legislatures, Utility Submetering, http://www.ncsl.org/research/energy/utility-submetering.aspx

on all available programs will increase the value and use of these incentives and programs by making them easier to access and understand. This will, in turn, help the District to leverage its program investments and generate more private investment in the actions required to achieve its climate and energy targets.

Details: The creation of a single online platform for residential building owners will make it easier for residents, multifamily building owners, and developers to learn about and access energy efficiency programs, incentives, and financing offered by the District. A flexible, commerce-focused resource should be integrated with other building-related resources and incentives to provide a complete package of information, simplifying the process of investing in residential energy efficiency improvement and renewable energy installations.

This platform should be integrated with the DCSEU's existing energy efficiency website.[100] The DCSEU site provides both information and the means to solicit additional information either by phone, online chat, or email. Additional existing DOEE and Department of Housing and Community Development (DHCD) programs that should be integrated include:

- DOEE Weatherization
- DOEE Low Income Home Energy Assistance Program
- DOEE/DCSEU Solar for All Program
- DOEE Healthy Homes Program
- DOEE RiverSmart Homes/Communities
- DHCD Single Family Residential Rehabilitation Program
- DOEE and DHCD Lead Safe Program
- DHCD Home Purchase Assistance Program
- DHCD Employee Assisted Housing Program

To minimize barriers to adoption, the site should be made as intuitive as possible. The first step for this is three separate entry points for the three main targets: residents, multifamily building owners, and developers. Separating the portal into spaces targeting each of these specific groups will improve the likelihood that users stay on the site and take action on the information and programs.

Given their mandate and experience managing their existing energy efficiency website, the DCSEU may be the ideal body for the coordination of this platform. Management could also be coordinated by a similar third party organization, or even the District itself.

Next Steps:

- Contact jurisdictions with similar online platforms to derive insights on the use, perceived effectiveness, and administrative costs of these initiatives in 2016 and early 2017.
- Determine the costs associated with website design, maintenance, and content development, as well as any staff time required in early 2017.

[100] https://www.dcseu.com

- Direct the DCSEU to expand their existing website to include other residential building-focused programs in the District and provide separate platforms for different audiences, or contract a separate arms-length organization to develop the site in 2017.
- Launch the website by 2018.

3.3.1.2 Education and Training

CCB.4 Develop a deep energy efficiency and renewable energy education series

Action: Partner with local organizations to create a local education series about net-zero energy and high performance buildings.

Relevance: Creating a baseline of understanding is foundational to any change. An energy education series can provide a low-cost, low-barrier entryway to engage the local professional community in moving the energy conversation forward. It can also enable a deeper understanding of how designs and technologies work, as well as the broader landscape of innovation.

Details: An example of a local net-zero energy class with high attendance and positive results is the American Institute of Architects' in-depth net-zero energy curriculum offered in Portland, Oregon and Seattle, Washington. Both the ILFI and the NBI also provide net-zero energy education series and webinars. In partnering with such organizations, District Government staff and building and real estate professionals can acquire broader perspectives on national trends and new projects and technologies.

The District should consider hosting multiple series with different topics for different audiences. As cost can be another barrier to entry for such classes, the District should explore options to underwrite the class and/or ensure basic provider costs are met to improve attendance and popularity. Potential topics include:

- The basics of net-zero energy
- Net-zero energy case studies
- Next generation technologies and designs
- Maximizing passive and active energy opportunities
- Financing deep energy efficiency and renewable energy
- Practical considerations: lessons learned from the field

To boost attendance in energy education sessions, the District should also utilize and strengthen existing partnerships with local professional organizations, such as the District of Columbia Building Industry Association, the Apartment and Office Building Association of Metropolitan Washington, the Urban Land Institute Washington, National Capital Region chapter of the U.S. Green Building Council, the American Institute of Architects, the International Living Future Institute's DC Collaborative, and the local ASHRAE chapters.

Next Steps:

- Create a high-performance building and net-zero energy series. Establish an education and marketing partnership in 2017, and hold the series in 2018.

CCB.5 Host energy catalyzation tours

Action: Sponsor local and international tours of examples of deep energy efficiency and community renewable energy provision best practices.

Relevance: There are several examples of innovation in building technology and design across the world. By visiting these innovative projects, District Government staff and leaders can gain a rapid appreciation of where they are headed by learning of existing work and becoming inspired to take quick and deep action. These excursions can also serve to create and deepen personal connections between District Government staff and energy leaders in other parts of the world. There is no substitute for time spent together in an open, creative setting, and seeing inspiring new buildings and communities. Visits like these have been the source of many creative and innovative outcomes.

Details: A working model for this recommendation can be found in the energy and green building tours provided by i-SUSTAIN. In operation since 2004, i-SUSTAIN has a long track record of connecting local leaders with their innovative counterparts in other parts of the world. While the District may wish to lead its own tours, it should also consider contracting or partnering with organizations such as i-SUSTAIN.

A number of local and international destinations represent potential destinations:

- The SEED classroom at the Mary McLeod Bethune Day Academy Public Charter School (District of Columbia)
- The Chesapeake Bay Foundation Brock Environmental Center (Virginia Beach, Virginia)
- Various net-zero energy commercial, institutional, and residential buildings, including the Kern Center, Kellogg House, and Smith Bechtel Field Station (Central Massachusetts)
- The Omega Center (Rhinebeck, New York)
- The Phipps Conservatory (Pittsburgh, Pennsylvania)
- Cascadia Energy Innovation, including the Alexandra District ground source system, Vancouver sewage heat recovery systems, University of British Columbia Center for Interactive Research on Sustainability, Dockside Green, Bullitt Center (British Columbia, Canada and Washington State)
- The 10 million square feet of buildings built to a Passive House standard between 2010 and 2016 (Brussels, Belgium)
- Community sustainability revitalization projects, including very low energy intensity buildings and stringent energy codes (Malmo, Sweden)
- A military base redeveloped into a low carbon community (Freiburg, Germany)

The District should consider covering the educational and logistical costs of setting up these tours, while asking participants to cover their own travel and accommodations. Additionally, the District should explore where private foundation funding might be available to facilitate participation.

Next Steps:

- As part of building local partnerships, organize one of the regional tours listed above.
- Consider arranging a visit by key staff to Brussels and Sweden as a way of learning first-hand about experiences in building code acceleration.

CCB.6 Partner to support subcontractor training and realignment

Action: Actively partner with HVAC and envelope/siding subcontracting unions and trade associations to prepare for a transition to heat pump based systems and high-performance envelopes. Support the creation of a job skills program focused on next generation building technologies.

Relevance: A key element in fostering a transition in the building market is the need to develop a sense of comfort with new designs, products, and construction methods. Contractors and fabricators are highly refined in their production technique and often have little ability to invest time and money into learning about or taking on alternative technologies and approaches. There is therefore a need to support the building and construction industry by providing job training to local residents in new technologies and approaches to building design and operations. These efforts can connect to the District's existing economic initiatives in providing local District residents with important, well-paying jobs that are integral to the community.

Details: To improve the capacity of the local workforce, the District should develop a partnership with a college, technical school or union to hold a technical series on select technologies and approaches, including heat pumps, high-performance detailing, and air sealing performance testing. The University of the District of Columbia offers a potential partner for such a series, while the District can act as a facilitator. Participation should be sought from the local private inspection community, as well as the District's own code and inspection staff.

To expand the development of construction professionals, the District should also identify a technical education partner to undertake specific job training. An existing example of such a program is offered by the Central Community College of Nebraska (Central CC). The Mechatronics high-performance building program offers training on ground source heat pumps, solar electric and solar thermal systems, wind turbines, and efficient switching systems. Other areas of the College also offer classes on high-performance thermal envelopes.

Next Steps:

- In 2016, identify and establish relationships with appropriate education and channel partners.
- In 2017, launch education programming.
- Aim to have the job training program operational by 2018.

CCB.7 Expand existing energy conferences to provide additional focus on net-zero energy buildings

Action: Partner with the DowntownDC Business Improvement District (Downtown BID) to provide additional content on net-zero energy technologies, design, and examples.

Relevance: Conferences and symposia offer another means of bringing industry members together to build a common understanding of high-performance building technologies. Conferences are established forums that can be used to create a sense of community, provide opportunities for networking, and educate the industry.

The Downtown BID has a history of innovation and excellence in high-performance buildings, and has hosted a number of conferences on building energy management and operations in the past, including the 2016 Building Energy Summit. The latest conference in March 2016 included a session on net-zero

energy buildings. However, these could be expanded to include more dedicated content on net-zero energy innovations, including specific tracks on net-zero energy retrofits, building-scale renewable energy systems, and tours of high-performance buildings.

Details: A number of conferences already focus on net-zero and deep energy efficiency. Examples of regional one-day events include the Northwest Ecobuilding Guild, and the Northeast Sustainable Energy Association (NESEA) New York conference. These each receive an average of 200 to 300 participants, and provide good networking opportunities and excellent, hands-on education. Medium-sized overnight conferences, such as the New Buildings Institute *Getting to Zero*, or the ILFI's *Net Positive*, boast an attendance of 300 to 500 attendees. Larger conferences, such as NESEA's *BuildingEnergy*, the ILFI's *Living Future*, and *GreenBuild*, offer a full range of topics and shoulder events.

To hold such an event, the District should work with a local partner such as the DowntownDC BID to hold a single day symposium on energy innovation. Local universities such as Georgetown University or George Washington University have excellent venue spaces that could be provided at low or no cost to the District. The Downtown BID and District Government may wish to consider partnering with a larger organization as well, such as NESEA, NBI, or ILFI to help facilitate programming of top caliber educators, and/or include a national speaker to help build attendance, interest, and program strength.

Next Steps:

- Approach the Downtown BID to create a conference partnership in 2017, targeting an expanded conference in 2018.

CCB.8 Support efforts to integrate energy performance information into residential transactions

Action: Support ongoing green appraisal and green multiple listing service (MRIS) initiatives focused on residential buildings.

Relevance: Home buyers and the professionals involved in home purchases (e.g., real estate agents, residential lenders and underwriters) often have limited understanding of energy and other sustainability performance issues. Only by improving this understanding will they be able to identify relevant issues to make more informed decisions. In DC, efforts are already underway to support the increases in knowledge and capabilities needed for homebuyers and relevant professionals to participate in the shift toward a high-performance building market. The District Government should continue to support these efforts, while taking action to fill in remaining gaps.

Details: To improve the capacity of homebuyers and professionals, the District should take the following actions:

- Continue to support efforts to integrate sustainable features into home and valuation sales process.
- Work with cities across the country, utilities and real estate community to develop new standard for the multiple listing service.
- Consider adopting a transparent home energy scale for residential units (e.g., NEEP Home Energy Labeling Information Exchange).
- Continue green training for appraisers and collaborating with the Appraisal Institute.

- Continue outreach to residential lenders and underwriters to encourage them to be trained to appropriately value sustainable features.
- Support education and collaboration efforts with real estate associations to educate real estate agents on use of green valuation fields.
- Support MRIS and DCRA efforts to encourage agents to use green fields in listings.
- Streamline the process of how consumers acquire data to appropriately value sustainable features of homes.
- Support a follow up study to the Institute for Market Transformation green home valuation study.[101]

Next Steps:

- Assign staff in DOEE and DCRA to take action on the recommendations listed above through 2016 and beyond.
- Conduct annual reviews of these efforts to gauge effectiveness and adjust actions accordingly.

3.3.1.3 Leadership and Catalyzing Change

CCB.9 Create a Mid-Atlantic government leadership group to accelerate market transition

Action: Work with partners to establish a Mid-Atlantic Deep Energy Leadership Group with other leading jurisdictions to help accelerate the market transition toward high-performance buildings.

Relevance: While the District market is substantial, it remains limited in terms of the momentum toward high-performance buildings it can create. Through the creation of partnerships with leading jurisdictions, however, this momentum can be expanded to facilitate the broader transformation of the market. The District already collaborates through the Metropolitan Washington Council of Governments (MWCOG) on energy and climate related work. This coordination can be expanded in both depth with the MWCOG and breadth with larger cities within the Mid-Atlantic region. This would especially facilitate the adoption of code-related elements (e.g., triple-pane windows) by creating a larger market for their use. In bringing other cities, counties, and states into a common regional agenda, the District could greatly facilitate its own transition and likely reduce costs via the creation of a sizeable aggregate product market.

Details: The District should identify partner jurisdictions and begin building a regional action coalition, using the elements of the CEP as a platform. The District already plays a leading role in the Climate, Energy, and Environment Policy Committee of the MWCOG, which can be leveraged to facilitate the adoption of building-related CEP actions by other MWCOG cities.

Collaborations with larger cities in the Mid-Atlantic region such as Baltimore, Richmond, and Philadelphia should also be formed, facilitated by the Carbon Neutral Cities Alliance or a similar organization. By bringing these other cities together, action on several other elements of the CEP could be facilitated. For example, the creation of a more aggressive code update may be easier as a joint effort between jurisdictions in the same climate zone. Regional building energy conferences would enjoy higher levels of

[101] Recommendations from DOEE's Single Family and Small Multifamily Working Group.

participation than those held at the city scale. Similarly, building tours and other educational programs could attract a broader audience if advertised at a regional scale.

A small but compelling example of such a partnership is the Regional Code Collaboration (RCC) in Washington State, led by King County. Over the last several years, the RCC has worked collaboratively to develop an array of draft deep green codes, which RCC members are able to adopt or modify to suit their particular needs. The RCC has also acted as a highly effective center for information and action that recently pushed the statewide adoption of a significantly higher energy efficiency requirement for multifamily buildings. However, while the District can benefit from such a regional coalition, it should not let it limit its own progress. Inter-jurisdictional consensus is always challenging, and the District should maintain its momentum and include other leaders as they are able and willing to join in.

Next Steps:

- In 2016, begin preliminary conversations with potential partner jurisdictions and share the adopted energy plan.
- In 2017, work to establish the actual coalition and begin forming a common agenda

CCB.10 Build examples of breakthrough design in government and/or publicly-financed buildings

Action: Require all significant new construction built or financed by the District to meet 2032 EUI targets, and achieve a net-zero level of performance wherever feasible. Place net-zero energy requirements on surplus properties that are bid out to the private sector for redevelopment.

Relevance: In every sector, the presence of high-profile, visible examples of what is possible helps to rapidly advance sector-wide change. Buildings like the Bullitt Center in Seattle have completely recalibrated the national conversation about what is feasible in a way that building models cannot. Issaquah, Washington's zHome, the first multifamily net-zero energy building in the U.S., has also had impressive catalytic effects. Within two years of the completion of zHome, two other highly energy efficient projects were built only a few miles away.[102] Neither building was required to achieve a high level of performance but was instead responding to local expectations and possibilities.

The District Government has recently begun to include net-zero energy criteria for projects built or financed by the District This groundbreaking approach should be expanded upon and institutionalized to maximize its impact.

Details: Over the next five years, the District should build on the existing net-zero energy criteria in its Request for Proposals (RFPs) process by requiring new construction funded by the District to achieve net-zero energy performance. Through this expansion, the District will:

- Provide leadership by example.
- Create built examples and real-life education platforms.
- Gain substantial internal experience and know-how in the design and construction of advanced energy buildings, building respect within the private sector.

[102] The two buildings are Fire Station 72, the most efficient fire station in the world, and the Swedish Regional Medical Centre, one of the most efficient regional hospitals in the United States with an observed EUI of 108.

- Develop financial cost effectiveness analytics based on actual performance.
- Build knowledge in the local design, contracting, and subcontracting communities about advanced energy buildings.

An additional benefit of municipal net-zero energy buildings is their improved resilience to power outages, in that they tend to maintain a more habitable internal temperature in the absence of power.[103] As such, the District may wish to include thorough resilience performance criteria in addition to net-zero energy requirements, emphasizing the possibility of multiple benefits.

The District should also leverage its powers by including net-zero requirements for the properties it brokers for sale. As the kinds of financial information and bid processes necessary for District Government-funded project can differ from those associated with private development, the inclusion of these types of projects will offer more relatable examples of net-zero building processes to private builders. It is important for the District to ensure that the bid design process clearly establishes expectations for design performance. These should be based on a building's projected EUI without plug loads in order to ensure that the core functions of the building (e.g., heating and cooling) operate at the highest possible level of performance. The District may also choose to specify certain components (such as ground source and/or CO_2 based heat pumps) to promote the use of more desirable technologies.

The overall costs of these higher performing buildings should also be similar to what the District itself would have built, providing the District Government the opportunity to share their financial success stories to help move the broader market. A study conducted within the District indicated that the cost premium for highly energy efficient buildings is approximately 1% to 12%, and that achieving net-zero energy performance increases the estimated cost premium to 5% to 19%, depending on building type.[104] However, it also indicated that the total cost of ownership of these buildings (including energy costs) is likely to be lower, depending on interest rates.[105]

For many projects, affordable housing in particular, creating financing tools that allow for incremental increases in first costs is therefore critical to enabling high energy performance. With their long term payback structure and low interest, bonds would be an effective net-zero energy finance tool, particularly as the increase in bonded amount and monthly payment is typically less than the saved energy costs.[106] Upon project completion, financial data should be documented and reported by the District Government to help tell the story of the District's transition to net-zero buildings.

Finally, the District should maximize the visibility and thus the educational benefit of existing high performance facilities. The DC Department of General Services' BuildSmartDC website is the current forum to find information on the District's existing cohort of high performance buildings. However, little information on each building is actually provided. Moreover, the site itself is difficult to find. To raise the profile of these exemplary buildings, each one should be cross-referenced across various District

[103] Wilson, A., 2015, Icebox or Oven - What Happens to Interior Temperatures When the Power Goes Out.

[104] Net Zero and Living Building Challenge Financial Study: A Cost Comparison Report for Buildings in the District of Columbia, 2013, http://doee.dc.gov/sites/default/files/dc/sites/ddoe/service_content/attachments/20140411_Net%20%20Zero%20and%20Living%20Building%20Challenge%20Study_FINAL.pdf

[105] Matthiessen, 2012, The Power of Zero report; Maclay, 2014, The New Net Zero.

[106] Matthiessen, 2012.

Government websites, which should in turn be optimized for the easy location of building information using standard search engines.

The existing cohort of high performance buildings can also be highlighted using tours, case studies, or similar marketing efforts. Openings of future high performance District Government buildings should coincide with community green living festivals, and should feature in any tours conducted for industry professionals. Public access to key design elements should be facilitated wherever possible. The District may also want to consider turning these buildings into sustainability hubs by locating key energy and environmental programs into their spaces, including DOEE and/or the DCSEU.

Next Steps:

- Immediately begin efforts to use the District's high performing buildings for education and market catalyzation activities.
- In early 2018, adopt a policy requiring all future facilities built or partially funded by the District to achieve 2032 EUI targets and include appropriate resilience measures. Where practical, all new buildings should be required to meet net-zero energy standards. The most immediate upcoming projects should have a preliminary assessment of potential net-zero energy opportunities and strategies.

CCB.11 Use benchmarking data to create a catalog of best-in-class performers

Action: Use available energy performance benchmarking data to identify and highlight the District's best-in-class energy performers.

Relevance: Since 2012, the District's energy benchmarking disclosure program has required the reporting of energy performance by buildings of a certain size and type. This program has created a valuable database of information on building performance that can be used to identify the District's building energy leaders. This group of top performers can then be used as case studies to set new benchmarks for energy performance in the District. They also offer inspirational examples that can be used in education and outreach efforts.

Details: The steps required to create a group of building energy leaders are straightforward. First, the top performing buildings in each building use type (office, multifamily, institutional, etc.) should be determined. Additional data about these buildings should be obtained to create short case studies of each one, including submetering data and technical information on their design, equipment, and technologies. These can then be compared to top performers at national and international levels to derive a sense of where the District's top performers sit relative to their peers.

Particularly high performers (for example, office buildings that use less than 35 kBtu/ft^2/year of energy) should then be highlighted through the various forums recommended in this chapter.

Next Steps:

- In 2016, perform an initial assessment of best-in-class buildings using energy performance information from the benchmarking dataset, and begin obtaining case study information.
- In 2017, require buildings' Target Finder scores to be published as soon as they have been determined during the development process. Once an ENERGY STAR® score is received, it will be published as well.
- In 2017, require building energy models to use standardized and realistic assumptions for key factors such as occupancy, set points and plug loads. Specify these assumptions by referencing one or more national and publicly available sources, such as the COMNET Modeling Guidelines and Procedures.[107]

CCB.12 Create home and business of the future tours and energy events

Action: Collaborate with local organizations to co-sponsor and organize in-depth tours and energy events at new and remodeled net-zero homes and small businesses.

Relevance: Providing an inspiring forum for engagement can provide momentum and support for the District's energy targets and help foster an increase in small actions taken by District residents and employers alike. Actions of this nature were already taken by the District Government when it hosted a design competition for a potential net-zero energy townhome development using a surplus site owned by the District. Such processes should be accompanied by other, broader events that engage a larger portion of the District's population.

Details: The District should partner with local groups to create a Buildings of the Future open house series in the following categories:

- Remodeled Townhome
- New Townhome
- Tenant Improvement – Restaurant
- Tenant Improvement – Office
- Tenant Improvement – Retail

Similar approaches have proven highly successful elsewhere. A major component of Issaquah's zHome project was a nine weekend-long open house of three of the ten net-zero townhomes. A fourth unit was dedicated entirely to the promotion of energy rebates, home improvements, and incentives. Approximately 30 tour docents were trained on the history and design of the homes, including the technologies that were used and the levels of energy efficiency that were achieved. The project was well-publicized through a network of project partners, including the City of Issaquah, King County, local utility Puget Sound Energy, and Built Green, the regional green building council. For example, Puget Sound Energy included a profile on the open houses in their bill inserts, while local media coverage was gained through the Seattle Times, local NPR stations, local TV stations, and the Issaquah Press. 10,000 people participated in the zHome tours over the period of the open house. The general sense among all

[107] http://comnet.org/download-pdfs-mgp-manual

participants was that the event served to catalyze the professional building and design community while building awareness of climate solutions and energy use reduction actions among visitors.

Such projects and programs take a significant commitment of time and resources; however, partnering with other organizations can help to distribute costs and responsibilities. A key factor is the identification of an appropriate partner to act as a project developer. Such a partner can be enticed by the marketing and exposure opportunities that their participation will provide. A memorandum of understanding should be used guide their participation, as well as a binding contract.

Next Steps:

- In 2016, investigate potential partners and avenues for a Buildings of the Future tour.

CCB.13 Implement a high performance energy media, outreach, and communications strategy

Action: Create a narrative of success in addressing climate change and fossil fuel independence in the building sector as a core element of the District Government's media and outreach strategy.

Relevance: Connecting communications about the need for basic energy efficiency and renewable energy with the success of early examples of net-zero energy buildings can create a virtuous cycle of achievement. As examples of high performance buildings become well-known and understood, demand for more examples can increase. Individual homeowners and office tenants will both seek higher levels of efficiency in their homes and places of work.

Details: The District is uniquely positioned near major media channels such as National Public Radio, The Washington Post, and bureau offices of nearly every major media network. Many of these organizations have dedicated coverage on climate-related issues. For example, The Washington Post hosts a section on their website called The Climate Agenda, which covers the latest science of climate change and presents solutions to the climate crisis. The District Government itself also has a strong tradition of excellent communications to its residents via the District website and other forms of digital outreach.

The District Government should build on these existing forums by creating a targeted media that combines positive success stories with information about energy incentives and opportunities. Stories on District residents and businesses who have engaged in net-zero energy buildings should be presented in a narrative and accessible form, on topics such as:

- What it is like to live in a net-zero energy home.
- How much it costs to achieve net-zero energy performance and what incentives are available.
- How to invest in renewables.
- How a building can be retrofitted to achieve net-zero energy performance over time.

These stories should include practical information about the basic things that residents and businesses can do to incrementally improve energy performance, such as LED retrofits, insulation, home sealing, PV installation, etc. along with any appropriate incentives.

A critical element of these communications is the need for a simple message accompanied by quality infographics and images that tie small actions to financial and environmental impacts. Government-led energy communications can often be dry and overly technical; instead, messaging that emphasizes

interesting advances in technology, innovation, and thoughtful lifestyles of integrity can resonate much more powerfully.

Next Steps:

- In 2016, create a short term media strategy for specific stories related to energy innovation and efficiency. Establish strong coordination between DOEE and District Government communications to ensure stories are told as part of a larger narrative of change.

CCB.14 Provide a Sustainability Award for climate and energy solutions leadership in buildings

Action: Expand the District's Sustainability Awards to include a dedicated annual award to the person or organization in the District who has done the most to reduce fossil fuel use from buildings.

Relevance: Awards are a simple but powerful way to recognize leadership. They take little time and require few financial resources, but can have a powerful influence on the recipients and their community. The District of Columbia has offered Sustainability Awards to sustainability leaders across the District since 2009. However, current award winners represent a diverse array of sustainability-related issues. By establishing a dedicated award for leadership on climate solutions, the importance of climate action will become clear.

Details: The presentation of an award sends a strong signal around the importance of leadership. Such an award could be presented at an annual conference as a way of building excitement and fostering competition. Awards are frequently covered by local media and marketed separately by their recipients, amplifying their impact.

Next Steps:

- Develop and present an award in conjunction with first regional energy conference starting in 2017.

CCB.15 Establish net-zero energy leadership cohorts

Action: Establish building energy leadership groups made up of prominent and forward-thinking design and construction industry members.

Relevance: A key element of any movement is leadership. Individual leaders working within organizations are often responsible for driving agendas forward and making change. Pulling these leaders together, recognizing their contributions, and uniting them around a common understanding and strategy could greatly accelerate forward movement on energy efficiency and renewable energy. These leadership cohorts should coordinate closely and share membership with (or be subcommittees of) the District's Green Building Advisory Council and the Green Building Technical Advisory Group to the District's Construction Codes Coordinating Board (CCCB).[108]

Details: Leadership cohorts should be established in conjunction with local partner organizations in the respective categories of existing buildings, new construction, and renewable installation. Under new construction, both the local chapter of the U.S. Green Building Council and the DC Collaborative of the ILFI

[108] http://dcra.DCgov/service/construction-codes-coordinating-board

could provide partner organizations for supporting regular (i.e., quarterly) meetings for developers and designers to come together to discuss and cooperate on a future energy agenda.

Next Steps:

- In 2016, establish partnerships with one or two leading organizations dedicated to advancing deep energy efficiency in new construction.
- Use the existing Green Building Advisory Council (GBAC) to act as a sounding board and advocate for deep energy efficiency acceleration in the District.

3.3.2 Cross-Cutting Building Actions Roadmap

		The Five-Year CEP					Projected Path to 2032 Climate and Energy Targets										
Cross-Cutting Building Actions	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Policy and Program Recommendations																	
CCB.1 Increase code compliance in all buildings through Smart Code Enforcement																	
CCB.2 Incentivize and require submetering																	
CCB.3 Develop a centralized online platform for residential energy efficiency programs																	
Education and Training																	
CCB.4 Develop a deep energy efficiency and renewable energy education series																	
CCB.5 Host energy catalyzation tours																	
CCB.6 Partner to support subcontractor training and realignment																	
CCB.7 Expand existing energy conferences to provide additional focus on net-zero energy buildings																	
CCB.8 Support efforts to integrate energy performance information																	
Cross-Cutting Building Actions																	
CCB.9 Create a Mid-Atlantic government leadership group to accelerate market transition																	
CCB.10 Build examples of breakthrough design in government and/or publicly-financed buildings																	
CCB.11 Use benchmarking data to create a catalog of best-in-class performers																	
CCB.12 Create home and business of the future tours and energy events																	
CCB.13 Implement a high performance energy media, outreach, and communications strategy																	
CCB.14 Provide a Sustainability Award for climate and energy solutions leadership																	
CCB.15 Establish net-zero energy leadership cohorts																	

Legend	
Planning, Research, and Program and Policy Development	
Plan or Program Implementation	
Policy or Regulation Implementation	
Pilot Project	
Program Evaluation	

4 ENERGY SUPPLY SYSTEM

In this chapter, recommendations are provided for two areas related to the District's energy supply system: actions to increase the supply of zero GHG energy (Section 4.1) and actions to modernize the electricity system to ensure it is capable of supporting this supply (Section 4.2). Both sets of recommendations are summarized into individual roadmaps at the end of the chapter that can be used by the District to guide their implementation over the five-year span of the CEP, as well as future actions to 2032.

4.1 Clean & Renewable Energy Supply

4.1.1 Existing Policies and Actions

An important component to meeting the District's GHG reduction targets is to significantly increase the share of renewable energy in the District of Columbia's energy supply. To this end, the District has set a target to ensure that 50% of the energy used in the district will be supplied by clean and renewable sources by 2032.[109] In support of these targets, the District Government has implemented a broad set of tools and programs to 1) increase renewable energy supply, both within and outside the District; 2) foster demand for PV and other renewable energy systems, and; 3) adjust planning and policy in support of these objectives.

4.1.1.1 Energy Generated Outside the District

The District receives over 99% of its energy from sources outside its borders. While the majority of this energy is generated from conventional sources such as natural gas, coal, and nuclear, a growing portion of this power comes from renewable sources, including solar and wind. The District's primary renewable energy policy for utility-supplied energy is its Renewable Portfolio Standard (RPS), a citywide mandate intended to increase the total proportion of renewable energy sold by electricity suppliers to customers within the District. As of July 2016, the RPS requires 20% of District electricity to come from renewable sources by 2020 (including 2.5% from local solar systems by 2023) and 50% by 2032 (including 5% from local solar systems).[110] Pepco (in its role as a Standard Offer Service provider[111]) and competitive suppliers can comply with the RPS through one or a combination of pathways:

1. Procure new renewable energy generation;
2. Purchase renewable energy credits, or solar renewable energy credits (for the solar requirement), or;
3. Make alternative compliance payments.

[109] Sustainable DC Plan, 2012, p.11

[110] Renewable Portfolio Standard Expansion Amendment Act of 2016.2015 Quarterly State of the Market Report for PJM: January through March, p.248, http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2015/2015q1-som-pjm-sec8.pdf

[111] Recall that the Standard Offer Service is the electricity purchased for those District ratepayers who do not choose a competitive supplier for their electricity. This purchase is made by a third party under oversight of the PSC.

Renewable energy credits, or RECs, are tradable certificates that represent ownership of renewable energy generation. The owners of renewable energy generators can choose to retain ownership of the credits attributed to their renewable energy generation, or sell this ownership to another party – in this case, a utility regulated under the District's RPS. Once sold, RECs are retired, meaning that they cannot be used by another party to meet their renewable energy generation targets. This avoids a situation in which RECs are double-counted, or where the quantity of renewable energy generated is accounted for by both the energy generator and any REC purchasers.

To comply with the District's RPS, RECs must be generated within the PJM Energy Market plus adjoining states, while solar renewable energy credits (SRECs) must be generated by a solar system connected to the distribution grid that serves the District. [112,113] These compliance options influence the GHG reductions that the District can achieve and can account for. For example, the 2014 RPS required renewable energy to supply 10.5% of total electricity in the District, whereas Pepco's fuel mix for its Standard Offer Service included only approximately 4.0% from renewables. Pepco thus had to purchase RECs and SRECs and make alternative compliance payments to comply with the RPS requirements.[114] As discussed in Chapter 2, RECs and SRECs cannot be counted as GHG emissions reductions according to the GHG accounting protocol used by the District, and alternative compliance payments do not directly lead to new renewable energy generation nor associated GHG reductions.[115] Therefore, how electricity suppliers comply with the RPS has a significant impact on renewable energy utilization and GHG emissions reductions.

While it is not affected by the RPS, the District's primary natural gas provider has also been active in reducing emissions. In March 2016, Washington Gas became a founding partner in the U.S. EPA's Natural Gas STAR Methane Challenge, a voluntary program focused on efforts to reduce methane emissions and improve air quality. The commitment includes a goal to reduce the GHG emissions per unit of natural gas delivered 18% by 2020 relative to 2008, which the company is on track to achieve.[116]

4.1.1.2 Energy Generated Within the District

Energy generated within the District refers to energy supplied to District customers via on-site generators, such as solar photovoltaic (PV) or combined heat and power (CHP). A 2013 study of the District's renewable energy potential commissioned by DOEE found the technical potential for solar PV generation capacity within the District lies between 1207 and 2000 MW. A more recent analysis by Mapdwell indicates a solar PV technical potential of approximately 1300 MW.[117] This solar PV technical potential may be drastically reduced when considering other limitations, such as suitable roof space, historical preservation, zoning, and other building design priorities such as storm water requirements and green roof spaces. Still, solar PV very likely represents the vast majority of renewable energy generation capacity

[112] PJM Interconnection coordinates the movement of wholesale electricity to meet consumers' demands within the PJM Energy Market, which covers all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. http://www.pjm.com/

[113] Clean and Affordable Energy Act of 2008, http://www.dcpsc.org/pdf_files/customerchoice/electric/CAE_Enrolled_Legislation.pdf

[114] Pepco, 2015, http://www.pepco.com/uploadedFiles/wwwpepcocom/Content/Page_Content/2015/Pepco%20DC%20Env.pdf

[115] Recall from Chapter 2 that the District uses ICLEI's *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions*.

[116] Washington Gas Joins the EPA's Natural Gas STAR Methane Challenge Program as Founding Partner, March 30, 2016, http://www.businesswire.com/news/home/20160330005985/en/Washington-Gas-Joins-EPA%E2%80%99s-Natural-Gas-STAR

[117] Email between DOEE and Mapdwell staff (April 8, 2016).

possible in District.[118] However, only 19.2 MW of solar PV and thermal systems had been installed within the District and certified by the Public Service Commission (PSC) as of May 1, 2016, with an additional 20.4 MW eligible for the RPS' solar requirement and certified by the PSC located outside the District.[119] The difference between installed and potential capacity indicates a significant opportunity for the District to expand the number of local rooftop solar systems.

As noted above, the District Government's expanded RPS now requires 5% of the District's electricity to be derived from local solar systems by 2032.[120] To achieve this target, the District Government has committed to funding renewable energy and energy efficiency projects through two means: the RPS's Sustainable Energy Trust Fund, and via programs such as the DCSEU and Solar for All.[121,122] Other actions that have recently been proposed or are in progress include:

- The development of legislation to reduce fossil fuel consumption and increase opportunities for community solar and renewable energy systems.
- A feasibility study to identify opportunities for community-scale microgrids using renewable energy systems.
- The construction of 1,000 additional residential and commercial renewable energy projects.
- The creation of opportunities to arrange power purchase agreements and install renewable energy systems on government and institutional buildings.[123]

The District also provides a range of financial incentives to encourage solar adoption, including:

- Exemptions of residential solar systems from property taxes.
- Net metering and virtual net metering (via the District's Community Renewables Energy Act of 2013).
- The opportunity to sell SRECs to electricity suppliers regulated by the District's Renewable Portfolio Standard.[124]
- Support in procuring community solar purchases.
- A commercial property assessed clean energy (PACE) program to minimize or eliminate upfront system costs.
- A program for low-income residents that fully subsidizes the cost of installing a solar PV system.

[118] The report's generation potential and cost figures will change as technologies improve, particularly for rooftop solar. GDS Associates for the District Department of the Environment, Renewable Energy Technologies Potential for the District of Columbia, 2013, p.3

[119] Public Service Commission of the District of Columbia, Monthly Update of Solar Generator Certification, retrieved July 27, 2016 from http://dcpsc.datanetusa.com/Electric/Solar_generator_certification.asp.

[120] Renewable Portfolio Standard Expansion Amendment Act of 2016.

[121] Renewable Portfolio Standard Expansion Amendment Act of 2016.

[122] Energy Action 1.4, Sustainable DC, 2012, p.59

[123] Actions 2.1-2.5 of Energy Goal 2, Sustainable DC, 2012; Sustainable DC Second Year Progress Report, 2015, pp.5,10

[124] Solar renewable energy credits (SRECs) are used to meet the solar requirement of the District's Renewable Portfolio Standard and have a higher value than other renewable energy credits (RECs).

With these programs combined, a 5kW system in the District with an upfront cost of $20,000 could be eligible for as much as $9,507 in upfront incentives, and generate a $27,840 profit for the system owner over 20 years.[125]

In addition, the District is actively exploring a requirement for all new buildings to be either net-zero consumers of energy, where all energy required to operate the building is produced on-site, or net-positive, in which on-site renewable energy sources will be required to ensure the building can produce more energy than it consumes.[126] In support of these and other actions (noted below), the District's PSC has initiated investigations into the modernization of its electricity infrastructure to enable the integration of increased local generation. As a part of this endeavor, the District Government will work with local educational and workforce development institutions to train residents for new jobs in the renewable energy and energy efficiency industry.[127]

Finally, the District is also home to DC Solar United Neighborhoods (DC SUN), a community organization that works to expand solar access by educating citizens about the benefits of solar, helping them coordinate group solar installations, and working to strengthen the District's solar policies and programs.[128] DC SUN has played an instrumental role in the installation of solar systems in the District and is coordinating with partner SUN programs in Maryland, Virginia, and West Virginia.

4.1.1.3 Government Leadership

In addition to the policy actions above, the District has demonstrated considerable leadership in renewable energy procurement by sourcing 100% of its own operational electricity from renewable sources. This has been accomplished through the purchase of renewable energy credits, as well as via two 20-year power purchase agreements signed in 2015.[129] Power purchase agreements, or PPA, are contracts between electricity generators (i.e., sellers) and consumers (i.e., buyers) in which a buyer provides the payment stream necessary for a seller to generate the electricity.[130] PPA contracts ensure that electricity generation can be financed in instances where it might otherwise be unfeasible.

The first PPA, signed by the District in 2015, is one of the largest PPA ever arranged by a U.S. municipality, which sources wind power from Pennsylvania to provide approximately 35% of the District Government's energy needs. [131] The second is an arrangement for 11.4 MW of local solar PVs to be installed on the roofs and parking lots of District-owned facilities.[132] It is the largest municipal on-site solar project in the U.S., and will meet an additional 3.5% of the municipal government energy needs.

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[125] Incentives and profits calculated by SolarPowerRocks.com based on estimated incentives and SREC values at the time of calculation, https://solarpowerrocks.com/washington-dc/.

[126] Sustainable DC, 2012, p.54

[127] Actions 3.3 and 3.4 of Energy Goal 3, Sustainable DC, 2012; Sustainable DC Second Year Progress Report, 2015, p.10

[128] http://www.dcsun.org/

[129] Sustainable DC Plan, 2012, p.14; Federal Department of Energy, http://www.energy.gov/savings/green-power-purchasing-1, accessed February 8, 2016

[130] More information on PPAs can be found on the World Bank website: http://ppp.worldbank.org/public-private-partnership/sector/energy/energy-power-agreements/power-purchase-agreements

[131] http://DCgov/release/mayor-bowser-announces-groundbreaking-wind-power-purchase-agreement

[132] Mayor Bowser Announces Largest Municipal Onsite Solar Project in US, http://dc.gov/release/mayor-bowser-announces-largest-municipal-onsite-solar-project-us

As a result of the District Government's leadership, the District leads the country in the EPA's Green Power Community Challenge. As of April 2016, clean energy power purchases now comprise 13.2% of all electricity sold in the District.[133] In recognition of these efforts, the District received a C40 Cities Award for Global Leadership on Climate Change at the COP21 climate change conference in Paris in 2015.[134]

Like other jurisdictions leading the shift to renewable energy, the District has much to build on but will nevertheless require stronger and more coordinated action to achieve its long-term targets. The remainder of this chapter provides a series of short-term actions and long-term policy and regulatory adjustments that the District can quickly implement to advance its renewable energy programs.

4.1.2 Recommended Actions

4.1.2.1 Renewable Electricity Supply from outside the District

CRE.1 Design and manage the RPS to drive renewable energy generation and set a 100% requirement for 2050

Action: Design and manage the current RPS to drive increasing investments in new renewable electricity generating capacity and utilization to maximize GHG reductions and renewable energy utilization. Pass additional RPS legislation to require 100% renewable energy by 2050 at the very latest.

Relevance: In 2016, the District Government adopted a 50% Renewable Portfolio Standard for 2032, including a requirement for 5% of electricity consumed in the District to come from qualifying local solar systems.[135] The new RPS builds on an earlier requirement for 20% of electricity to come from renewable sources by 2020,[136] with at least 2.5% from qualifying local solar PV and thermal systems by 2023 (expected to be approximately 200 MW).[137]

As nearly 75% of GHG emissions in the District come from buildings that get the majority of their energy from electricity,[138] the RPS will play a crucial role in achieving the District's 2032 GHG reduction and renewable energy utilization targets.[139] However, the District's renewable energy target applies to the entire energy supply, not just electricity. Thus, a 50% RPS, while no doubt significant, does not itself achieve this target. Furthermore, the RPS offers three compliance options (discussed in further detail below), only one of which leads to GHG reductions in the District, i.e., sourcing new renewable generation. Therefore, to maximize the effectiveness of the RPS and achieve the District's 2032 targets, the District

[133] EPA Green Power Partnership, Community Profile, Washington, DC, https://www.epa.gov/greenpower/green-power-communities, accessed May 30, 2016

[134] DC.gov, 2015, http://DC.gov/release/district-columbia-receives-c40-cities-award-global-leadership-climate-change

[135] Renewable Portfolio Standard Expansion Act of 2016.

[136] 2015 Quarterly State of the Market Report for PJM: January through March, p.248, http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2015/2015q1-som-pjm-sec8.pdf

[137] DC Green Building Fund Report: Green Bank, Carbon Pricing, & Deep Retrofit Incentive Study, 2015, prepared by the Coalition for Green Capital, Capital E and the Center for Climate & Energy Solutions

[138] 2011 District of Columbia Greenhouse Gas Inventory, http://doee.DC.gov/sites/default/files/dc/sites/ddoe/publication/attachments/GHGinventory-1205-.pdf

[139] Sustainable DC, 2012

Government should adopt a higher future RPS requirement and must take steps to drive electricity suppliers to comply by supplying new renewable energy to electricity consumers in the District.

Details: The recent strengthening of the new RPS requirement (50% by 2032) is in line with some other leading states, including New York and California (both 50% by 2030).[140] This is a positive step toward the energy supply system change required to achieve its 2050 GHG reduction target of 80% lower emissions.

Moving forward, the District will need to continue increasing the RPS requirement while designing and managing the RPS to cost-effectively maximize GHG reductions and renewable energy increases. Cost-effectiveness is important both to avoid unnecessary costs for consumers and to manage the limited resources available to implement and comply with the District's climate and energy programs and policies. In particular, the District Government should evaluate the costs of the current RPS' local solar requirement (5% of the District's electricity by 2032) versus the costs of procuring renewable energy from other sources. The District Government has directed the PSC to analyze the District's ability to achieve the 5% local solar requirement, so there exists a short window of opportunity in which to affect the design of the current RPS. Most of the recommendations below focus on using this window of opportunity to maximize the RPS's impact on the District's 2032 targets. The recommendations are based in part on analyses that other states conducted prior to adopting their own RPS requirements. Some of these items can be informed by previous and ongoing work being done by the District and Pepco.

Compliance Options: As introduced in Section 4.1.1.1, retail suppliers can comply with the RPS through a combination of (1) sourcing new renewable energy generation, (2) purchasing renewable energy credits (RECs) or solar renewable energy credits (SRECs), for the solar requirement, and (3) making alternative compliance payments (ACPs). Each compliance option has a different impact on actual GHG emissions and the GHG emissions reductions that the District can account for under the GHG accounting and reporting protocol used by the District and many other cities in the U.S.[141]

As discussed in Chapter 2, ICLEI's *U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions* requires the District to calculate its GHG emissions based on the GHG intensity of the electricity transmitted to and distributed within the District, and prohibits the use of RECs to account for GHG emissions reductions. As such, the District cannot account for GHG emissions reductions where electricity suppliers comply with the RPS using RECs. Similarly, the District does not necessarily achieve any GHG reductions where electricity suppliers comply with the RPS using ACPs. Although the funding provided to the District Government through ACPs is used to invest in renewable energy generation and other actions to meet the District's 2032 targets, there is not enough data to determine how funding collected through ACPs translates to new renewable energy generation. This makes it difficult to calculate how much GHG emissions could actually be attributed to ACPs.

As a result, the GHG reduction impact of the RPS will depend significantly on how energy suppliers choose to comply with it. The District must therefore consider how to design the RPS to increasingly push suppliers to comply by directly purchasing bulk renewable generation and installing new renewable

[140] State Renewable Portfolio Standards and Goals, Jan 15, 2016, National Conference of State Legislatures, http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx

[141] Like many other U.S. cities, the District uses ICLEI's *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*, http://www.ghgprotocol.org/city-accounting.

energy generation connected to the District's grid, and steadily shift away from compliance via RECs/SRECs and ACPs. Potential levers include:

- Narrowing compliance options over time.
- Increasing the cost of ACPs.
- Collaborating with suppliers to finance renewable energy generators.
- Coordinating other PJM Energy Market states to increase the number of cost-effective renewable energy generation opportunities (relative to other energy source options).

Costs: Shifting to clean and renewable sources of electricity is critical to achieving the District's 2032 and 2050 GHG targets. As such, the District should determine how best to design and manage the RPS to minimize costs for ratepayers and taxpayers. The PSC's *Report on the Renewable Energy Portfolio Standard for Compliance Year 2015* notes that electricity suppliers generally comply with the RPS by purchasing renewable energy credits, while ACPs tripled between 2014 and 2015 ($6.3 million vs. $19.9 million).[142] This suggests that RECs and ACPs currently offer less expensive ways to comply than sourcing new renewable energy. This is particularly true for local solar energy systems, where a shortage of certified solar systems, and thus SRECs, is driving electricity and suppliers to pay ACPs to comply with the RPS' solar requirement. This trend is expected to increase.

Over the long-term, the rapid growth and steep cost declines in renewable energy generation will make it difficult to determine compliance costs and their potential impacts on ratepayers and taxpayers. The direct costs of using and maintaining a renewable energy-dominated electricity system could be either higher or lower than the current business-as-usual path. However, the indirect costs of climate change vastly overwhelm any investment in transitioning the energy system. For example, a 2015 analysis by Citigroup found that overhauling the global power market to mitigate climate change requires an additional undiscounted cost of $1.1 trillion between 2015 and 2040.[143] Even with these costs, the total projected spend on energy (including capital and fuel costs) is estimated to be $1.8 trillion lower that business-as-usual costs over that time period. For comparison, Citigroup finds inaction on climate change results in $44 trillion in lost GDP if average global warming reaches +2.5°C (versus pre-industrial levels). This does not include costs related to population displacement, infrastructure investments required to adapt to climate change, and other costs due to climate impacts. As such, the District must move forward with strong renewable energy policies, while identifying ways to minimize the cost burden.

Other Areas for Study: Other potential issues the District may wish to investigate should be narrowed down to a list of urgent items to be completed by February 2017. These investigations should be scheduled to occur during annual RPS Working Group discussions and engage with other states that rely on electricity from the PJM Energy Market. Issues of interest that could be studied include:

- Determining how much of the District's solar PV technical potential, as estimated in the 2013 Renewable Energy Technologies Potential study, can be realized given all constraints. This study could also estimate the cost-effectiveness of installing different levels of this realizable potential.

[142] Public Service Commission of the District of Columbia, Report on the Renewable Energy Portfolio Standard for Compliance Year 2015

[143] Citigroup, *Energy Darwinism II: Why a Low Carbon Future Doesn't Have to Cost the Earth*, http://climateobserver.org/wp-content/uploads/2015/09/Energy-Darwinism-Citi-GPS.pdf

- Alignment with and establishment of related programs to support project financing, reduce compliance costs, provide price stability (for both consumers and suppliers), strategically upgrade the grid, and encourage demand.
- The continued role of a solar-specific requirement, as well as the role that in-District solar can play in meeting other District objectives (e.g., cost-effectiveness, equity, local economic development, grid reliability).
- The role that existing low carbon (but not renewable) electricity sources can play in bridging the transition to a renewable electricity system. For example, consider the role of existing nuclear facilities (35.6% of the PJM System Mix in 2015[144]) as the priority non-renewable resource to be maintained during the transition to 100% renewables.
- How best to encourage private investment, promote business model innovation, and reduce costs (e.g., market mechanisms, government purchasing power, roles for a green bank).
- How to determine alternative compliance payments, how and how often to review them, and what to do with the funds (e.g., support renewable energy deployment, reduce cost burden on consumers).
- The level and type of investments needed to modernize the electricity system to integrate renewable energy generators, ensure reliability, increase resilience, and maintain cost-effectiveness. The District will likely need to consider the grid both within the existing distribution system, including microgrids, and the larger transmission system shared with neighboring states where electricity is generated. Grid modernization issues are discussed in more detail in section 4.2.
- The potential of different approaches to mitigate grid impacts through coordinated supply curtailment, energy storage, supply diversity, advanced demand response (i.e., can adjust demand both down and up as necessary), and regional coordination. This work will likely need to be done in phases as the RPS requirement increases and different approaches to mitigate grid impacts are tested by the District and others.
- Leading up to decarbonization, how the RPS can be designed to drive only strategic investments in fossil fuel-based energy sources like natural gas, such as facilities that can be used to meet peak demand in medium-term and support grid resilience objectives in the long-term.
- The potential for energy storage (both within and outside of the District) to increase the proportion of electricity consumed from renewable sources.
- The need for coordination with other PJM Energy Market states regarding potential competition for renewable electricity sources as states increase RPS requirements.
- How to balance regulatory stringency with flexible and alternative compliance options.
- The structure and scope of regular RPS reviews to account for potential issues related to oversupply, grid impacts, and technology and market developments.

These studies should be aligned with existing and future initiatives focused on improving grid resilience, protecting critical infrastructure from power outages, building microgrids, and integrating local electrical and thermal generating capacity (e.g., FC1050 Investigation of Interconnection Standards, FC1130

[144] PJM System Mix By Fuel – 01/2015 to 12/2015, https://gats.pjm-eis.com/gats2/PublicReports/PJMSystemMix/Filter

Investigation into Modernizing the Energy Delivery Structure for Increased Sustainability). See section 4.2 for a more detailed discussion of electricity system modernization.

While the process should be co-led by the District Government and the PSC, the development of increased RPS requirements may require the involvement of other key actors. These may include Pepco, neighboring states in the PJM Energy Market, other District agencies and staff involved in related electricity initiatives, and consultants with expertise in the impact of renewable energy on grid operations, critical infrastructure needs, and cost implications.

Coordination with Other States: The District should ensure regular coordination with other PJM Energy Market states regarding the strategic growth of renewable electricity generation and the ability of the grid to manage this generation. As other PJM Energy Market states increase their demand for renewable energy (e.g., through the use of their own RPS), jurisdictions dependent on electricity sources located in or used by other states may be faced with a limited situation where demand is greater than supply, but all regions have a shared goal of cost-effectively reducing GHG emissions. Furthermore, renewable energy generating capacity may be located in areas without the transmission line capacity needed to send to power to large demand centers. To pre-empt challenges associated with these sorts of situations, the District should lead the development of a committee consisting of stakeholders from states, energy suppliers, and related organizations (including PJM) that work to cooperatively and cost-effectively increase the availability and accessibility of renewable energy on the grid in line with state RPS goals. This committee – the PJM State Electricity System Transformation Committee – can also share information and resources to help each state transition to a low carbon electricity system over the long-term.

A 2050 RPS Requirement: Finally, to send clear signals to the market regarding the long-term energy supply system changes that must be achieved, the District Government needs to legislate a long-term renewable energy requirement. For electricity, the District Government should do this by adopting a 100% RPS requirement for 2050 and designing the RPS to allow a lower portion of requirements to be met be RECs and ACPs each year, until the RPS can be met only by procuring renewable energy. This will align the District with states that are more increasingly focused on the need to eliminate fossil fuels from their electricity system, including Hawaii (100% by 2050) and Vermont (75% by 2032).[145]

[145] State Renewable Portfolio Standards and Goals, Jan 15, 2016, National Conference of State Legislatures, http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx

Next Steps:

- Immediately announce the District's intention to adopt a 100% RPS for 2050.
- Direct District Government staff and the PSC to complete priority studies before February 2017 to ensure there is an opportunity to revise the design of the current RPS. Priority studies should be selected from the list above, but must explain how to drive electricity suppliers to comply by supplying increased renewable energy and the implications this could have on alternative compliance payments, and thus the District Government's renewable energy program funding.
- After February 2017, schedule and staff the additional analyses and actions listed above to begin within two years.
- By 2018, adopt a 100% RPS requirement for 2050.
- Periodically review pre-determined aspects of the regulation every three to five years and hold regular meetings with the (new) PJM State Electricity System Transformation Committee.

CRE.2 Provide the Standard Offer Service through a long-term power purchase agreement

Action: Sign a power purchase agreements with a renewable electricity supplier and use it to provide the Standard Offer Service for electricity in DC.

Relevance: Alongside the RPS, power purchase agreements (PPAs) are an instrument that the District can use to make significant progress toward its renewable energy and GHG reduction targets. As noted above, the District already signed two PPAs in 2015 to supply approximately 38.5% of the municipal government's electricity demand with wind and solar energy. The District Government realized a drastic reduction in energy costs due to the two PPAs that it signed, which is projected to save the city approximately $75 million during a 20-year period. It is similarly expected that a long-term PPA for the SOS would actualize substantial savings for customers.

Details: The Standard Offer Service (SOS) is the electricity purchased for those District ratepayers who do not choose a competitive supplier for their electricity, and this purchase is made by a third party under oversight of the PSC. Pepco has been providing this service, procuring a 3-year power supply contract through a PSC-approved short-term competitive bidding process. Although the PSC has directed Pepco to buy power for these ratepayers who do not choose a competitive supplier, the PSC is currently reviewing, through Formal Case 1017, whether another entity other than Pepco should be providing this role. In 2015, approximately 24% of electricity consumption in the District, mostly residential ratepayers, was through the SOS.[146] The PSC tracks which electricity suppliers provide power under the SOS contract, and the fuel mix report for the current SOS shows that 59.9% of electricity came from fossil-fuel generation in 2015.[147]

As noted above, a PPA is an agreement between an electricity seller (i.e., supplier) and buyer (i.e., consumer), in which a buyer provides the payment stream necessary for a seller to generate electricity. For suppliers, PPA contracts provide the guaranteed revenue stream necessary to make the electricity

[146] Correspondence with DOEE staff on Aug 1, 2016.

[147] Environmental Information for Standard Offer Service Provided by Pepco, http://www.pepco.com/uploadedFiles/wwwpepcocom/Content/Page_Content/my-home/Pay_Your_Bill/Pepco%20Fuel%20Mix%20DC%204.16.pdf

generation feasible. For buyers, PPA contracts allow the long-term procurement of clean, renewable electricity with no or minimal upfront capital costs (as compared to generating renewable energy themselves). Compared to procuring non-renewable electricity from the PJM Energy Market, a PPA for the SOS would allow the District customers to purchase renewable energy, and thus reduce the city's GHG emissions.

Rather than continuing with the current method of buying electricity for the SOS, the District could supply all or part of the SOS with one or more PPAs signed with renewable energy suppliers. The modelling done for the CEP assumes 80% of the PPA is met by renewable energy with the remainder from the sport market. This would help the District shift a large portion of its electricity supply to renewable, zero-emission sources.[148] Using this approach, customers would be required to opt out of using renewable energy rather than opt in, thereby making renewable energy the default electricity offering. Working through the requirements of the SOS will also ensure the identification and structuring of renewable energy contracts that satisfy the rate and load requirements of customers in the District. The District can then steadily increase the portion electricity sourced from renewable energy generation as renewable energy costs continue to decline and opportunities for new generating facilities increase.

A long-term renewable energy PPA may result in lower electricity rates than the current SOS. If this is the case, the District Government should share the savings to both reduce SOS customers' electricity costs and increase the funding available for other renewable energy and energy efficiency programs. These funds could support the District Government achieve its goal of connecting 100,000 low-income households to solar power and cutting their electricity bills in half by 2032. [149] These funds can also help make up for any lost funding from RPS alternative compliance payments as the District Government steadily reduces the portion of the RPS requirements that can be met by RECs, SRECs, and ACPs.

Next Steps:

- Immediately begin investigating PPA contract opportunities that can satisfy the rate and load requirements outlined by the District's SOS program.
- Set a medium-term target to meet a certain portion of the Standard Offer Service through PPAs with renewable energy generators.
- Aim to sign the first PPA agreement in 2017 or as early as practicable for transition from the existing SOS contracts.
- Where the PPA results in lower electricity rates, use a portion of the savings to fund additional renewable energy and energy efficiency programs.

CRE.3 Enact legislation that sets a maximum GHG intensity for electricity supplied to the District

Action: Pass legislation requiring energy suppliers to avoid buying electricity that exceeds a certain GHG intensity threshold (i.e., GHG emissions per unity of energy). Design legislation to steadily increase

[148] In other jurisdictions, the bulk purchase and sale of renewable electricity by a municipality is referred to as community choice aggregation and must be approved by the state government. In this case, the District Government is effectively the state and municipal government, allowing the District Government to secure a PPA directly and supply it to local consumers. The U.S. Department of Energy describes community choice aggregation (CCA) at http://apps3.eere.energy.gov/greenpower/markets/community_choice.shtml.

[149] Mayor Bowser Signs Renewable Portfolio Standard Bill into Law, July 25, 2016, http://mayor.dc.gov/release/mayor-bowser-signs-renewable-portfolio-standard-bill-law

requirements over time, shifting the District's non-renewable electricity supply to less GHG intensive generators.

Relevance: The District's current RPS seeks to shift the District's electricity supply toward a portfolio of generators dominated by clean, renewable energy. As a complement to the RPS, the District should focus on avoiding the purchase of electricity from those generators that emit large quantities of GHG emissions per unit of energy. This will support the District in achieving its 2032 GHG reduction target by strategically eliminating the largest sources of GHG emissions in the District's electricity system.

Details: The purpose of this recommendation is to set a maximum allowable GHG intensity for all electricity delivered to the District, and establish a timeline for compliance by electricity suppliers. It applies to all electricity supplied to the District (both new and current generators), but begins by targeting the largest sources of emissions per unit.

Regulations of this kind have already been adopted by a few jurisdictions in North America, including Ontario (Canada) and Oregon. In 2003, the Province of Ontario committed to phasing out all coal-fired generation using a collaborative approach designed to address system capacity, reliability, flexibility, labor, and cost-effectiveness.[150] Between 2003 and 2014, the use of coal-fired electricity declined from 25% of Ontario's electricity to a full phase-out, while nuclear generation increased from 42% to 60%.[151] In 2016, Oregon announced a similar program to phase out coal-based electricity by 2030.[152] Under the same legislation, the state increased its RPS to require 50% of all electricity sold to customers to be sourced from clean, renewable sources by 2040. A similar program has been announced by the State of New York, which intends to phase out coal by 2020 but has not yet enacted any legislation.[153] Ontario and Oregon differ from the District in that they were able to regulate coal-fired electricity generated within their jurisdictions, whereas the District can only use the power of the purse when it comes to procuring electricity from other states. However, these experiences can provide valuable lessons to help guide the District in designing and managing this regulation.

The District should first enact legislation requiring that all electricity purchased to serve District customers meet a GHG intensity/emissions standard. Such a measure will significantly help in meeting the District's GHG targets by disincentivizing electricity generated through traditional fossil-fuel combustion. In 2015, approximately 36.5% of electricity generated in the PJM territory came from coal-fired power plants, down from approximately 43.5% in 2014 and 44.5% in 2013.[154] It is unknown at this time how much of this was delivered to the District.

The District does not have electricity generation plants within its borders so is not regulated by the federal Clean Power Plan. A GHG emissions standard for electricity supplied to the District would, however, have a similar effect as the Clean Power Plan in that both drive down the GHG emissions intensity of the overall electricity supply. While the GHG intensity of electricity supplied from other states to the District will

[150] The End of Coal, Ontario Ministry of Environment, http://www.energy.gov.on.ca/en/archive/the-end-of-coal/

[151] The End of Coal, Ontario Ministry of Environment.

[152] Senate Bill 1547, Oregon Legislative Assembly, https://olis.leg.state.or.us/liz/2016R1/Downloads/MeasureDocument/SB1547/Enrolled

[153] NY gov aims to phase out coal by 2020, The Hill, http://thehill.com/policy/energy-environment/265786-ny-gov-aims-to-phase-out-coal-by-2020

[154] PJM System Mix By Fuel, https://gats.pjm-eis.com/gats2/PublicReports/PJMSystemMix/Filter

decline due to the Clean Power Plan, enacting an emissions standard will give the District greater control over the impact of grid cleaning efforts. Additionally, the District can reduce the emissions intensity of electricity sooner than states regulated under the Clean Power Plan, which does not begin until 2022 and will not achieve the mandated emissions intensity reductions until 2029.

Furthermore, the District should carefully consider the role of natural gas in the District's electricity supply and its potential impact on the achievement of its GHG emission reduction targets. While natural gas can be less GHG intensive than coal if methane leakage is properly managed, the GHG intensity of natural gas is still much higher than renewables. Shifting from coal-fired generation to natural gas facilities may decrease GHG emissions in the short-term; however, the useful life of natural gas facilities (30 to 40-plus years) may lock the District into an electricity supply infrastructure that is incongruent with the 2050 GHG target.

The District should therefore ensure that any energy supply needed to replace traditional fossil-fuel generation align with the District's 2050 GHG target of 80% emissions reductions. To this end, what is needed is a maximum GHG intensity regulation that steadily declines and forces a transition to lower-emissions energy sources over time. The District should additionally encourage and coordinate with the PJM states to ensure that such a GHG intensity regulation for electricity does not simply shift the consumption of coal-fired and other high GHG intensity generators from supplying the District to supplying other jurisdictions, which is also known as leakage. However, if coordination is unsuccessful, the District should nevertheless move forward with its own plans with the hope that other jurisdictions will pursue stronger climate and energy policies.

Next Steps:

- Immediately announce a plan to legislate the maximum GHG intensity regulation as soon as possible.
- Investigate the potential impacts of the maximum GHG intensity regulation on system capacity, reliability, flexibility, and the cost-effectiveness of energy.
- Continue engaging the PJM states regarding how to steadily shift to less GHG intensive resources, and promoting only strategic use of natural gas in such a way that it aligns with 2050 GHG targets (could be the same as that set up to coordinate on RPSs).
- Direct DOEE to develop energy supply scenarios out to 2050 that achieve the District's 2050 GHG target or eliminate GHG emissions altogether.
- Enact legislation by 2020.

4.1.2.2 Renewable Electricity Supply within the District

CRE.4 Develop a centralized solar information and commerce platform

Action: Create a centralized online platform, a clearing house, to provide information on solar PV and thermal systems and facilitate their adoption. Provide resources and information on the purchase process, available incentives and financing, and any other useful information for citizens, businesses, building owners, contractors, and developers in the District.

Relevance: The purpose of this recommendation is to provide education and other resources to facilitate the process of learning about, paying for, and installing solar systems. As noted in the introduction of this section, the District already offers an array of incentives and programs to make solar systems more accessible and affordable. However, information about these offerings is spread out over multiple sites. A central resource that provides information on all available programs can help to increase the value of existing solar incentives and programs, and eliminate potential barriers that can prevent citizens from switching to renewable energy. By improving the ease of accessing relevant information, potential cost savings and thus the likelihood that District citizens and businesses will install solar systems can be improved. This will in turn assist the District in achieving the solar requirement outlined in the RPS and making progress toward the District's renewable energy targets.

Details: The creation of a single online platform makes it simple for building owners and contractors to learn about solar systems, access incentives and other programs provided by the District and Federal Government, and connect with contractors that can provide additional information and provide installation. This flexible, commerce-focused resource can be integrated with other energy-related resources and incentives to provide a complete package of information, simplifying the process of investing in renewable energy and energy efficiency. This should include some form of integration with Mapdwell's Washington, DC Solar System ™ mapping tool, which depicts the solar potential of different every building in the District. Funding for this initiative could come from revenues generated through the RPS's alternative compliance payments program.

The DCSEU's energy efficiency website and the *Incentives and financing for solar* website managed by the EnergyTrust of Oregon both provide strong examples of centralized information platforms. [155,156] For example, the EnergyTrust website aggregates and plainly communicates information on incentives, tax credits, financing options, system requirements, purchase and installation steps, and available contractors, as well as a set of clearly organized links to other useful resources. Both the DCSEU and EnergyTrust also provide a means of soliciting additional information either by phone or email, including staff assigned to primarily help clients navigate the complexities of implementing energy efficiency and renewable energy measures.

Given their mandate and experience managing their existing energy efficiency website, the DCSEU may be the ideal body for the coordination of such a platform. Management could also be coordinated by a similar third party organization, or even the District itself. Important considerations include the way in which current solar developers and installers will fit into the commerce platform.

Next Steps:

- Direct the DCSEU to expand their existing website to include a focus on solar, or contract a separate arms-length organization to develop the site.
- Contact jurisdictions with existing online resource and commerce sites to derive insights on the use, perceived effectiveness, and administrative costs of these initiatives.

[155] https://www.dcseu.com

[156] https://energytrust.org/renewable-energy/incentives/solar/Residential/SolarElectric

- Explore the costs associated with website design, maintenance, and content development, as well as any staff time required.
- Launch the website within the next two years.

CRE.5 Implement a targeted solar proliferation strategy

Action: Develop a targeted solar proliferation strategy to install solar PV and thermal systems on District buildings with high potential and that allow easy access.

Relevance: A solar proliferation strategy is a flagship initiative that will both support the District Government's *Solar for All* program, and build on the District's other solar policies and actions.[157] A strategy of this nature has the potential to yield tangible, measurable and immediate progress toward the District's RPS solar requirement. Recent findings also indicate that solar power installations are contagious, in that the installation of solar panels on one roof increases the likelihood that solar panels will be installed on other nearby buildings.[158] As such, a solar proliferation strategy can help to increase the number of solar PV installations, while generating citizen and business awareness and interest. It builds on ongoing work to modernize and increase the resilience of the grid, and act as a catalyst to build local workforce capacity and economic development opportunities in the renewable energy sector.

A solar proliferation strategy also aligns with several of the District's ongoing actions. The District Government is already working to increase the number of solar installations citywide to meet its goal of connecting 100,000 low-income households to solar power and cutting their electricity bills in half by 2032.[159] This will also contribute to the District's RPS requirement of meeting 2.5% of the District's electricity needs using solar PV systems (or displaced by solar thermal systems) by 2023 and 5% by 2032. To achieve these RPS requirements, the District is seeking to identify and pursue specific opportunities to install building- and community-scale solar systems on both public and privately-owned buildings and lots.

Between March and September 2016, the District also worked with DCSEU program managers to create 140 solar installations on single-family homes, install 100-150 kW of solar installations on commercial buildings, and investigate opportunities to fund larger-scale community solar arrays. With 42.5 MW of solar capacity certified as of July 1, 2016, approximately 17.7 MW of additional solar generation per year will be needed to reach the 2023 RPS solar requirement under the CEP's set of recommended actions.[160]

Details: A solar proliferation strategy is a one-time effort to grow solar generating capacity in a short period of time. Such a campaign could be launched to coincide with the release of the District's *Centralized Solar Information and Commerce Platform*, and could be funded using revenues generated through the RPS's alternative compliance payments program. The District may also wish to apply to the U.S DOE to use the solar proliferation strategy as a demonstration project for other U.S. cities to learn from. Once the platform has been established, the strategy can be broken into four primary phases.

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[157] Renewable Portfolio Standard Expansion Amendment Act of 2016.

[158] Graziano and Gillingham, 2014, Spatial patterns of solar photovoltaic system adoption: the influence of neighbors and the built environment, http://joeg.oxfordjournals.org/content/early/2014/10/07/jeg.lbu036.abstract

[159] Mayor Bowser Signs Renewable Portfolio Standard Bill into Law, July 25, 2016, http://mayor.dc.gov/release/mayor-bowser-signs-renewable-portfolio-standard-bill-law

[160] Includes all certified solar systems within and outside the District, from the Monthly Update of Solar Generator Certification, Public Service Commission of the District of Columbia, retrieved on July 27, 2016, http://www.dcpsc.org/Electric/Solar_generator_certification.asp

Phase 1: Determine the subset of buildings to target: The first step is to identify a subset of the District's building rooftops with the highest solar potential and that are relatively easy to access. Key considerations in the identification of target buildings and land areas include:

- Solar generating potential (e.g., solar aspect, shadows).
- Ease of rooftop accessibility (e.g., by an aerial work platform or cherry picker).
- Capability of the building to accommodate a solar system.
- Ability of the local grid to absorb new renewable energy generating capacity.
- Ability of the building to accommodate energy storage infrastructure.
- Opportunities to coordinate with upcoming construction projects to reduce installation costs.
- Expected future lifespan of the buildings and their current roof (to avoid solar installations on buildings or roofs likely to be replaced in the near term).
- The buildings needed to achieve the 2032 solar requirement in the RPS.
- The necessity of achieving equity goals by targeting low-income households.
- Opportunities to install larger solar systems (e.g., community-scale).

Given the large area of land owned by the Federal Government in the District, access to federal land may be important to increasing solar installations.

Several existing resources will facilitate the identification of target buildings. The District Government procured updated LiDAR data from 2015 from Mapdwell's Washington, DC Solar System ™ map to estimate the solar potential of all District buildings.[161] Alongside documents from the District's Office of Planning, this data can help the District identify buildings that have both a high solar potential and are accessible by a cherry picker. Pepco was additionally granted funding from the federal DOE's SunShot Initiative to analyze and plan for the transmission and distribution system work necessary for the integration of a larger number of solar PV systems and other distributed energy resources.[162] Collaborations between DOEE and Pepco staff will allow the District to identify specific neighborhoods to target or avoid, and to identify other possible installation requirements, such as the need for devices to support the relationship between solar panels and the grid. Working meetings with these actors, as well as local industry representatives and District staff focused on grid modernization and resilience, neighborhood-scale energy systems, energy storage, and microgrids, could also be of value.[163]

Finally, the DCSEU can likely bring valuable lessons from their Small-Scale Solar initiatives launched in 2012, which focuses on the installation of renewable energy systems (and other sustainability projects) for low-income households at no cost to the homeowner.[164]

[161] Conversation with DOEE staff on February 19, 2016.

[162] Tackling Challenges in Solar: 2014 Portfolio, p.64, http://energy.gov/sites/prod/files/2014/08/f18/2014_SunShot_Initiative_Portfolio8.13.14.pdf

[163] The term "neighborhood-scale energy systems" refers to what are commonly called "district energy systems." The term neighborhood-scale is used to avoid confusion between district and District, where the latter refers to the District of Columbia.

[164] Clean Energy States Alliance, http://www.cesa.org/projects/Clean-Energy-for-Low-Income-Communities/news/newsitem/washington-dc-bridges-the-solar-gap, retrieved Feb 10 2016

Phase 2: Prioritize buildings to minimize the costs of achieving the installation target: The second step is to prioritize the subset of buildings and neighborhoods to target by exploring means of reducing installation and other soft costs. Soft costs such as design, financing, legal or others pre- and post-installation fees can account for up to 64% of total solar system costs.[165] It is therefore important to design the strategy and installation process in such a way as to minimize these costs and increase potential consumer uptake.

An increasingly common strategy to lower costs is to purchase PV panels in bulk and schedule installations by neighborhoods during each wave of installation. As discussed in Action EV.3, the City of Boulder, Colorado's solar panel and electric vehicle bulk buy program enjoyed considerable success in 2015, which has prompted the City to explore a second program.[166] Potential sources of information and support for District Government can be sourced from Boulder staff, as well as DC SUN, which has coordinated bulk buy programs, and/or federal staff involved in the SunShot Initiative's soft costs program.[167] The District should also consider consulting with local solar and related professionals to explore how best to reduce these costs.

Phase 3: Design and implement a targeted marketing campaign: Once target buildings have been identified, a marketing campaign should be designed to directly engage with owners of identified buildings. This campaign should clearly and simply communicate the benefits of solar systems, and summarize available incentives and support. Messaging should be informed by an understanding of consumer perceptions of solar systems' pricing, value and reliability, as well as the perceived complexity and duration of the purchase, installation, and rebate process.[168] Messaging should also come from a high-profile, trusted, and credible individual in the District (e.g., the Mayor) and encourage residents to participate in what is a momentous and meaningful program. Finally, the District should identify opportunities to increase the impact of this initiative by publicizing, promoting, and branding installations as they are being constructed.

Once fully implemented, the District may wish to consider expanding the targeted customer base to include citizens and businesses that do not reside in the buildings targeted for solar systems. The rationale for this expansion lies in the Community Renewables Energy Act of 2013, which allows residents and businesses to purchase electricity from solar panels on other buildings and receive credit on their utility bill as though they owned the panels themselves.[169] This is known as virtual net-metering, in that like conventional net-metering, it requires utilities to compensate residents and businesses for any solar they generate on-site and supply to the grid's distribution network.

As such, the establishment of PPA between potential consumers of PV-generated energy and those who own on-site installations has the potential to create additional demand and improve the business case for

[165] U.S. Department of Energy SunShot Initiative, http://energy.gov/eere/sunshot/soft-costs, retrieved Feb 15 2016

[166] Discussion with Boulder planning staff, February 29, 2016.

[167] For example: Non-Hardware ("Soft") Cost-Reduction Roadmap for Residential and Small Commercial Solar Photovoltaics, 2013-2020, http://www.nrel.gov/docs/fy13osti/59155.pdf.

Reducing the Solar PV Soft Cost: Focus on Installation Labor, http://bit.ly/1QC5LxI

[168] Smart Solar Marketing Strategies, 2009, http://www.cesa.org/assets/Uploads/Resources-pre-8-16/CEG-Solar-Marketing-Report-2009.pdf

[169] Community Renewables Energy Act of 2013, http://dcclims1.dccouncil.us/images/00001/20130110170938.pdf

building owners. Such an expansion of the project would likely improve demand for installations while making the program more inclusive and inspiring. However, virtual net-metering credits are worth approximately half of regular net-metering credits, rendering the financial incentive for customer participation in this aspect of the strategy somewhat weaker.[170]

Phase 4: Facilitate installations: The final step in the program is to identify the best approach to installation. Key considerations should include:

- Avoiding any liability for issues that occur during installation by private companies.
- Minimizing the District's administrative costs.
- Minimizing program participation and transaction complexity.
- Reducing soft costs as much as possible, e.g., through bulk buying and scheduling installation phases to concentrate in small areas.

Support for this work could be sourced via a green bank, including support for project financing, the identification and coordination of stable and certified contractors, and any evaluation, measurement, and verification required for technical underwriting. The various phases of the project can be administered by one or more arms-length organizations that the District can select via Request for Proposal. The selected organization(s) would be responsible for working with the District to identify and prioritize the subset of buildings, design and implement the marketing plan, and/or coordinate the installation process. One or more of these tasks could also be led by the DCSEU, given their existing responsibility to administer renewable energy generation programs.

Any data, information, and lessons generated through the implementation of this program should be used to design future solar programs. It will also be important to ensure that the solar proliferation strategy aligns with any actions taken to modernize the electricity system (see section 4.2). For example, updates to existing grid infrastructure may be required to absorb the energy provided by the increase in solar systems. The District may also wish to install solar systems in areas that are already targeted for the installation of microgrids or energy storage.

Next Steps: The District can begin the four phases of this recommendations (as outlined above) immediately, but should consider how to align this work with the development of a centralized solar information and commerce platform (Action CRE.4) and the early stages of the electricity system modernization work recommended in Section 4.2 (particularly Actions ESM.6 and ESM.7).

- Assign DOEE staff to manage the project and assemble a group of District staff and external stakeholders that can inform and design the overall strategy
- Create a subgroup of this team that consists of DOEE, Office of Planning, and Pepco staff to identify and prioritize the subset of buildings.
- Release an RFP for an organization to design and manage the marketing campaign and/or other phases of the strategy.

[170] Community Renewables Energy Act of 2013: Current status of community solar, 2016, http://www.dcsun.org/community-renewables-energy-act-of-2013/

CRE.6 Adopt solar-ready and renewable energy generation building code requirements

Action: Update building, energy, and construction codes to require new buildings to accommodate a renewable energy generating system and/or the ability to connect to a community-scale energy system. Update codes to require a certain percentage of building energy demand to be met with on-site renewable energy generation.

Relevance: Updating the building codes to incorporate renewable energy requirements will enable progress toward several of the District's targets. Renewable energy-ready buildings offer greater opportunity and flexibility in achieving the District's 2032 and 2050 GHG targets, and may also support grid resilience objectives. A requirement for the installation of renewable energy systems on new buildings (and existing buildings undergoing substantial retrofits) will also directly support ongoing efforts to study and implement measures in neighborhood-scale energy, microgrids, and net-zero or net positive buildings.

The District's current building codes do not require buildings to incorporate renewable energy. Instead, developers of select building types can install a renewable energy system as one option to meet a series of sustainable building requirements. This is achieved through the District's Green Construction Code (GCC), which requires new construction projects and substantial alterations of commercial and residential buildings to incorporate a minimum number of project electives from a menu of options. Three of these options include the installation of renewable energy systems, which must provide 5%, 10%, or 20% of the building's annual energy demand. However, no new construction projects had yet elected to install a renewable energy system to fulfill the GCC requirements as of February 2016.[171]

Details: One of two approaches to increasing building renewable energy generation and consumption can be pursued.

Under the first approach, the District Government can require new buildings to be renewable energy ready – in other words, capable of accommodating or connecting to on-site and/or neighborhood-scale energy systems. This requirement should apply to new construction projects of a certain building size and type, as well as to existing buildings that require major roof repairs or related retrofits.

New requirements should be implemented with discretion to account for barriers, such as individual sites' solar exposure, shading from nearby buildings, and storm water requirements. In these instances, the District Government should require building owners to supply the equivalent percentage of their electricity from other solar systems in the District (e.g., community solar) or purchase SRECs. The District Government should also consider how to phase in the requirements to both increase the proportion of buildings covered over time, and allow the local building and energy industries to prepare for change. Such a phased approach should be partnered with other requirements and incentives to support the transition. For example, certain rezoning applications can be required to conduct a feasibility study for the installation of an on-site renewable energy system. Similarly, expedited building permitting can be granted where a certain percentage of energy demand is met with on-site renewable generation.

[171] Email from the District of Columbia Department of Energy & Environment staff, Feb 11 2016

Using the second approach, the District can require new buildings to install a renewable energy system equal to a minimum percentage of the building's square footage, rooftop space, or projected energy demand. As with the renewable energy readiness requirement described above, this action can be phased in over time, with a long-term objective of supporting the District's GHG reduction, renewable energy generation, and net-zero and net positive building goals. The stringency and timeline of this proposed code update can be determined by means of a feasibility study that assesses any cost implications and determines the appropriate approach to compliance. Such a process should engage with the local building industry to harness existing knowledge and foster broader buy-in.

These actions follow in the footsteps of other leading jurisdictions. Vancouver (Canada) requires one- and two-family homes to be solar-ready, and all rezoning applicants with properties larger than two acres to conduct a feasibility study to assess the relative cost of constructing a low-carbon, on-site energy plant.[172] In April 2016, both San Francisco and Santa Monica announced requirements for new residential and commercial buildings to install solar PV or thermal systems based on their square footage (Santa Monica) or size of the building roof (San Francisco).[173] Several national, state-level, and municipal governments in Europe have also adopted ordinances that require buildings to install solar thermal systems.[174]

Aligning these building code updates with other initiatives will have considerable benefit, and should be informed by the results of solar proliferation and neighborhood-scale energy studies. Solar access and other renewable energy requirements should also be reviewed in the context of the District's planning process to ensure land use policies (e.g., building heights and shadow implications) and bylaws are aligned with building- and district-scale renewable energy actions.

Next Steps:

- Within the next year, direct staff to work and engage with the Building Code Advisory Committee, Building and Land Regulations Administration, and local building, construction, and renewable energy professionals to investigate and implement both of these building code updates.
- Update District building codes to require buildings to be capable of accommodating on-site or district-scale renewable energy systems
- Update District building codes to require buildings to install an on-site renewable energy system, or possible satisfy a minimum percentage of their energy demand with off-site renewable energy or renewable energy credits.
- Once implemented, investigate the feasibility of increasing renewable energy system requirements and expanding to include certain scales of building retrofits.

[172] Vancouver Building Bylaw, https://vancouver.ca/home-property-development/green-home-building-policies.aspx

[173] Santa Monica City Council Votes in Aggressive Renewable Energy Requirement on New Construction; Implementation Begins in 30 Days, http://newsroom.smgov.net/2016/04/28/santa-monica-city-council-votes-in-aggressive-renewable-energy-requirement-on-new-construction-implementation-begins-in-30-days
Press Release: Board of Supervisors Unanimously Passes Supervisor Wiener's Legislation to Require Solar Power on New Buildings, https://medium.com/@Scott_Wiener/press-release-board-of-supervisors-unanimously-passes-supervisor-wiener-s-legislation-to-require-693deb9c2369#.3w2i4v6ry

[174] European Solar Thermal Industry Federation, http://www.estif.org/policies/solar_ordinances/

4.1.2.3 Thermal Energy Supply within the District

CRE.7 Undertake a built environment thermal decarbonization study

Action: Conduct or commission a study to determine the best way to eliminate GHG emissions from thermal energy used in the District.

Relevance: Achieving the District's 2032 GHG reduction target will require a significant shift away from fossil fuels, including natural gas. Achieving its 2050 GHG target may require the District to eliminate or nearly eliminate fossil fuel use altogether. Consequently, the District must transition away from equipment and technologies that depend on fossil fuels to run. The equipment used to heat and cool space and water in buildings is a key aspect of this transition.

Details: Energy used to heat and cool both spaces and water is typically the largest source of a building's energy consumption. Depending on the building's design and equipment, this thermal energy is provided through one of three means: electricity, natural gas, or fuel oil. Building thermal energy demand is also expected to increase as climate change-induced increases in summer temperatures will increase the demand for air conditioning.[175] As of 2013, natural gas represented approximately 40.5% of total building energy use in the District, while fuel oil represented 2.5%.[176]

Low carbon energy sources and systems that can be used to elicit this shift include electricity, biofuels, and low carbon neighborhood-scale energy systems, while necessary types of building equipment include baseboard heaters, heat pumps, and hydronic systems. Given the long-term importance of building thermal energy demand to meeting the District's targets, careful research into which systems and technologies work best for the District should be prioritized. For each option, GHG implications should be assessed alongside other important variables, such as energy supply availability and stability, upfront capital requirements and costs to ratepayers, and resilience (e.g., the flexibility of the system to rely on backup energy sources, or the energy efficiency of equipment to minimize overall energy demand). As optimal solutions will likely differ by building type and location, research may best be broken into multiple parts and aligned with other energy-focused work, including updates to the building code (Action NC.1), the solar proliferation strategy (Action CRE.5), and a neighborhood-scale energy strategy (discussed next in Action CRE.8). An example of such a study was conducted in Boulder, Colorado in 2016. The *Natural Gas Replacement Strategies for Residential Uses* modeled building energy demands, assessed replacement technologies, conducted a financial and emissions analysis, and developed a transition strategy.[177]

Next Steps:

- Identify building and energy supply-focused actions that would benefit from a better understanding of how to decarbonize thermal energy in the District, and determine whether and how thermal energy research can be done to support those actions.
- Assign staff from DOEE and DCRA to determine whether and how to split up the components of this research based on the energy source, thermal energy equipment, and building type.

[175] Task 2 Report – Vulnerability & Risk Assessment for the District's *Climate Ready DC Plan*.

[176] Based on data from email from DOEE staff on January 20, 2016.

[177] Provided by staff at the City of Boulder on May 26, 2016.

- Commission a thermal decarbonization study of one or more of the components in the previous bullet with the objective of identifying preferred energy sources and systems for different building types and outlining the steps required to begin transitioning to these new solutions.

CRE.8 Develop a neighborhood-scale energy strategy

Action: Develop a neighborhood-scale energy strategy with a focus on identifying potential supply and demand opportunities and preparing the District to capitalize on opportunities to install neighborhood-scale energy systems.[178]

Relevance: Neighborhood-scale energy opportunities can be a cost-effective way of both reducing GHG emissions and improving grid resilience. The development of a neighborhood-scale energy strategy is a way of ensuring that the District is able to capitalize on neighborhood-scale energy wherever it is feasible as one component of larger shift to low carbon, renewable energy. Neighborhood-scale energy also has the potential to improve energy resilience by creating modular systems centralized at smaller scale than gas and power grids. Though not the focus here, neighborhood-scale energy systems can also be used to generate electricity (e.g., combined heat and power systems), sometimes in combination with microgrids.

The District's current neighborhood-scale energy facilities are operated by the General Services Administration as well as several District universities.[179] New neighborhood-scale energy systems and microgrids have also been proposed for the Walter Reed redevelopment, the SW Ecodistrict, the Kingman Park neighborhood, and other sites.[180] In 2016, DC Water produced an overview of DC Water's Energy Opportunities, including potential low GHG thermal energy sources such as the use of excess heat from the District's drinking water supply in summer, and the Blue Plains Advanced Wastewater Treatment Plant, in addition to opportunities for electricity generation and microgrids.[181] DC Water is now in the process of assessing whether there is sufficient demand to develop a neighborhood-scale energy system at Buzzard Point. The District is in the early stages of putting strategies and policies in place to capitalize on these or other potential neighborhood-scale energy opportunities that may exist or emerge.

Details: Three conditions help neighborhood-scale energy facilities cost-effectively reduce GHG emissions. First, a high *load density* is necessary to ensure enough heating and/or cooling demand is available in a small enough area to bring down the costs of installing piping and other infrastructure necessary for thermal distribution. Second, a *load diversity* is a function of the time of day that energy demands are being placed on the neighborhood-scale energy system. A high load diversity is valuable because it spreads the demand more evenly across the day, thereby increasing the overall efficiency of the energy supply system and improving its financial case. Finally, the use of *low carbon energy sources*, as well as efficiency gains from shifting to neighborhood-scale energy, can both significantly reduce GHG emissions.

[178] The term "neighborhood-scale energy systems" refers to what are commonly called "district energy systems." The term neighborhood-scale is used to avoid confusion between district and District, where the latter refers to the District of Columbia.

[179] 2014 Comprehensive Energy Plan for the District of Columbia (unreleased), pp.36-37, 159.

[180] Sustainable DC, 2012, p.19

[181] DC ENERGIZED, DC Water's Energy Opportunities, DRAFT 2-11-2016, unreleased as of March 21, 2016.

The aforementioned DC Water study has already identified several low carbon neighborhood-scale energy opportunities. While the majority of these will be used to satisfy DC Water's own energy requirements, DC Water has identified up to 200 MW of thermal energy available from wastewater that may be able to supply buildings at locations around the city.[182,183] There is therefore an opportunity to work with DC Water to explore where this wastewater thermal supply can be matched with nearby demand. This information should also be supplemented by a District-led study to identify potential geothermal and hydrological sites, opportunities for low carbon biomass and other waste-to-energy facilities, and sources of waste heat. As with solar electricity opportunities, access to federal land may be valuable to identifying supply and demand opportunities.

While not every opportunity can or should be pursued, a map and summary of potential low carbon neighborhood-scale energy sources will be a useful resource for District staff involved in community planning, energy supply system planning, infrastructure planning, and retrofit program activities. An understanding of these opportunities may affect how certain decisions are made to increase neighborhood-scale energy demand and reduce the capital cost to build the system (e.g., community planning to increase demand, adjusting infrastructure planning timelines to decrease costs).

The bulk of the neighborhood-scale energy strategy should focus on understanding potential demand – both load density and load diversity – and determining how the District can support the implementation of neighborhood-scale energy systems moving forward. The strategy can inform planning and policy making activities (e.g., land use planning, building and energy codes and bylaws, and related regulations) to ensure the District is prepared to capitalize on opportunities when they become available and potentially increase the number of feasible neighborhood-scale energy opportunities in the future. Importantly, the District needs to ensure that any neighborhood-scale energy opportunities that are pursued are designed to account for and not dis-incentivize increasing improvements in energy efficiency and conservation.

The neighborhood-scale energy strategy should be led by DOEE, involve DC Water, and engage other internal and external stakeholders that may be valuable to or affected by increasing neighborhood-scale energy. These stakeholders may include the Public Service Commission, Office of Planning, Building Code Advisory Committee, Building and Land Regulations Administration, DC Water, Pepco, Washington Gas, Office of Budget and Planning, Economic Development and Planning, Department of Transportation, the DC Chamber of Commerce, the DC Building Industry Association, and others. Participation by the Department of Transportation can help align infrastructure planning and development activities to share construction costs.

The development of a neighborhood-scale energy strategy could include the following activities:

- Identifying demand opportunities based on new construction, anticipated growth, and current neighborhood energy-compatible thermal energy demand.

[182] Communication with DOEE staff, March 29, 2016.

[183] DC ENERGIZED, DC Water's Energy Opportunities, DRAFT 2-11-2016, unreleased as of March 21, 2016.

- Performing a strengths, weaknesses, opportunities, and threats (SWOT) analysis of the potential role of the District with regards to the promotion and proliferation of low carbon neighborhood-scale energy systems.
- Identifying policy reforms required to remove barriers, enhance support, and expand the future market for neighborhood-scale energy (including infrastructure costs, green building policies and programs, utility policies and incentives, and municipal policies regarding specific energy sources, e.g., regarding biomass).
- Investigating phasing strategies to facilitate the long-term implementation of neighborhood-scale energy systems, considering future infrastructure planning (to reduce total costs), development plans, anchor loads, and other capital planning.
- The opportunity for the District to act as an anchor tenant to improve the financial case.
- Developing a memorandum of understanding between DOEE and DC Water regarding ongoing collaboration to identify and develop neighborhood-scale energy opportunities.
- Assembling a formal interdepartmental or interagency team focused on neighborhood-scale energy.
- Calculating energy and GHG emission performance implications of one or more neighborhood-scale energy systems compared to a business as usual scenario.
- Selecting specific neighborhoods with a high potential for thermal demand and low carbon supply and recommending feasibility analyses and other planning studies to further investigate these.
- Providing an extension service that offers technical expertise and planning support to private developers, neighborhood associations, and government agencies unfamiliar with the benefits and the complexities of neighborhood-scale energy and microgrid approaches.
- Identifying a pilot project and developing a framework for how to pursue it (e.g., through a public-private partnership, a balance of ownership and operation responsibilities between the District and DC Water, etc.).
- Investigating the value of applying a carbon price to thermal energy sources that result in GHG emissions.

Next Steps:

- Immediately begin discussions with DC Water regarding the opportunity to collaborate on neighborhood-scale energy initiatives, with a particular focus on wastewater thermal.
- Within the next two years, direct DOEE staff to assemble a group of key neighborhood-scale energy stakeholders and investigate and map other low carbon neighborhood-scale energy sources, assess neighborhood-scale energy demand potential, evaluate the role the District can play in facilitating neighborhood-scale energy opportunities, and conduct the planning and policy making necessary to ensure the District is able to capitalize on emerging neighborhood-scale energy opportunities that align with their long-term targets.
- At the conclusion of the strategy's development, initiate any action necessary to ensure planning and policy tools are able to support and will not hinder neighborhood-scale energy development.

4.1.3 Clean & Renewable Energy Supply Roadmap

		The Five-Year CEP					Projected Path to 2032 Climate and Energy Targets										
Clean & Renewable Energy Supply	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Renewable Electricity Supply from outside the District																	
CRE.1 Design and manage the RPS to drive renewable energy generation and set a 100% requirement for 2050																	
CRE.2 Provide the Standard Offer Service through a long-term power purchase agreement																	
CRE.3 Enact legislation that sets a maximum GHG intensity for electricity supplied to the District																	
Renewable Electricity Supply within the District																	
CRE.4 Develop a centralized solar information and commerce platform																	
CRE.5 Implement a targeted solar proliferation strategy																	
CRE.6 Adopt solar-ready and renewable energy generation building code requirements																	
Thermal Energy Supply within the District																	
CRE.7 Undertake a built environment thermal decarbonization study																	
CRE.8 Develop a neighborhood-scale energy strategy																	

Legend
Planning, Research, and Program and Policy Development
Plan or Program Implementation
Policy or Regulation Implementation
Pilot Project
Program Evaluation

4.2 Electricity System Modernization

4.2.1 An Overview of Electricity System Modernization

4.2.1.1 Current Electricity System Pressures

As discussed in Chapter 2, a much higher proportion of the District's total electricity supply must be shifted to renewable sources to meet the District's targets, both outside and within the District of Columbia. Ultimately, this will require a full phase-out of fossil fuels, coupled with more efficient electricity use and peak load reductions.

At the same time that the District pursues these climate and energy targets, increasing pressures are being placed on the electricity grid. Aging infrastructure will require ongoing maintenance and costly investments to ensure its continued and adequate performance. Indeed, Pepco in its 2016 rate case projects an expenditure of $1.52 billion in new capital projects between now and 2020 to ensure a continued level of service across the District.[184] While these investments are costly, avoiding them will see the overall reliability of the grid decline, while electricity costs for consumers will increase.[185,186]

In addition to the need to upgrade existing infrastructure, the grid is also challenged by climate change-induced extreme weather events and sea-level rise. A District-based *Vulnerability and Risk Assessment* recently found that major District infrastructure assets, including electric substations and Metrorail, will be vulnerable to both extreme heat events and periodic flooding as early as 2020. The consequent failure of these important pieces of infrastructure will have significant impacts on the businesses, governments, and residents that depend on this infrastructure every day.[187] To address these concerns, the District has made resilience of energy supply system a key priority. This includes ensuring the ongoing reliability of the electricity system, as well as its ability to resist, respond to, and recover from shocks or attacks on the system – whether these are natural (e.g., extreme weather, animals) or man-made (e.g., physical or cyber attacks).

To this end, the *Sustainable DC Plan* has set a goal to reduce the total number of annual power outages to between 0 and 2 events of less than 100 minutes per year.[188] A second goal has been established to improve the District's human preparedness and physical adaptability to future climate change, with a particular focus on the District's energy infrastructure.[189] These goals are addressed in further depth in the forthcoming *Climate Ready DC Plan* (2016), which outlines several actions focused particularly on electricity system resilience.

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[184] Formal Case 1139 – Application, Direct Testimony and Exhibits of Potomac Electric Power Company Witnesses Velazquez and McGowan

[185] Reliability refers to the ability of the grid to deliver high quality power consistently.

[186] Failure to Act: Closing the Investment Gap for America's Economic Future, American Society of Civil Engineers, http://www.infrastructurereportcard.org/wp-content/uploads/2016/05/ASCE-Failure-to-Act-Report-for-Web-5.23.16.pdf

[187] Vulnerability and Risk Assessment Report (p.4) developed as part of the development of the District's *Climate Ready DC Plan*.

[188] Sustainable DC Plan, 2012

[189] Sustainable DC Plan, 2012

Further, as in most jurisdictions, the District's current electrical grid is currently inefficient, as it was built to support the peak electricity demand that occurs for a short period of time each year. For the remainder of the year, the grid is underutilized and thus inefficient. With overall grid utilization at approximately 53%, there is a significant opportunity to improve the cost-effectiveness of the District's electricity system through a shift in grid infrastructure and operations.[190] This shift can be supported by distributed energy resources, which represent an emerging pressure on the grid and are discussed in more detail in the next section.

4.2.1.2 The Rise of Distributed Energy Resources

The past several years have seen the growing adoption of new energy technologies that interact with the grid in more complex ways known as distributed energy resources (DER). The Department of Energy and Environment (DOEE) broadly defines DER in a way that accounts for both the technologies themselves, as well as the multiple aspects of the electricity system with which these technologies interact. DER technologies both increase renewable energy generation and support more efficient and cost-effective management of the electricity system. DER includes end-use and grid energy efficiency, demand response, distributed storage, distributed generation (e.g., solar panels, thermal energy recovery systems), microgrids, and electric vehicles.[191] Altogether, DER will play an important role in achieving the District's 2032 GHG reduction, energy use reduction, and renewable energy generation targets. Improvements in technology, reductions in cost, and increases in GHG emissions policy have together driven significant growth in the demand for DER over the past several years. Continuing this growth will require new, strategic investments in infrastructure and operational capabilities to meet existing and new types of demands placed on the grid by these new technologies, while capitalizing on the opportunities DER technologies offer.

It should be noted that integrating DER into the existing grid entails challenges. While DER technologies can be connected to different parts of the grid, the District's existing grid infrastructure is based on a model of centralized, large-scale electricity generation (e.g., large-scale hydroelectric dams, coal-fired power plants, and nuclear power plants) that is transmitted through regional distribution networks to end-users. It may be difficult to integrate high quantities of DER technology into this existing grid structure without causing repercussions throughout the electricity system. For example, electricity generated at customers' residences can affect the performance of both the distribution network and the broader transmission network, as well as the way the centralized fleet of generators may be deployed to meet energy demand.[192] Such interactions can lead to problems of reliability, and challenge existing utility models, regulatory structures, and decision-making processes around the design and operation of the grid.[193] As such, utilities and regulators must consider current and future growth in DER when planning or

[190] Grid efficiency figure sourced from correspondence with DOEE staff on July 13, 2016.

[191] Comment on the Scope of the Proceeding by the District of Columbia Government (p.2), Formal Case 1130, District of Columbia Public Service Commission.

[192] Electric Power Research Institute, 2015, The Integrated Grid: A Benefit-Cost Framework (p.xviii).

[193] QER Report: Energy Transmission, Storage, and Distribution Infrastructure (p.S-14), 2015, Quadrennial Energy Review

making investment or regulatory decisions, or risk making costly grid investments that are incompatible with the future operation of the grid.

However, the growing focus on DER also offers considerable benefits over traditional electricity system planning and management. First, increases in DER can help reduce the need for traditional investments in the grid and ultimately lower rates for customers. In May 2016, the California-based Pacific Gas & Electric utility reported that the growth in DER, energy efficiency, and demand response measures have rendered $192 million in approved transmission improvements unnecessary.[194] This trend is likely to continue with the declining cost of DER as technology improvements drive down material costs and improve efficiencies, business model improvements lower soft costs (e.g., installation costs), and increased production improves economies of scale. At the same time, the price of electricity from wind and solar photovoltaic (PV) generators has fallen dramatically over the past decade, making solar the most affordable source of power in some areas even when compared to fossil fuels.[195]

DER can also support the District achieve peak demand reductions and associated cost savings. Peak demand refers to the maximum quantity of electricity a customer demands at a given time – for example, when a business is using all of its equipment, or when residents demand high amounts of electricity for cooling on a hot summer day. The total generation capacity that an electricity grid must be able to provide at any given time is defined by the peak load demanded by the sum total of all its users. Reductions in peak demand can be facilitated by certain DER technologies that help utilities and consumers to predict and adjust their energy demand.

DER technologies that generate and store electricity also allow customers to source a larger portion of their electricity from nearby generators (e.g., solar panels on their roof or in their neighborhood), thereby gaining efficiency through reduced distance that electricity must travel via transmission and distribution lines. This in turn decreases the need for additional power lines and associated investments, reducing line losses.[196] By extension, these increases in efficiency reduce the need for additional generating capacity and associated grid infrastructure, lowering costs for customers.

Finally, the addition of DER will facilitate the adoption of localized renewable energy generation. Consider that 99.2% of new electricity generation capacity added to the U.S. grid in Q1 of 2016 was renewables, more than half of which was distributed solar.[197] These technologies enable more advanced management of the grid that will help to ensure the affordability, efficiency, reliability, resilience, and security.

In sum, the various pressures and changes that the electricity grid is undergoing, or will undergo in the near future, require the District to engage in a process of changing, improving, and upgrading the electricity system, or what is commonly referred to as grid modernization. Making these changes in a

[194] Californians Just Saved $192 Million Thanks to Efficiency and Rooftop Solar, May 31 2016, Greentech Media, http://www.greentechmedia.com/articles/read/Californians-Just-Saved-192-Million-Thanks-to-Efficiency-and-Rooftop-Solar

[195] Solar Energy Is Cheapest Source of Power in Chile, Deutsche Says, Nov 4 2015, Bloomberg, http://www.bloomberg.com/news/articles/2015-11-04/solar-energy-is-cheapest-source-of-power-in-chile-deutsche-says
"A new analysis by Germany's Photon Magazine finds that solar might be the cheapest source of electricity already today – not in sunny regions, but in cloudy Germany." http://www.renewablesinternational.net/2-cent-solar/150/452/95575/

[196] Energy Information Administration, 2016, How much electricity is lost in transmission and distribution in the United States?, https://www.eia.gov/tools/faqs/faq.cfm?id=105&t=3

[197] Renewables = 99% Of New Electricity Capacity In Q1 2016 In USA (CleanTechnica Electricity Reports), May 31 2016, http://cleantechnica.com/2016/05/31/renewables-99-new-electricity-capacity-q1-2016-usa/

timely and thoughtful way will be crucial, as the inherent longevity of grid infrastructure means that any near-term decisions will influence the composition and function of the electrical grid for decades to come. This section of the CEP identifies electricity system modernization actions necessary to ensure the District's electricity system can support deep GHG reductions and capitalize on the opportunities presented by DER while meeting customers' needs both now and in the future.

4.2.1.3 Theory of Grid Modernization

Grid modernization, or electricity system modernization, can be summarized as the strategic process of assessing and updating grid infrastructure, utility business models, and regulatory structures to achieve a balance of an affordable, sustainable and resilient electricity system.[198] Grid modernization is critical to enabling widespread DER integration and helps jurisdictions improve reliability and resilience, lower GHG emissions and energy use, increase system flexibility, ensure security, and maintain affordability.[199]

A key feature of this description is the *integration* of DER into the grid. To maximize the value of DER and ensure it has a positive effect on the operation of the grid; DER cannot simply be connected to the grid. Rather, DER must be integrated through adjustments in other infrastructure, utility operations, and regulatory structures.[200] This holistic grid modernization approach to DER integration becomes increasingly important as the supply and use of DER increases.

Although the specific process through which jurisdictions will modernize their grid is not yet fully understood, one particular framework for the grid modernization process has been widely cited by jurisdictions in more advanced stages of grid modernization.[201] The framework outlines a three-stage evolutionary process driven by higher levels of DER adoption:

- Stage 1: Grid Modernization involves a low level of DER adoption that can be accommodated with existing distribution systems, and without any materials changes to infrastructure or operations.
- Stage 2: DER Integration occurs when DER adoption levels reach a threshold that requires enhanced functional capabilities to ensure reliable distribution system operation and capture system benefits. Based on current DER adoption experiences, this appears to occur when DER adoption reaches approximately 5% of distribution grid peak loading system-wide.
- Stage 3: Distributed Markets is a conceptual stage that results from a combination of high DER adoption and policy decisions to create distribution-level energy markets to facilitate distributed (e.g., peer-to-peer) transactions.

Most U.S. grids, including the District of Columbia's, are in Stage 1. However, DER adoption levels and public policy decisions in California and Hawaii place them in Stage 2 of the process, with New York State

[198] Although the term "grid modernization" is more commonly used, the District Government and Public Service Commission use the term "electricity delivery system modernization" to explicitly acknowledge the fact that the modernization process required changes to regulatory and market structures in addition to grid infrastructure. Both terms mean the same thing in the CEP, and "grid modernization" is often used for brevity.

[199] Grid Modernization Initiative, October 22, 2015, Presentation by Kevin Lynn of the Office of Energy Efficiency and Renewable Energy at the U.S. Department of Energy.

[200] Electric Power Research Institute, 2015, The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources (p.33).

[201] De Martini and Kristov, 2015, Distributed Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight

close behind. These three jurisdictions (as well as Germany) can provide valuable learning opportunities for the District and are referenced throughout the recommended actions below.

4.2.1.4 Policy Objective

To achieve the District's objectives and drive the necessary increases in DER adoption, the District Government should adopt the following language in establishing a specific policy objective for this critical work:

> *The District of Columbia will make a phased and strategic transition to a 21st Century energy supply system that supports the District in achieving its priorities as set forth in the Sustainable DC Plan. The modernized energy delivery system will be designed, operated, and regulated to empower District residents and businesses, while supporting innovation in energy services through advanced distributed energy resources and dynamic energy management capabilities. The system will be highly efficient, resilient, reliable, secure, flexible, and deliver affordable power to customers.*

4.2.1.5 Existing District Government Actions

The District is at an early stage in the process of modernizing its electricity system. From a regulatory standpoint, this process is being driven by the Public Service Commission's (PSC) Formal Case 1130 (FC1130), *In the Matter of the Investigation into Modernizing the Energy Delivery System for Increased Sustainability*. FC1130 was initiated in June 2015 with the objective to "identify technologies and policies that can modernize our energy delivery system for increased sustainability and will make our system more reliable, efficient, cost-effective and interactive."[202] DOEE has been engaged in this process through the submission of formal comments, presentations at workshops, and attendance at meetings. This ongoing proceeding will remain a critical early component of the District's long-term transition to a modernized electricity system.

Other related actions taken by the District Government include the near-complete deployment of advanced metering infrastructure (e.g., smart meters) and the District's climate change adaptation plan, the *Climate Ready DC Plan*.[203] As discussed in Action ESM.9 below, the extensive deployment of advanced metering infrastructure can support grid modernization by providing the District with valuable data with which to assess grid functioning, plan for DER integration, support more advanced energy demand management, and identify opportunities for pilot projects. This will be an important part of effectively managing the long-term transition to a modernized grid while maintaining reliability and resilience. The District's *Climate Ready DC Plan*, and related *Vulnerability and Risk Assessment Report*, will provide a crucial layer of information that will help to ensure that planning efforts and investment decisions are cognizant of the anticipated effects of climate change on the grid and the grid's role in the functioning of the city more generally. The forthcoming *Climate Ready DC Plan* also lays out a series of resilience-focused actions, many of which can support the District's grid modernization efforts. The District Government should thus align efforts coming out of both the CEP and *Climate Ready DC Plan*.

[202] Public Service Commission Order 17912.

[203] Smart meter deployment figures found in Fact Sheet, Pepco, http://www.pepco.com/uploadedFiles/wwwpepcocom/PepcoDCFactSheet.pdf

4.2.2 Recommended Actions

As noted above, modernizing the District's grid infrastructure, utility model, and regulatory structure will be fundamental to the achievement of the District's long-term climate and energy targets. It will affect the District Government's decision-making about buildings, electric transportation, and, most fundamentally, the transition toward a low carbon energy supply system dominated by renewables. As such, grid modernization actions will both affect and be affected by the pursuit of actions in the other sectors outlined in this CEP. The District Government must therefore work to align the actions recommended here with those in the other sections, as well as those discussed in the *Climate Ready DC Plan*.

4.2.2.1 Planning and Coordination

ESM.1 Define a vision of the future grid and characterize the stages of grid modernization

Action: Create a vision of the District's future electricity system. Use this vision to define the capabilities and characteristics the grid will require, and characterize the transition required to achieve this vision.

Relevance: As outlined in Section 4.2.1.3, modernizing the electricity system requires a phased transition through three stages to a loosely-defined future state. To guide their efforts in a strategic manner, the District must take steps to envision what this future electricity grid can and should look like. To some extent, this process is already underway via the PSC's Formal Case 1130 (FC1130). However, it is important to include it here to emphasize its importance and to provide guidance by drawing on the experiences of other jurisdictions and existing grid modernization literature.

Details: Planning and implementation work done by Germany, New York State, California, Hawaii, and other jurisdictions clearly indicates the significant value in modernizing the electricity grid and moving toward a more flexible and dynamic decentralized electricity system.[204] As such, the District Government should move swiftly beyond the evaluation of the potential value of a modernized grid and proceed to planning and implementation. As a first step, the District Government must clearly establish, reiterate, and quantify the District's objectives for grid modernization as they relate to its 2032 GHG reduction, energy use reduction, and renewable energy utilization targets, as well as the areas of efficiency, resilience, reliability, security, flexibility, and interactivity. With these objectives clarified, the District can begin to envision the future state of the electricity system and characterize the process to achieve it.

[204] e.g., Staff White Paper on Benefit-Cost Analysis in the Reforming Energy Vision Proceeding, Jul 1 2015, New York Department of Public Service, http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/c12c0a18f55877e785257e6f005d533e/$FILE/Staff_BCA_White paper_Final.pdf

In developing a grid vision, the District Government should conduct stakeholder engagement around the following questions:

- What functions must the future grid be capable of providing?
- What is the emerging vision of the distributed market structure? Are there multiple distinct options?
- What are the roles of key actors in the future system (e.g., market actors, regulators, distribution system operator, customers)?
- What market, technology, demographic, and environmental trends and developments are likely to influence the performance of the grid and how (e.g., increased DER adoption, climate change impacts)?
- How can potential market power concerns be mitigated? [205]

Similarly, the District Government must define the three transition stages of *Grid Modernization*, *DER Integration*, and *Distributed Markets* (described in Section 4.2.1.3) as they relate specifically to the District's electricity system.[206] Guiding questions that can help clarify the grid modernization process include the following:

- What is required to enable key actors to operate effectively in the envisioned market?
- How can customers and distributed energy suppliers be best empowered? How may the current market structure inhibit empowerment?
- How does each envisioned phase translate to changes at the different scales of the electricity grid: buildings, neighborhoods (feeders), the city, and outside the District?
- What may change about the interface between the distribution and transmission networks (e.g., potential role of high voltage direct current transmission)?

Following the example of New York State, the District Government should consider defining a small set of critical path features to provide clarity on the general processes the District must pursue. These features will assist the District in its evaluation of the current state of infrastructure, utility models, and regulatory structures (see related actions in Section 4.2.2.2). As the grid vision continues to evolve and specific actions become clearer through additional research, analysis, and piloting, a set of critical path features will also help the District Government to identify no regrets actions for the design of near-term efforts (see Section 4.2.2.3). Examples from New York State include:

- Increasing the DER asset base.
- Building market and customer confidence in the expanded role of DER.
- Removing key barriers to DER adoption.
- Gaining experience and capabilities to support the implementation of the modernized electricity system platform and distributed markets.

[205] Adapted from Developing the REV Market in New York: Department of Public Service Staff Straw Proposal on Track One Issues, Aug 22 2015, http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7bCA26764A-09C8-46BF-9CF6-F5215F63EF62%7d

[206] U.S. Energy Information Administration, District of Columbia Electricity Profile 2014, Table 1: 2014 Summary Statistics, http://www.eia.gov/electricity/state/districtofcolumbia/

To guide the definition of both a grid vision and the specific transition stages, the District Government should consider applying principles that have been developed to guide other jurisdictions. Such principles set a tone for the overall grid modernization process and can improve stakeholder confidence in their ability to engage in it. Examples include the four principles found in the *More Than Smart* initiative based in California as well as the five principles proposed to guide New York's *Reforming the Energy Vision* proceedings.[207,208] These include principles focused on collaboration, transparency, standardization, action-orientation, planning processes, roles, open access, flexibility, and scenario-based planning. However, as nearly all electricity is generated outside the District's borders, the District will need to define a set of principles most appropriate to its context.

Next Steps:

- Develop a District grid vision and characterize the expected transition stages before the end of 2016**.**
- Review and update the grid vision during the development of the next CEP, as needed.

ESM.2 Adopt a framework for valuing distributed energy resource costs and benefits

Action: Develop or adapt an existing benefit-cost analysis framework for the consistent and transparent evaluation of DER additions and updates to the grid.

Relevance: In moving toward a grid planning model that explicitly and increasingly focuses on DER, governments and utilities will need to reevaluate their approach to investment decisions. To ensure investments in infrastructure will provide value throughout their lifetime (i.e., decades into the future), decision-makers will need appropriate methods to comprehensively value the private and societal costs and benefits of the existing distribution grid, grid enhancements, and DER integration.

Details: A benefit-cost analysis framework should provide a consistent and transparent approach to evaluating all potential DER and grid modernization investments. It must be capable of accounting for the value of making progress toward each of the District's grid objectives (e.g., efficiency, flexibility, resilience) and focus on the short- and long-term impacts of DER integration. Among other things, such a framework must also be capable of accounting for:

- Current grid capabilities.
- Opportunities to defer or avoid infrastructure costs.
- Cross-dependencies between technologies.
- Anticipated capability needs of the future (Stage 3) grid.
- The equity impacts of costs and benefits.

[207] More Than Smart: A Framework to Make the Distribution Grid More Open, Efficient and Resilient (pp3-4,11), 2014, Greentech Leadership Group, http://morethansmart.org/wp-content/uploads/2015/06/More-Than-Smart-Report-by-GTLG-and-Caltech-08.11.14.pdf

[208] Developing the REV Market in New York: Department of Public Service Staff Straw Proposal on Track One Issues, Aug 22 2015, http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7bCA26764A-09C8-46BF-9CF6-F5215F63EF62%7d

- The locational value of DER, including a valuation of integrating DER in a specific location on the distribution grid, and its ability to support real-time operational services, reduce peak demand, and defer other infrastructure investments.[209]

Several examples of benefit-cost frameworks have been developed that can provide a template for the District, including:

- Advanced Energy Economy Institute's *Benefit-Cost Analysis for Distributed Energy Resources*[210]
- California's proposed *Locational Net Benefit Analysis*[211]
- The *Distributed Energy Resource Avoided Cost Calculator* (DERAC)[212]
- New York's proposed *Benefit-Cost Analysis (BCA) Framework*[213]
- EPRI's *The Integrated Grid Benefit-Cost Framework*[214]
- Analysis Group's *The Value of "DER" to "D"*[215]

Once this framework has been developed, the District Government should establish a clear set of procedures to evaluate any DER proposed by the District Government, utilities, or other energy supply system stakeholders. Individual customers that add DER privately should be exempt; however, the benefit-cost framework can and should be used to inform the design of policies, programs, and targeted outreach (e.g., the solar proliferation strategy in Action CRE.5).

Next Steps:

- Collaborate with the Public Service Commission in 2016 and early 2017 to develop a framework through which to evaluate DER.
- Review and revise the framework as needed when updating the grid vision during the development of the next CEP.

ESM.3 Support the collaborative development of an integrated distribution plan

Action: Work with the PSC and Pepco to develop an integrated distribution plan designed to strategically and cost-effectively support the modernization of the grid to its envisioned future state.

Relevance: Electricity systems require significant investments to maintain reliable and efficient energy delivery. As an example, Pepco is planning to invest about $1.5 billion into its distribution infrastructure between 2016 and 2020.[216] These are investments into infrastructure that will last for decades into the

[209] De Martini and Kristov, 2015, Distributed Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight

[210] 2014, https://www.aee.net/aeei/resources/benefit-cost-analysis-der.html

[211] 2016, http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M161/K474/161474143.PDF

[212] 2011, https://www.ethree.com/documents/DERAvoidedCostModel_v3_9_2011_v4d.xlsm

[213] 2015, http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/c12c0a18f55877e785257e6f005d533e/$FILE/Staff_BCA_White paper_Final.pdf

[214] 2015, http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002004878

[215] 2016, http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Organization/Divisions/Policy_and_Planning/Thought_Leaders_Events/Tierney%20White%20Paper%20-%20Value%20of%20DER%20to%20D%20-%203-30-2016%20FINAL.pdf

[216] Formal Case 1139 – Application, Direct Testimony and Exhibits of Potomac Electric Power Company Witnesses Velazquez and McGowan

future, and thus require careful planning and analysis to ensure that infrastructure is designed to adequately serve the District's future needs. Without anticipating future integration with DER, these costly investments risk becoming stranded assets.

To ensure investments in the grid are designed to support and accommodate grid modernization efforts, the District needs a formal planning process that accounts for high levels of DER integration. Integrated distribution planning (IDP) explicitly accounts for DER to help utilities and regulators make short- and medium-term investment decisions, understand where to dedicate resources, and identify outstanding issues that need additional evaluation or investigation.[217]

Details: Utilities traditionally engage in planning processes that focus on utility-owned infrastructure and assets, and are driven by financial needs and reliability obligations. This type of planning has been found to be ill-suited to a grid with a high penetration of DER.[218] By contrast, IDP involves the following:

- Explicit consideration of energy-efficiency and load-management programs as alternatives to typical solutions using traditional generation resources.
- Consideration of environmental factors in addition to direct economic costs;
- Public participation.
- Analysis of the uncertainties and risks posed by different resource portfolios and by external factors.[219]

As noted by the District Government, stakeholder comments on the Formal Case 1130 proceedings indicate that there may be an emerging consensus by a majority of stakeholders regarding the importance of a holistic and comprehensive integrated planning process.[220]

To succeed with IDP, the District Government needs to a framework to guide the electricity system planning process. Two states have recognized the need for IDP through legislation—California and Hawaii—while several regulators and utilities are tackling IDP in other states. [221,222] While the District imports nearly all its electricity, key principles and lessons learned from other jurisdictions will nevertheless remain consistent. As such, the District Government should work with the PSC and Pepco to review the proceedings and experiences in other jurisdictions to determine how to develop their own IDP framework. To begin, the District can build on existing IDP frameworks outlined in grid modernization literature.[223] Possible IDP processes include:

http://phx.corporate-ir.net/phoenix.zhtml?c=62854&p=irol-newsArticle&ID=2140909

[217] Integrated distribution planning (IDP) is also known as distributed resource planning (DRP).

[218] Comment on the Scope of the Proceeding by the District of Columbia Government (p.3), Formal Case 1130, District of Columbia Public Service Commission.

[219] Hirst and Goldman, 1991, Creating the Future: Integrated Resource Planning for Electric Utilities, Annu. Rev. Energy Environ (p. 91)

[220] Supplementary Comment for the Third Information Session by the District of Columbia Government, Formal Case 1130, District of Columbia Public Service Commission

[221] California Public Utility Code §769 and regulation: http://www.cpuc.ca.gov/PUC/energy/drp/.

[222] Hawaii Grid Modernization Law HB1943: http://www.capitol.hawaii.gov/session2014/bills/HB1943_CD1_.htm.

[223] e.g., De Martini and Kristov, 2015, Distributed Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight;
Electric Power Research Institute, 2015, The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources

- Running multiple multi-decade DER adoption scenarios with probabilistic engineering methods.
- Updating interconnection studies and procedures for DER based on revised planning methods and to accommodate an expanded volume of requests.
- Conducting a hosting capacity study to determine the distribution grid's ability to accommodate DER.
- Assessing the locational net value of adding DERs to different parts of the grid (may be positive or negative).
- Aligning transmission and distribution (T&D) planning and specifying the linkages between of activities to the jurisdiction's demand forecasting and procurement proceedings.
- Identifying which capital projects are likely candidates for deferral or avoidance through the procurement of DER alternatives.[224,225]

An effective IDP process should be aligned with and informed by several other recommended grid modernization actions, including the grid vision (ESM.1), DER benefit-cost framework (ESM.2), hosting capacity study (ESM.6), and energy mapping (ESM.7). IDP should then inform other recommended actions, including developing a list of no regrets actions (ESM.8), removing legislative and regulatory barriers (ESM.5), and pursuing pilot and demonstration projects (ESM.11). Actions identified in the District's forthcoming *Climate Ready DC Plan* should also be considered in the development of the IDP process.

Next Steps:

- After the development of the grid vision and DER benefit-cost framework in 2017, collaborate with the PSC and Pepco to develop a new electricity system planning framework based on IDP.
- Continue to work with the PSC and Pepco to update the IDP with updates to the CEP.

ESM.4 Intervene in Public Service Commission proceedings related to grid modernization

Action: Intervene and participate in PSC proceedings related to grid modernization to ensure their coordination with other cases and filings that may affect or be affected by modernization efforts.

Relevance: Grid modernization efforts currently underway in the District have been primarily led by the Public Services Commission (PSC) through Formal Case 1130 (FC1130) *Investigation into Modernizing the Energy Delivery Structure for Increased Sustainability*.[226] The PSC process invites input from and collaboration with relevant stakeholders, and will continue to be a central actor in processes and decisions affecting grid modernization through its proceedings on formal cases and filings.

Details: As noted above, the District Government is already actively engaged in Formal Case 1130 (FC1130) and must remain engaged to ensure the District's long-term needs and objectives are adequately addressed. The specific formal case and filings relevant to the District's interests will be defined by the

[224] Adapted from De Martini and Kristov, 2015, Distributed Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight

[225] Developing the REV Market in New York: Department of Public Service Staff Straw Proposal on Track One Issues, Aug 22 2015, http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7bCA26764A-09C8-46BF-9CF6-F5215F63EF62%7d

[226] http://www.dcpsc.org/esr/FC1130_IncreasedSustainability.asp

District's grid vision (Action ESM.1) and integrated distribution plan (Action ESM.3). Two recent examples in the District include FC1050 *Investigation of Implementation of Interconnection Standards in the District of Columbia* and FC1114 *Investigation of the policy, economic, legal and technical issues and questions related to establishing a dynamic pricing plan in the District of Columbia*.[227,228] FC1050 will likely have implications for customers' ability and willingness to install DER, while FC1114 may provide an opportunity to propose changes to rate structures that encourage greater demand management and energy efficiency.

Next Steps:

- Continue to actively intervene in FC1130.
- Identify, monitor and intervene in other current and future PSC proceedings pertinent to grid modernization efforts.

4.2.2.2 Analysis of the Electricity System Needs and Capabilities

ESM.5 Outline a path to overcome legislative and regulatory barriers to grid modernization

Action: Investigate grid modernization actions in other leading regions. Outline the path the District will take to shift the current regulatory model to one capable of supporting a grid with the characteristics necessary to achieve the District's 2032 and 2050 climate and energy targets.

Relevance: Like the grid itself, jurisdictions' current legislative and regulatory frameworks were designed to function in a centralized electricity generation model. Utilities, customers, and other actors connected to the grid all make decisions that fit within the existing legislative and regulatory framework. Where that framework is misaligned with grid modernization needs, actors will make decisions that may run counter to those needed to support the grid modernization process. As such, the District Government must update its legislative and regulatory framework through multiple phases to properly guide actors' decision-making as overall learning increases and the electricity system evolves through the modernization stages (see Section 4.2.1.3).

Details: As noted in Section 4.2.1.3, the development of a grid vision and the definition of grid modernization transition stages are both important actions to help the District Government develop an understanding of future grid needs, and to clarify the technologies, utility business models, and regulatory structures required to support them.

A next important step for the District Government will be to use this information to compare existing legislative and regulatory frameworks to the anticipated needs of the future grid. As with other actions in this section, looking to other jurisdictions further along in their grid modernization process will help to clarify what future legislative and regulatory framework may require. This process should be aligned with integrated distribution planning (Action ESM.3).

This process should result in two sets of legislative and regulatory reforms: reforms that can be pursued right away, and those that will require additional time or information to implement, such as additional

[227] FC1050 Investigation of Implementation of Interconnection Standards in the District of Columbia, http://www.dcpsc.org/esr/FC1050_IIISinDCasp

[228] FC1114 Investigation of the policy, economic, legal and technical issues and questions related to establishing a dynamic pricing plan in the District of Columbia, http://bit.ly/FC1114

analysis, pilot projects, or phased changes based on the scale of DER adoption and market readiness. For example, the District Government can begin by assessing and streamlining rules and procedures for interconnecting DER to the system, where barriers to DER implementation can easily arise.[229] Once identified, the District Government should implement actions that support a movement into the next stage of the grid modernization process.

An example of reforms that may require additional analysis is the set of rules governing peer-to-peer energy transactions. These rules will be critical to move the electricity system to the third stage of grid modernization, and can provide significant opportunities to improve grid efficiency and reduce incidences of wasted energy in the medium-term. Realizing the benefits of these reforms will also require the concurrent development of a fair and efficient market with associated regulatory oversight, and will therefore require careful investigation and strategic planning to be executed successfully.

Next Steps:

- Following the development of the grid vision, develop an inventory of legislation and regulation that may affect grid modernization.
- Identify legislation and regulations that present barriers to the District's progression through the stages of grid modernization, and collaborate with the PSC (and other agencies as necessary) to revise them.

ESM.6 Conduct a hosting capacity study of the District's distribution grid

Action: Conduct or commission a hosting capacity study to determine the level of DER integration that can be accommodated on different parts of the distribution grid without impacting the current grid infrastructure's ability to deliver high quality and reliable electricity.

Relevance: Different sections of the District's existing grid will be able to accommodate different levels of DER, and will consequently require different types of upgrade and investment. This detailed information on the grid's capacity will be necessary for the District to effectively proceed with grid modernization efforts and ultimately achieve its 2032 targets.

Details: Hosting capacity refers to the capacity of any given portion of the distribution system to accommodate additional DER given existing and already-planned facilities.[230] A hosting capacity study of the District's distribution grid will provide critical information for integrated distribution planning (Action ESM.3), as well as any locational value assessments. In particular, study results will help the District identify and compare different opportunities to increase the capacity of existing feeder lines, either through targeted building energy use reduction actions, or the use of new DER technologies (e.g., smart inverters).

Study results will also help the District to prioritize grid modernization actions by identifying no regrets actions (Action ESM.8) and opportunities for pilot and demonstration projects (Action ESM.11). The

[229] De Martini and Kristov, 2015, Distributed Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight

[230] Electric Power Research Institute, 2015, The Integrated Grid: A Benefit-Cost Framework

results of a hosting study could also provide valuable information for the development of the solar proliferation strategy (Action CRE.5).

As grid modernization efforts proceed and evolve, hosting capacity studies triggered by certain thresholds of DER adoption can be conducted on a regular basis.

Next Steps:

- Initiate a hosting capacity analysis with Pepco in 2017, for completion in 2018.

ESM.7 Develop a location-based profile of energy use and GHG emissions

Action: Conduct a geospatial analysis of energy consumption, energy demand, PJM's locational marginal price, and GHG intensity based on grid location. Once complete, evaluate the usefulness of the tool and its potential improvements, and work to integrate it in regular, iterative analyses of the District's energy supply system.

Relevance: While the hosting capacity study recommended above reveals information on energy supply, an energy mapping exercise provides insights into energy demand. This provides valuable information on the current demand on the electricity system, as well as the potential future demand of a District more heavily reliant on electricity. This exercise supports both grid modernization efforts, as well as actions that target energy use and GHG emissions reductions directly.

Details: The District's existing building energy benchmarking data and advanced metering infrastructure provide a foundation upon which an energy map can be developed. Such a map can provide a geographic picture of energy consumption, energy price, energy demand, and GHG emissions in the District, providing valuable information for integrated distribution planning activities (see Action ESM.3), including decisions about peak demand reduction opportunities and infrastructure investments and deferrals. While the map may initially depend on both real data and simulations, accuracy will be improved with the use of real data and as such should be prioritized.

As with London's Heat Map, the primary purpose of this mapping exercise is to support the identification of neighborhoods where DER can be deployed to provide robust benefit to the distribution system.[231] As the prevalence of DER increases, the energy map can be overlaid with the hosting capacity analysis (Action ESM.6). With this combined data, the District can simulate rates of DER adoption at the neighborhood scale to help identify priority targets for different types of investment, as well as potential candidate areas for pilot projects (see Action ESM.11).

In developing this energy map, the District Government should account for all types of energy – both electricity and other, fossil fuel based energy sources. Developing a geospatial understanding of natural gas demand (and building thermal demand in general) will assist in the identification of neighborhoods where thermal energy demand is high and where a neighborhood energy system may consequently be supported (see Action CRE.8). It will additionally help to identify areas of high natural gas use and by extension, where electricity growth can be anticipated as buildings shift from natural gas to electricity-based equipment for their thermal needs.

[231] London Heat Map, http://www.londonheatmap.org.uk/Content/HeatMap.aspx

Next Steps:

- Undertake an initial mapping analysis in 2016 and 2017 to support energy use reductions and DER increases.
- Institute the mapping analysis as a regularly used tool through the implementation of the CEP and progression of the grid modernization process.

4.2.2.3 Immediate No Regrets Actions

ESM.8 Generate, evaluate, and prioritize a list of actions that the can be taken immediately

Action: Identify the necessary infrastructural, organizational, operational, financial, regulatory, and technological features and components for grid modernization and the realization of the grid vision. Prioritize these actions for immediate and short-term implementation.

Relevance: While the specific characteristics of a modernized grid will continue to emerge, jurisdictions further along in the grid modernization process have indicated a set of key features that are consistent across future scenarios. These characteristics should be the focal points for immediate planning, action, and investment.

Details: The pace and scope of change required for grid modernization can be a decade-long process. However, both DER demand and the need for energy use and GHG reductions increases and accelerates each year. To keep pace with these changes, the District must begin to act immediately, even while planning its grid modernization process. No regrets actions represent key opportunities for the District Government to make swift progress toward its 2032 targets.

A first step is to generate a list of the infrastructural, organizational, operational, financial, regulatory, and technological features and components that appear to be consistent and necessary to modernizing the grid. From this list, a subset of near-term no regrets actions that can be taken immediately should be prioritized for investment. No regrets actions are those initiatives that both improve the state of a conventional electricity system or support the shift to a modernized electricity systems, and can help key stakeholders gain important experience around key aspects of grid modernization.[232] They may address aspects of grid infrastructure, DER technologies, operational changes, regulatory structures, or any other aspect of the electricity system.

Though the precise nature of these actions will depend on the District's particular context, analysts have identified a list of potential no regrets actions:

- Advanced field telecommunications networks.
- Increased grid operational visibility.
- Fast and flexible bulk electric storage to balance power fluctuations and mismatches resulting from non-dispatchable generation.
- Aggregated advanced meter data at the feeder level to enhance energy services.
- Smart inverters that enable DER to provide voltage and frequency support and to communicate with energy management systems.

[232] Developing the REV Market in New York: Department of Public Service Staff Straw Proposal on Track One Issues, Aug 22 2015, http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7bCA26764A-09C8-46BF-9CF6-F5215F63EF62%7d

- Tools that increase customer knowledge of their electricity use and how to better manage it.
- Building codes that facilitate the integration of DER with a focus on long-term grid capabilities needed to achieve the grid vision (see Action CRE.6).
- Tools to provide electronic sensing and automated data extraction.
- Adjustable electronics that allow dynamic control of grid power flows.
- Utility and regulatory procedures that expedite the evaluation and integration of DER.
- Legislation allowing third-party access to grid data. [233,234,235]

The District Government should align this action with the development of integrated resource plans (Action ESM.3) and utilize the newly developed benefit-cost framework for DER (Action ESM.2).

Next Steps:

- After the development of the grid vision and the characterization of the District's grid modernization stages, conduct additional research on commonalities in grid modernization activities across leading jurisdictions.
- Generate a list of no regrets actions that the District Government, PSC, and Pepco can implement immediately.

ESM.9 Leverage existing advanced metering infrastructure data

Action: Identify and pursue opportunities to utilize the data collected by advanced metering infrastructure already installed across the District.

Relevance: In partnership with Pepco, the District Government undertook a *Smart Grid Project* that included the deployment of advanced metering infrastructure (AMI) throughout the District.[236] Pepco has now exchanged over 99% (>296,000) of the District's traditional meters with smart meters.[237] This deployment of AMI offers the District a strong foundation on which to strategically modernize the grid, plan for DER deployment, and improve grid resilience.

Details: While the District is one of only a few jurisdictions in the U.S. with an extensive AMI network, it has not yet begun to take advantage of the full functionality of this infrastructure. For example, smart meters collect and transmit detailed real-time customer use, which can be used by both customers and regulators to reduce peak demand. However, this data is not yet available. Customers can get the data on a next-day basis via Green Button's Connect My Data Application Program Interface, but this historical interval data is not nearly as useful as true real-time data. The AMI meters have the capability to transmit real time data to customers via the ZigBee network; however, Pepco has not turned this function on.

By making this data available to the District and other potential stakeholders, a greater understanding of energy use in different development contexts in the District can be achieved. Interval meter data is useful

[233] More Than Smart: A Framework to Make the Distribution Grid More Open, Efficient and Resilient (pp3-4,11), 2014, Greentech Leadership Group, http://morethansmart.org/wp-content/uploads/2015/06/More-Than-Smart-Report-by-GTLG-and-Caltech-08.11.14.pdf

[234] Electric Power Research Institute, 2015, The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources

[235] Testimony of Dr. Jeffrey Taft, Chief Architect for Electric Grid Transformation, Pacific Northwest National Laboratory before the U.S. Senate Committee on Energy and Natural Resources, March 17, 2015.

[236] Pepco-District of Columbia: Smart Grid Project, https://www.smartgrid.gov/files/Pepco-District-Columbia-Smart-Grid-Project-2015.pdf

[237] Fact Sheet, Pepco, http://www.pepco.com/uploadedFiles/wwwpepcocom/PepcoDCFactSheet.pdf

to the District, consumers, Demand-Side Management program operators, and potential microgrid providers. It can support the District and its stakeholders in achieving energy use reductions, peak load reductions, GHG reductions, DER installations, and the overall grid modernizing process.

Next Steps:

- Work with Pepco and the PSC to develop a timeline to realize the full potential of AMI in the District.
- If needed, develop one or more pilot programs to test the potential of improved access to information before taking this initiative further.

ESM.10 Identify near-term projects that should be coordinated with grid modernization activities

Action: Develop an inventory of large-scale development projects and government regulatory procedures scheduled to occur within the next five years that may affect or be affected by grid modernization. Take steps to align grid modernization efforts with these actions.

Relevance: The District Government and its stakeholders are implementing many actions beyond grid modernization, some of which may offer mutually beneficial opportunities through project alignment. Coordinating grid modernization efforts with such actions can lower costs, accelerate the grid modernization process, and ultimately support the District achieve its 2032 climate and energy targets more easily.

Details: Actions planned or currently underway offer opportunities to share upfront investment costs, reduce transaction costs (e.g., labor and management), accelerate implementation, and support pilot projects. The most obvious examples are larger-scale infrastructure and construction projects. However, aligning with less tangible actions such as building and energy code updates (see Action NC.1) or ongoing regulatory procedures (Action ESM.4) will also help to ensure that District Government actions will cost-effectively and reliably support a modernized grid.

As such, the District Government should develop an inventory of relevant projects and proceedings that are either currently ongoing or expected to occur over the next five years, and seek opportunities for alignment. This process should be repeated as grid modernization efforts continue to ensure that staff focused on grid modernization are made aware of any new projects and proceedings.

This action should also be aligned with the actions presented in the forthcoming *Climate Ready DC Plan*, which will require significant upgrades to critical infrastructure (e.g., electricity substations, hospitals).

Next Steps:

- Immediately assemble an inventory of ongoing projects that may affect or be affected by grid modernization
- In 2016 and 2017, institute a regular process whereby such projects can be identified.

4.2.2.4 Proof of Concept Projects

ESM.11 Pursue pilot projects related to key modernization capabilities and technologies

Action: Identify and prioritize key capabilities and technologies that are critical to successful grid modernization but that would benefit from learning generated through a real-world test application. Develop and implement plans to undertake these pilot projects.

Relevance: As outlined in Section 4.2.1.3, grid modernization requires a phased transition through three stages to a future state that is currently only loosely defined. To clarify that future state, pilot projects can be used to test and evaluate grid modernization actions with uncertain impacts to better understand both their impact and value.

Details: Grid modernization requires coordinated long-term action supported by multiple stakeholders. The inherent uncertainty of the outcome of such a broad process can be reduced using research or analysis (as in several of the actions discussed above), or by conducting and evaluating real-world tests. An example of such program is California's Demand Response Auction Mechanism (DRAM) pilot program, initiated in 2015. The purpose of the DRAM program is to establish demand response as a market-based and highly responsive electricity resource. Through DRAM, California is working to establish a market-based auction, auction protocols, a standard contract, evaluation criteria, and non-binding cost estimates. In doing so, California will encourage third-parties to bid demand response resources into wholesale markets, in a similar way to how generators be bid into markets, by making the process easier, more consistent, and less risky.[238]

Other examples of pilot projects can be found in Australia, which will place select neighborhoods on microgrids powered entirely by solar and storage.[239,240] These kinds of projects are important tests of the viability of a zero GHG grid model, while providing valuable lessons for the utilities and regulators involved. Applied in the District, such pilot projects can help the District Government to understand the potential value of certain technologies (e.g., energy storage) and grid configurations (e.g., microgrids), as well as key modernization concepts. They help to clarify both the modernization process, as well as the final end state.

Pilot projects on a range of technologies and grid modernization concepts should be considered, including:

- Aggregated solar plus battery storage microgrids
- Demand side management as virtual power plant
- Automated distribution communication and sensing
- Conservation voltage regulation
- Smart inverters
- Fault location and isolation and service restoration

[238] California Public Utilities Commission, 2015 Annual Report, http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Annual_Reports/2015%20CPUC%20Performance%20and%20Accountability%20Annual%20Report_v004.pdf

[239] Utility to take part of Melbourne suburb off-grid with solar + storage, Apr 18 2016, Reneweconomy, http://reneweconomy.com.au/2016/utility-to-take-part-of-melbourne-suburb-off-grid-with-solar-storage-94822

[240] South Australia Launches Largest Trial Of Rooftop Solar & Energy Storage, May 19 2016, CleanTechnica http://cleantechnica.com/2016/05/19/south-australia-launches-biggest-trial-rooftop-solar-energy-storage/

- Microgrids for critical infrastructure
- Zero GHG emergency or backup generation
- Batteries and other energy storage and backup generation as peak shaving resources
- Peer-to-peer energy transaction models

The District should pursue such pilot projects in coordination with stakeholders where appropriate, and ensure the broad communication and dissemination of lessons learned.

A pilot project opportunity in the short-term already exists at Mt. Vernon Square, where Pepco has identified a need to install a new $298.4 million substation as early as 2020 to address anticipated network overloads and to serve an increased load associated with new mixed-used developments.[241] In lieu of the investment in the substation, the District could work with Pepco to design and implement a pilot project focused on demonstrating the ability of demand management-focused DER to defer traditional grid infrastructure investments. Such a project draws on the experiences of California-based Pacific Gas & Electric, which estimated that a $192 million investment into transmission improvements could be avoided due to the growth in DER, energy efficiency, and demand response.[242] Applying this principle in the District would demonstrate the potential of grid modernization to both avoid future investment costs and reduce GHG emissions.

Next Steps:

- Pursue the development of a pilot project at Mt. Vernon Square.
- Using the results of other grid modernization actions, identify and pursue pilot projects that will help the District and its stakeholders understand the process and potential outcome of grid modernization.

[241] Supplementary Comment for the Third Information Session by the District of Columbia Government, Formal Case 1130, District of Columbia Public Service Commission

[242] Californians Just Saved $192 Million Thanks to Efficiency and Rooftop Solar, May 31 2016, Greentech Media, http://www.greentechmedia.com/articles/read/Californians-Just-Saved-192-Million-Thanks-to-Efficiency-and-Rooftop-Solar

4.2.3 Electricity System Modernization Roadmap

		The Five-Year CEP					Projected Path to 2032 Climate and Energy Targets										
Electricity System Modernization	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Planning and Coordination																	
ESM.1 Define a vision of the future grid and characterize the stages of grid modernization																	
ESM.2 Adopt a framework for valuing distributed energy resource costs and benefits																	
ESM.3 Support the collaborative development of an integrated distribution plan																	
ESM.4 Intervene in Public Service Commission proceedings related to grid modernization																	
Analysis of the Electricity System Needs and Capabilities																	
ESM.5 Outline a path to overcome legislative and regulatory barriers to grid modernization																	
ESM.6 Conduct a hosting capacity study of the District's distribution grid																	
ESM.7 Develop a location-based profile of energy use and GHG emissions																	
Immediate No Regrets Actions																	
ESM.8 Generate, evaluate, and prioritize a list of actions that the can be taken immediately																	
ESM.9 Leverage existing advanced metering infrastructure data																	
ESM.10 Identify near-term projects that should be coordinated with grid modernization activities																	
Proof of Concept Projects																	
ESM.11 Pursue pilot projects related to key modernization capabilities and technologies																	

Legend	
Planning, Research, and Program and Policy Development	
Plan or Program Implementation	
Policy or Regulation Implementation	
Pilot Project	
Program Evaluation	

5 TRANSPORTATION

This chapter outlines the actions necessary to reduce the GHG emissions that result from the District's use of passenger vehicles. It is important to note that it does not include actions to shift the District's mode share (e.g., from driving to cycling), nor does it refer to actions to reduce GHG emissions from fleet vehicles. This omission is deliberate and intended to ensure that the chapter does not duplicate other research, planning, and policy efforts, including the District's Multimodal Long-Range Transportation Plan *moveDC*, the *Sustainable DC Plan*, and the forthcoming *Greening the Fleet Study*. The *moveDC Plan* in particular provides long- and short-term recommendations for the achievement of a number of transportation-related objectives, including the installation of public electric vehicle chargers.[243]

However, the actions recommended below align with those in the *Sustainable DC Plan*, the *moveDC Plan*, and other District plans, particularly those focused on achieving the 2032 mode share target established in the *Sustainable DC Plan*: 50% of commuter trips from public transit, 25% from biking and walking, and 25% by car or taxi.[244] The impact of the actions described below have been calculated based on the assumption that the District will achieve this mode share target, thus contributing to the total emissions reductions needed to achieve the 2032 target. The set of transportation-focused actions is summarized in a roadmap at the end of the chapter.

5.1 Electric Vehicle Readiness & Adoption

5.1.1 Reducing GHG Emissions from Transportation

As in other urban centers, emissions from the transportation sector are significantly lower in the District than those from the built environment, largely as a result of the District's high density land use and abundance of transit options. Vehicle miles traveled (VMT) per capita have also decreased considerably between 2000 and 2010, in part attributable to a decrease in the number of District residents who travel by private vehicle from 49.4% to 40.7%.[245] During this same period, gasoline and diesel used in vehicles made up only 12% of the District's energy use, with use steadily declining as federal standards improved vehicle fuel efficiencies and transit ridership increased, due in part to high gasoline prices.[246] However, approximately 21% of the District's annual GHG emissions come from vehicles, making the transportation sector an important target in efforts to achieve the District's target of reducing emissions by 80% by 2050.[247] The focus of this section is therefore on recommended actions designed to shift the existing passenger vehicle stock (e.g., cars and trucks owned by individuals) from one dependent on fossil fuels to one made up entirely of low carbon and eventually zero-emission passenger vehicles.

[243] moveDC, http://www.wemoveDCorg/index2.html

[244] Sustainable DC Plan, p.12

[245] This does not include people who commute from outside the District. moveDC – Multimodal Long-Range Transportation Plan, 2014, p.5.

[246] 2014 Comprehensive Energy Plan for the District of Columbia (unreleased), pp.4, 24.

[247] 2011 District of Columbia Greenhouse Gas Emissions Inventory, http://doee.DC.gov/sites/default/files/dc/sites/ddoe/publication/attachments/GHGinventory-1205-.pdf.

5.1.1.1 The Need for Zero Emission Vehicles

While increases in fuel efficiency and shifts to transit and other lower emission transportation options will continue to play important roles in reducing GHG emissions, passenger vehicles will continue to form a substantial part of personal mobility. Research has indicated that achieving an 80% reduction in GHG emissions by 2050 will require passenger vehicle fleets to consist entirely, or nearly entirely of vehicles that emit no GHG emissions.[248] As vehicles typically remain in use for an average of 11.5 years or greater, shifting passenger vehicle fleets to new no-carbon technology will require a longer-term process.[249] Furthermore, none of the available zero-emission vehicle technologies are suitable replacements for fossil fuel use in heavy freight uses (e.g., airline, rail, etc.). This means that even if transportation emissions are cut by 80% by 2050, the remaining 20% will require a focus on heavy freight. As such, the District must quickly begin eliciting the shift from petroleum-powered vehicles to zero-emission vehicles if GHG emission reduction targets are to be achieved.

Zero emission vehicles are defined as those that emit zero pollutants (GHG or otherwise) during their operation, including emissions that result from fuel production. Zero emission vehicles can be powered by a range of energy sources such as electricity, hydrogen, or ethanol; however, electric vehicles have enjoyed the most success in terms of market uptake and adoption.[250] Compared to hydrogen vehicles, electric vehicles are more advanced in their technological development, come in a wider variety of models, and can be charged at home and work, making them more attractive and less reliant on the public charging infrastructure. Low- and zero-carbon electricity production is also more established and cheaper than in hydrogen production, and has an established transmission and distribution network. By contrast, zero-emission ethanol vehicles depend on the development of cost-effective cellulosic ethanol production - which has thus far proved difficult - and a stable supply of feedstock, which has been controversial in the U.S. due to perceived competition with food production. Thus, while hydrogen and ethanol vehicles may have a long-term role to play in a low- or zero-carbon passenger vehicle future, they are a lower priority for local and state governments than electric vehicles.

Recommendations in this section therefore focus on policies and programs that can support a transition to electric vehicles, or EVs. These include *battery* electric vehicles powered entirely by electricity from the grid, as well as *plug-in hybrid* electric vehicles powered by electricity from the grid and supplemented by a gasoline or diesel engine to provide a longer driving range. In some states, plug-in hybrid electric vehicles are considered a transitional vehicle on the pathway to a 100% zero-emission passenger vehicle fleet.[251]

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[248] E.g., Williams et al. (2012). The technology path to deep greenhouse gas emissions cuts by 2050: the pivotal role of electricity. Science, 335(6064), 53–9;
Kyle, P., Kim, S.H., 2011. Long-term implications of alternative light-duty vehicle technologies for global greenhouse gas emissions and primary energy demands. Energy Policy 39, 3012–3024. doi:10.1016/j.enpol.2011.03.016;
National Research Council, 2013. Transitions to Alternative Vehicles and Fuels. The National Academies Press, Washington, DC;
California Air Resources Board, 2009, Attachment B - 2050 Greenhouse Gas Emissions Analysis: Staff Modeling in Support of the Zero Emission Vehicle Regulation.

[249] Average Age of Light Vehicles in the U.S. Rises Slightly in 2015 to 11.5 years, IHS Reports, http://press.ihs.com/press-release/automotive/average-age-light-vehicles-us-rises-slightly-2015-115-years-ihs-reports

[250] International Energy Agency, 2016, Tracking Clean Energy Progress 2016, http://www.iea.org/publications/freepublications/publication/TrackingCleanEnergyProgress2016.pdf

[251] California Air Resources Board, 2009.

To transition to the passenger vehicle sector to EVs, the District Government must remove or overcome adoption barriers that limit citizens' interest and willingness to purchase them. These barriers are rooted in both technological characteristics and consumer preferences that have made EVs more expensive and less attractive than conventional vehicles. In addition to higher prices, consumers also have concerns over EV driving range, the availability of charging infrastructure, the risks associated with a new technology, adequate choice in available models, and overall reliability.[252] Some of these barriers can be addressed directly by the District Government; for example, through the provision of charging infrastructure. Others depend on action by automakers, such as the continued expansion of EV driving range.

5.1.1.2 The District's Passenger Vehicle Market Context

Like all jurisdictions, the scale of EV adoption in the District depends significantly on the extent to which automakers produce and sell affordable EVs that are attractive to a majority of consumers. However, the District has some unique characteristics that will require novel approaches to increasing EVs. From a geographical perspective, the District covers a small, dense land area that makes public transit, cycling, and walking more accessible and attractive to citizens. As a result, 37% of households do not own a vehicle – a number that is approximately twice the national average.[253] However, the District's geography and economy also means that approximately 400,000 commuters enter the District every workday (equivalent to 60% of the District's population), with the majority reliant on personal vehicles. [254,255] Furthermore, the District contains no new vehicle dealerships (with the exception of a single Tesla showroom), meaning purchase incentives currently have limited value. The District's geography and land use patterns make this number unlikely to change.[256]

As such, the District is highly dependent on actions taken by neighboring states (Maryland and Virginia), and is tasked with identifying novel approaches to convince both District residents and commuters to choose EVs rather than conventional petroleum-fueled vehicles. As a member of the *Transportation & Climate Initiative of the Northeast and Mid-Atlantic States,* and a member jurisdiction of the Metropolitan Washington Council of Governments, the District Government has two valuable forums in which to coordinate actions and approaches with neighboring states.[257,258]

5.1.1.3 Current District Government Actions

Several actions have already been taken. As of 2015, the District had more policies and programs supporting EVs than any other city outside California (tied with Portland).[259] However, the District has a

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[252] Sierzchula, W., Bakker, S., Maat, K., van Wee, B., 2014. The influence of financial incentives and other socio-economic factors on electric vehicle adoption. Energy Policy 68, 183–194. doi:10.1016/j.enpol.2014.01.043

[253] *National Capitol Region Transportation Planning Board (NCRTPB)*

[254] Commuter figures from *NCRTPB*.

[255] Personal vehicle reliance information from 2014 Comprehensive Energy Plan for the District of Columbia (unreleased), p.180.

[256] Discussion with DOEE staff, March 18, 2016.

[257] Transportation & Climate Initiative - Northeast Electric Vehicle Network in Action, http://www.transportationandclimate.org/northeast-electric-vehicle-network-action

[258] Metropolitan Washington Council of Governments, Electric Vehicle Planning Initiative – Documents, http://www.mwcog.org/committee/committee/documents.asp?COMMITTEE_ID=272

[259] Lutsey, N., Searle, S., Chambliss, S., Bandivadekar, A., 2015, Assessment of leading electric vehicle promotion activities in United States cities. Washington DC, USA.

lower-than-average EV market share when compared to the other 24 most populous cities in the U.S (0.75% of new vehicles registered in the District in 2014).[260] Current actions include:

- An exemption for vehicle title fees (available to any vehicle with a fuel economy over 40 mpg).[261]
- A tax incentive to convert petroleum-fueled vehicles to electricity (and other qualifying alternative fuels).[262]
- Exemptions from high occupancy vehicle lane restrictions and any time-of-day and day-of-week driving restrictions.[263]
- Tax incentives for residential and public charging infrastructure.[264]

In 2012, the District was the tenth most EV-ready city in the United States, with approximately 4.7 public charging stations for every 100,000 residents.[265] Furthermore, EV charger incentives are available until December 31, 2026, indicative of the District's commitment to facilitating a long-term shift to EVs.

The actions recommended below take two broad forms. EV adoption actions aim to shift vehicle purchases from petroleum-fueled vehicles to EVs, while EV readiness actions aim to prepare the District to support a long-term transition to zero-emission EVs. These recommendations should be implemented in conjunction with mode share-focused strategies included in the *moveDC Plan* and the *Sustainable DC Plan,* as well as fleet-focused actions in a forthcoming *Greening the Fleet Study* (2016). In addition to the recommendations below, the District should continue to exempt qualified EVs from high occupancy vehicle lane restrictions and any future congestion charges until EVs reach a significant level of adoption by drivers.

It should be noted that these recommendations target a critical aspect of reducing GHG emissions from vehicles – transitioning from petroleum-fueled vehicles to zero-emission vehicles – but do not cover the range of actions required to reduce both GHG emissions and energy use from vehicles. To significantly reduce GHG emissions from passenger vehicles, the District must also decarbonize the electricity the District consumes. Indeed, the very concept of EVs as zero-emission transportation mode assumes and requires a decarbonized electricity grid. Actions focused on this objective are included in the CEP's Clean & Renewable Energy Supply section.

[260] Lutsey, 2015, ICCT White Paper – Transition to a Global Zero-Emission Vehicle Fleet: A Collaborative Agenda for Governments; Jin et al., Oct 2014, ICCT White Paper – Evaluation of State-Level U.S. Electric Vehicle Incentives.

[261] DMV (2016) Green Driver State Incentives in Washington DC, http://www.dmv.org/washington-dc/green-driver-state-incentives.php

[262] Up to a maximum of $19,000. Applies to other qualified alternative fuels as well. National Conference of State Legislatures, 2015, State Efforts Promote Hybrid and Electric Vehicles, http://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx

[263] DMV (2016) Green Driver State Incentives in Washington DC

[264] GoElectricDrive Incentive Locator – District of Columbia, http://www.goelectricdrive.org/select-country/united-states/itemlist/category/120-district-of-columbia

[265] GTM Research, 2012, Top 10 EV-Ready Cities, http://www.greentechmedia.com/articles/read/Top-10-EV-Ready-Cities

5.1.2 Recommended Actions

5.1.2.1 Electric Vehicle Readiness

EV.1 Adopt an EV-ready building code

Action: Update building and construction codes to require buildings to install EV charging equipment and/or the ability to install future EV charging equipment.

Relevance: Over 80% of EV charging occurs at home or work. To achieve the level of EV adoption necessary to achieve the District's long-term GHG reductions, many more residential and commercial parking spaces will therefore need to be equipped with charging infrastructure. Both the perceived and actual availability of charging stations are critical to increasing consumer comfort with EVs, and thus the willingness to purchase one. While the installation of charging infrastructure can be costly, work in other jurisdictions indicates that it is significantly more cost-effective to install EV charging stations if the electrical infrastructure has already been in place.[266] As such, ensuring building parking and electrical systems are designed to accommodate future EV charging stations will improve the overall cost-effectiveness of achieving the District's GHG reduction target.

The District currently offers financial incentives for the installation of EV charging stations, but does not require charging stations or associated electrical infrastructure to actually be installed.[267] The District's Green Construction Code requires that new buildings and substantial building alterations install a minimum number of sustainable building requirements from a set of options, One option is the installation of one electric vehicle charging station (or the equivalent electrical infrastructure suitable for a future installation of electric vehicle charging stations) for every 30 parking spots. This applies to residential and commercial buildings greater than three stories and 10,000 square feet. Thus far, however, it appears only one development has elected to install an EV charger or the required electrical infrastructure.[268]

Details: At least three other cities have adopted building codes with EV requirements. Los Angeles requires that all residential buildings be equipped with either an EV charging outlet or the infrastructure necessary to install an outlet in the future.[269] The code requires all 1 to 2 family residential buildings to provide at least one EV charger-ready space, while all other residential buildings and high-rise commercial buildings are to ensure that 5% of parking stalls are EV charger-ready. Similarly, San Francisco's building code requires all new structures to be wired for EV charging stations, while Vancouver (Canada) requires a minimum of 20% of parking stalls in multi-family residential buildings to include a receptacle for EV

[266] California Department of Housing and Community Development, 2014, Electric Vehicle Ready Homes: Report on Electric Vehicle Readiness Study, http://www.hcd.ca.gov/codes/calgreen/ev_readiness_report_complete.pdf.

[267] Residential stations are eligible for a $1,000 tax credit and public charging stations are eligible for a $10,000 tax credit (up to 50% of purchase and installation cost).

[268] Conversation with DOEE Staff on Feb 10, 2016.

[269] U.S. Department of Energy Alternative Fuels Data Center, 2014, Los Angeles Sets the Stage for Plug-In Electric Vehicles, http://www.afDC.energy.gov/case/1002.

charging. [270,271] The City of Vancouver also requires developers to ensure that electrical rooms in these buildings provide sufficient space to contain the equipment necessary to provide EV chargers to 100% of stalls in the future.

The experience of these and other jurisdictions indicates that it is particularly difficult to get EV charging infrastructure installed at multi-family residential buildings.[272] As noted above, it is also more expensive to install chargers once the building has been constructed. Given that buildings stand for several decades, it is important for the District to take steps now to prepare for the transportation needs of the future. As such, the following recommendations are suggested:

- Update the building code to require single-family, multi-family, and commercial buildings to install a minimum number of EV charging stations and/or provide the electrical infrastructure (e.g., conduits, outlets) necessary for the installation of future charging stations.
- To gain value from the visibility of charging stations, ensure that the code requires EV charging stations and not only the infrastructure for future stations. Apply these rules to major retrofits to parking areas as well.
- Ensure building systems can accommodate EV future charging infrastructure across the entire parking lot.

In designing these building code requirements, the District may need to consider the electrical grid's ability to absorb large EV loads. For example, an analysis of California's electrical system showed that its grid could reliably handle 240 volt/40 amp charging stations, but that it could become overloaded with 240 volt/80 amp stations.[273] The District's grid should be evaluated in a similar way, particularly during future code reviews as the grid is upgraded, EV market share expands, and EV charging technology evolves. This action should also be coordinated with the adoption of an EV-ready parking lot requirement (Action EV.2) to ensure that requirements are mutually reinforcing and cover both building-sited and standalone parking lots.

Next Steps:

- During the next code cycle update, add a requirement for EV charging stations and EV-ready infrastructure in new and renovated buildings. Develop the code requirements with an understanding of the scale of EVs required in the future for the District to achieve its GHG targets.
- Review the requirement during each code review and update it to steadily increase requirements, account for EV adoption and the projected number of EVs necessary to achieve the District's GHG targets, and account for developments in EV charging infrastructure technology.

[270] San Francisco requirements from Lutsey, N., Searle, S., Chambliss, S., Bandivadekar, A., 2015.

[271] City of Vancouver, 2012, Electric vehicle charging requirements, http://vancouver.ca/home-property-development/electric-vehicle-charging-requirements.aspx.

[272] California Department of Housing and Community Development, 2014

[273] Herron, D., 2014, California soon to require all new housing to be "EV Capable", with conduit for electric vehicle charging infrastructure, http://bit.ly/1TBRFP0.

- Work with Pepco to continue to assess the ability of the electrical grid to absorb more and higher power charging stations. This work should be conducted by Building Code Advisory Committee and Building and Land Regulations Administration in coordination with District Department of Energy & Environment (DOEE) staff focused on EV infrastructure planning and Pepco.

EV.2 Adopt an EV-ready parking lot requirement

Action: Update building and construction codes to require new and renovated parking lots and garages to install EV chargers and/or the electrical infrastructure necessary to install EV charging infrastructure in the future.

Relevance: While they are used less than residential and workplace chargers, publicly available EV chargers (e.g., in parks and shopping centers) play a valuable role in facilitating a long-term transition to EVs. Parking lot charging stations increase consumer awareness of and comfort with EV technology, which can help increase adoption. Requiring parking lots to install EV chargers and/or infrastructure helps ensure publicly accessible parking lots can add EV chargers in the future more easily and at a lower cost. Further, the costs to install conduits can be 95% lower if carried out during initial construction or ongoing retrofit than as a standalone construction project.[274] However, the District currently has no requirements for publicly accessible parking lots to be EV-ready. Rather, publicly available EV chargers have been installed voluntarily by businesses or in partnership with the District.

Details: Two precedents form a basis for this recommendation. First, New York City requires a minimum of 20% of parking spaces in open lots and garages be embedded with the conduits necessary to install EV charging stations in the future.[275] This applies to both new construction and lots undergoing upgrades, with the exception of retail parking spaces. Similarly, California began a process of updating its construction codes in May 2016, and is expected to require all parking lots to have a minimum number of EV charger-ready spots.[276] The precise number of spots is contingent on the size of the parking lot, but covers approximately 6% to 12% of stalls. Drawing from these examples, the following recommendations are suggested:

- Update the District's construction codes to require that a minimum percentage of parking stalls in all parking lots contain EV chargers and are wired to add EV charging stations in the future.
- Apply the new codes to all new parking lots and parking lots in the process of being upgraded.
- As with the building codes, include a requirement for some EV chargers to increase awareness with and comfort with EVs.

This action should be coordinated with the adoption of an EV-ready building code (Action EV.1) to ensure the requirements are mutually reinforcing and cover both building-sited and standalone parking lots. The ways in which this action may align with other recommendations to pursue an EV-only car sharing fleet (Action EV.6) should also be considered.

[274] plugincars, 2013, New York Requires Garages and Lots to be Built EV-Ready, http://www.plugincars.com/new-york-requires-lots-and-garages-be-built-ev-ready-129063.html.

[275] Ibid.

[276] Final Express Terms for Proposed Building Standards of the California Building Standards Commission, 2015, http://www.documents.dgs.ca.gov/bsc/2015TriCycle/Commission-Review/Jan-2016/BSC-04-15-FET-Pt11.pdf.

Next Steps:

- During the next code cycle update, add a requirement for new and renovated parking lots and garages to install a minimum percentage of EV-ready spots and EV charging stations. As with the EV-ready building code above, develop these requirements with an understanding of the scale of EVs required in the future for the District to achieve its GHG targets, as well as the ability of the grid to absorb new EV loads.
- Review the requirements during each code review and update it to steadily increase requirements, while accounting for EV adoption, the projected number of EVs necessary to achieve the District's GHG targets, and developments in EV charging infrastructure technology. This work should be conducted by Building Code Advisory Committee and Building and Land Regulations Administration in coordination with DOEE staff focused on EV infrastructure planning and Pepco.

5.1.2.2 Electric Vehicle Adoption

EV.3 Implement an EV bulk buy program

Action: Partner with one or more automakers to offer an EV bulk buy program to District residents.

Relevance: As noted above, the District's small size and high land values restrict the possibility of any new vehicle dealerships.[277] Rather, the District is dependent on what dealerships in neighboring states offer. Furthermore, District residents cannot take advantage of those state incentives if the vehicles are registered in the District. As such, drivers may be even less likely to be interested in EVs than drivers in other regions. To overcome this barrier, the District must find innovative ways to increase both the availability and attractiveness of EVs to local drivers. An EV bulk buy program offers a feasible near-term solution: in addition to generating a one-time increase in the number of EVs on District roads, the program can increase the visibility of EVs, thus potentially improving consumer awareness of and comfort with EVs as a vehicle that can meet their driving needs.

Details: Boulder, Colorado (and nearby Adams County and Denver counties) implemented a bulk buy program of both EVs and solar panels in 2015, to great success. Boulder collaborated with Nissan North America and Boulder Nissan to offer the 2015 Nissan LEAF S with Quick Charge Package for over $8,000 less than the retail price ($23,461 vs. $31,810), before state and federal tax credits (which total $12,500).[278] Nissan Boulder sold 150 vehicles in just two months (a substantive increase over the monthly average of 15-20 sales), with an additional 300 customers in the pipeline. Given the success of the program, Boulder is currently investigating a second EV bulk buy program with Nissan and other automakers.[279]

[277] Discussion with DOEE staff, March 18, 2016.

[278] RMI Outlet, 2015.

[279] Discussion with Boulder planning staff, February 29, 2016.

Drawing on the results of this program, the District should take the following actions:

- As in Boulder, the District may wish to align the EV bulk buy program with EV chargers and solar panels. If so, the District should align this bulk buy program with the recommendation to implement a targeted solar proliferation strategy in the CEP's Clean & Renewable Energy Supply section.
- This program should also be used as an opportunity for the District to develop EV information materials and introduce the vehicle purchase incentive recommended below. Importantly, the program will need to be coordinated with the next recommendation (Install an EV Showcase and Purchase Center) to ensure the two programs support rather than undermine the cost-effectiveness of one another.

A well-orchestrated bulk buy program will require no government funding (other than staff time), and will result in an increase in the number of EVs on the road and the overall presence of EVs in the region. Consumers will also benefit from lower EV pricing, while participating automakers can enjoy substantially lower acquisition fees, marketing costs, transaction costs, and failed leads. [280]

Next Steps:

- Assign DOEE staff to connect with Boulder to learn how the program was designed and managed. Determine which staff may be best to lead the initiative, how the discount was arranged, and whether a minimum number of buyers would need to be procured.
- Within the next year, coordinate with one or more automakers to participate in the program. Depending on the success of the program's first round, repeat it with additional automakers, as is currently being explored in Boulder.
- To increase the value of District Government staff efforts on this action, consider aligning either the first or second round of this program with the marketing involved in the solar proliferation strategy.

EV.4 Establish an EV Showcase and Purchase Center

Action: Partner with multiple automakers to install an EV-only Showcase and Purchase Center in the District.

Relevance: While the EV bulk buy program recommended above offers a short-term solution to the low accessibility of EV, an EV Showcase and Purchase Center offers a more permanent and effective solution over the long-term. The Center would offer prospective EV drivers a wide variety of EV models from several automakers, thus expanding the potential market for EVs in the District. Furthermore, it can allow residents to learn about and consider the prospect of purchasing an EV over a longer period of time, potentially generating additional sales than would be generated during a short-term bulk buy program. Finally, such a program will increase EV adoption and improve consumer awareness of, comfort with, and interest in EV technology. It also creates an opportunity to collect information about prospective EV

[280] RMI Outlet, 2015, What Electric Vehicles Can Learn From the Solar Market, http://blog.rmi.org/blog_2015_10_29_what_electric_vehicles_can_learn_from_the_solar_market

buyers in the District and set up opportunities to potentially contact them in the future, thus laying the groundwork necessary for mass adoption of EVs in the future.

Details: This action will require either the District or an arms-length organization to set up and manage an EV Showcase and Purchase Center to sell EVs and/or generate customers for online purchases. Such a program would be unique to the District and suitable given its lack of vehicle dealerships. It has flagship program potential that can demonstrate the District's leadership in facilitating a long-term transition to a zero-emission passenger vehicles and a low carbon economy. Such a showroom would offer residents the opportunity to learn about, test drive, and purchase EVs without leaving the District. The District could also claim that the only new vehicles available for sale in the District are EVs.

Based on the above, the following actions should be taken:

- Design the showcase to maximize visibility and accessibility. The location should be determined by balancing costs and the opportunity to maximize visitors, including commuters from outside the District. The hours of operation should be set to be convenient for people to visit, including evenings and weekends.
- Partner with as many automakers as are willing to offer their EVs for purchase through this program and make models available for test drives. To reduce costs, test drive vehicles could be kept at a separate location, such as a government parking lot. Test drives could be scheduled with prospective drivers either over the phone, online, or in the showcase center.
- Share costs and other resources required to develop and run the center with participating automakers.
- Develop information regarding what it is like to own an EV in the District, including benefits (e.g., fuel savings, HOV lane access), financial incentives, the ability of vehicles to meet daily driving needs, and the placement of public EV charging stations. These materials could also be designed to address misperceptions and misunderstandings about EV ownership that may be limiting purchases.

Under this program, automakers are responsible for providing clear and easy-to-understand marketing materials about their vehicles. These marketing materials must be customized to provide prospective buyers the opportunity to easily understand both basic and detailed information about the vehicles, with a focus on the types of information that consumers typically have access to at dealerships. Rather than provide a staff member, automakers should provide a phone number that prospective buyers can call to ask questions about specific vehicles. Customers can then have more direct contact with the automakers through the test-drive program, whereby a representative of the automaker can be scheduled to join prospective purchasers on a test drive.

The program should also be coordinated with the implementation of an EV bulk buy program to ensure that the two programs support rather than undermine one another. It should also be coordinated with a financial purchase incentive adopted by the District (see below) and the development of any information and marketing materials.

Next Steps:

- Within the next year, assign DOEE staff with the support of other key internal District Government stakeholders to outline a public-private partnership proposal that the District can take to all automakers offering EVs and release a request for proposal for the development and management of the center.
- Outline the overall programming of the initiative and potential roles and contributions of each party.
- By year two, implement the showcase program alongside the financial purchase incentive recommended below. The program will likely require coordination between staff involved in EV policy and programming alongside District Government staff that run marketing campaigns and events.

EV.5 Provide a vehicle purchase incentive

Action: Adopt a financial incentive for the purchase of EVs registered in the District.

Relevance: While they form an important part of EV adoption strategies in other regions, strong vehicle purchase incentives have not been a part of the District's EV adoption policies, again due to the lack of new vehicle dealerships in the District.[281] However, the District does exempt vehicles with a fuel economy above 40 mpg (including EVs) from vehicle title fees (typically 6% to 8% of the vehicle price), and offers an income tax credit for vehicles converted from petroleum to a qualified clean fuel (including electricity).[282,283]

In implementing an EV bulk buy program and installing an EV Showcase and Purchase Center, the District may require a financial purchase incentive as a short-term tool to convince residents to buy EVs over conventional petroleum-fueled vehicles.

Details: Purchase incentives that decrease the upfront cost of EVs are one of the most common tools used by states to generate EV sales. The effect of these incentives on vehicle sales varies between regions. For example, Colorado offers one of the highest state vehicle credits (up to $6,000), but this has not translated into high EV adoption.[284] Georgia, however, saw very high EV sales while it had a tax credit in place, but sales collapsed when the credit was removed midway through 2015.[285] For a local comparison, Maryland offers an excise tax credit of up to $3,000 and, like the District, less than 1% of new vehicles sold in the state are EVs.[286] California has the highest market share at around 3.5% in 2015.

[281] Overview of EV strategies in other regions from Lutsey, N., Searle, S., Chambliss, S., Bandivadekar, A., 2015.

[282] Vehicle title fee exemption from DMV (2016) Green Driver State Incentives in Washington DC, http://www.dmv.org/washington-dc/green-driver-state-incentives.php

[283] Income tax credit covers 50% of the conversion cost up to $19,000. National Conference of State Legislatures, 2015, State Efforts Promote Hybrid and Electric Vehicles, http://www.ncsl.org/research/energy/state-electric-vehicle-incentives-state-chart.aspx

[284] Lutsey, N., Searle, S., Chambliss, S., Bandivadekar, A., 2015.

[285] Caputo, M., 2015, Georgia EV sales sputter without tax credit, http://www.marketplace.org/2016/01/08/world/georgia-ev-sales-sputter-without-tax-break.

[286] Lutsey, N., 2015, Transition to a Global Zero-Emission Vehicle Fleet: A Collaborative Agenda for Governments.

Based on these programs, the District should take the following actions:

- Adopt a financial purchase incentive designed to prioritize vehicles that offer the largest GHG reductions (e.g., full battery electric vehicles should receive a higher incentive than plug-in hybrid electric vehicles with a gasoline engine to back up the battery).
- The size of the purchase incentive needed may depend on vehicle discounts the District can arrange with automakers through both of these the EV adoption recommendations above, most importantly the installation of an EV Showcase and Purchase center.

Next Steps:

- In developing an EV bulk buy program and/or EV Showcase and Purchase Center, determine the level of discount the District can obtain from the automakers.
- Review financial incentives in other jurisdictions and determine what level of financial incentive may be required to achieve a high level of EV adoption.
- Adopt a financial purchase incentive at the level required to make the bulk buy and Purchase Center actions viable and significantly increase vehicle adoption in the District.

EV.6 Pursue an EV-only car sharing fleet

Action: Contract one or more car share operators to supply an EV-only car share fleet in the District.

Relevance: The District is an excellent candidate for car sharing programs given its small geographic size, high land use density, and high number of households that do not own personal vehicles. These characteristics may also make it ideal for an all-electric car sharing fleet. Car sharing of any kind helps the District decrease congestion, achieve mode share objectives, and decrease GHGs and local air pollution. Implementing an EV-only car share program will further decrease GHGs and local air pollution while helping increase awareness of EVs as a passenger vehicle technology that is ready to meets individuals' driving needs. Three corporate and two peer-to-peer car sharing programs are already available in the District, but none of these are fully electric.[287]

Details: The District can follow in the footsteps of the increasing number of international cities offering EV-only car sharing fleets. Paris launched the first all EV car sharing program with Autolib' in 2011. The program now has 3,000 vehicles and more than 150,000 members, prompting London to announce in 2015 that it, too, would offer a full EV car sharing fleet.[288] In September 2015, Indianapolis began its own EV-only car sharing fleet with BlueIndy, while Montreal issued a call for proposals to invite companies to provide a fully electric car sharing fleet starting in 2016.[289,290] Montreal's existing car sharing programs welcomed the announcement, including Car2Go, which already has fully electric fleets in Amsterdam, San

[287] ZipCar, Car2Go, and Enterprise CarShare, as well as Getaround and Relayrides.

[288] Werber, C., 2015, The electric car-sharing service that swept through Paris is coming to London, http://qz.com/428116/the-electric-car-sharing-service-that-swept-through-paris-is-coming-to-london/.

[289] Matlack, C., 2015, Paris Is Sharing Electric Cars by the Thousand. Will It Play in Indianapolis?, http://www.bloomberg.com/news/articles/2015-09-17/paris-is-sharing-electric-cars-by-the-thousand-will-it-play-in-indianapolis-.

[290] Madger, J., 2015, Montreal looks into setting up an electric-car sharing service, http://montrealgazette.com/news/local-news/montreal-looking-into-setting-up-an-electric-car-sharing-service.

Diego, and Stuttgart. Similarly, Los Angeles is piloting a car-sharing program in 2016 targeted to low-income residents, with plans for 80% of the vehicles to be EVs.[291]

Key to the success of this program is the availability of public charging infrastructure and the ability to encourage enough membership. [292,293] The District should learn from the experiences of other cities, and then collaborate with the prospective car-share company (or companies) to determine how to install an adequate amount of EV chargers and market the program to residents. The District should additionally work to align the EV charger installation with efforts to make EV chargers available to more people and increase the visibility of EVs to citizens. Finally, given the proximity of the District to neighboring states and cities, as well as the high commuter population, the District Government should seek opportunities to coordinate with these governments and regional transit providers to develop an electric car share system that can augment existing interregional transit options, thus making it attractive to more commuters.

Next Steps:

- Immediately assign staff from DOEE and the District Department of Transportation (DDOT) to connect with staff from the cities identified above, as well as their EV car share providers, regarding their experience with an EV-only car sharing fleet.
- Engage with existing car share providers regarding the District's intention to establish a 100% electric car sharing fleet and gauge their interest in participating. If an existing car share company is willing to provide an electric fleet (steadily shifting to 100% electric), the next step may not be necessary.
- As needed, release a call for proposals for the provision of an EV-only car share fleet in the District.
- As needed, consult with Pepco regarding the ability of the electrical grid to handle additional loads. Aim to have an EV-only fleet in operation by the end of 2017.

[291] Spector, J., 2015, L.A.'s Bold Plan to Bring Car-Share to the Poor, http://www.citylab.com/cityfixer/2015/07/las-bold-plan-to-bring-car-share-to-the-poor/400031/.

[292] Importance of public infrastructure from Madger, J., 2015.

[293] Importance of encouraging adequate membership from Werber, C., 2015.

5.1.3 Electric Vehicle Readiness & Adoption Roadmap

		The Five-Year CEP					Projected Path to 2032 Climate and Energy Targets										
Electric Vehicle Readiness & Adoption	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Electric Vehicle Readiness																	
EV.1 Adopt an EV-ready building code																	
EV.2 Adopt an EV-ready parking lot requirement																	
Electric Vehicle Adoption																	
EV.3 Implement an EV bulk buy program																	
EV.4 Establish an EV Showcase and Purchase Center																	
EV.5 Provide a vehicle purchase incentive																	
EV.6 Pursue an EV-only car sharing fleet																	

Legend
Planning, Research, and Program and Policy Development
Plan or Program Implementation
Policy or Regulation Implementation
Pilot Project
Program Evaluation

APPENDIX 1

Greening the District of Columbia: Incentives and Policies to Achieve Deep Green Building Construction and Renovations

- - - This report is currently being reviewed by DOEE and will be released to the public soon. - - -