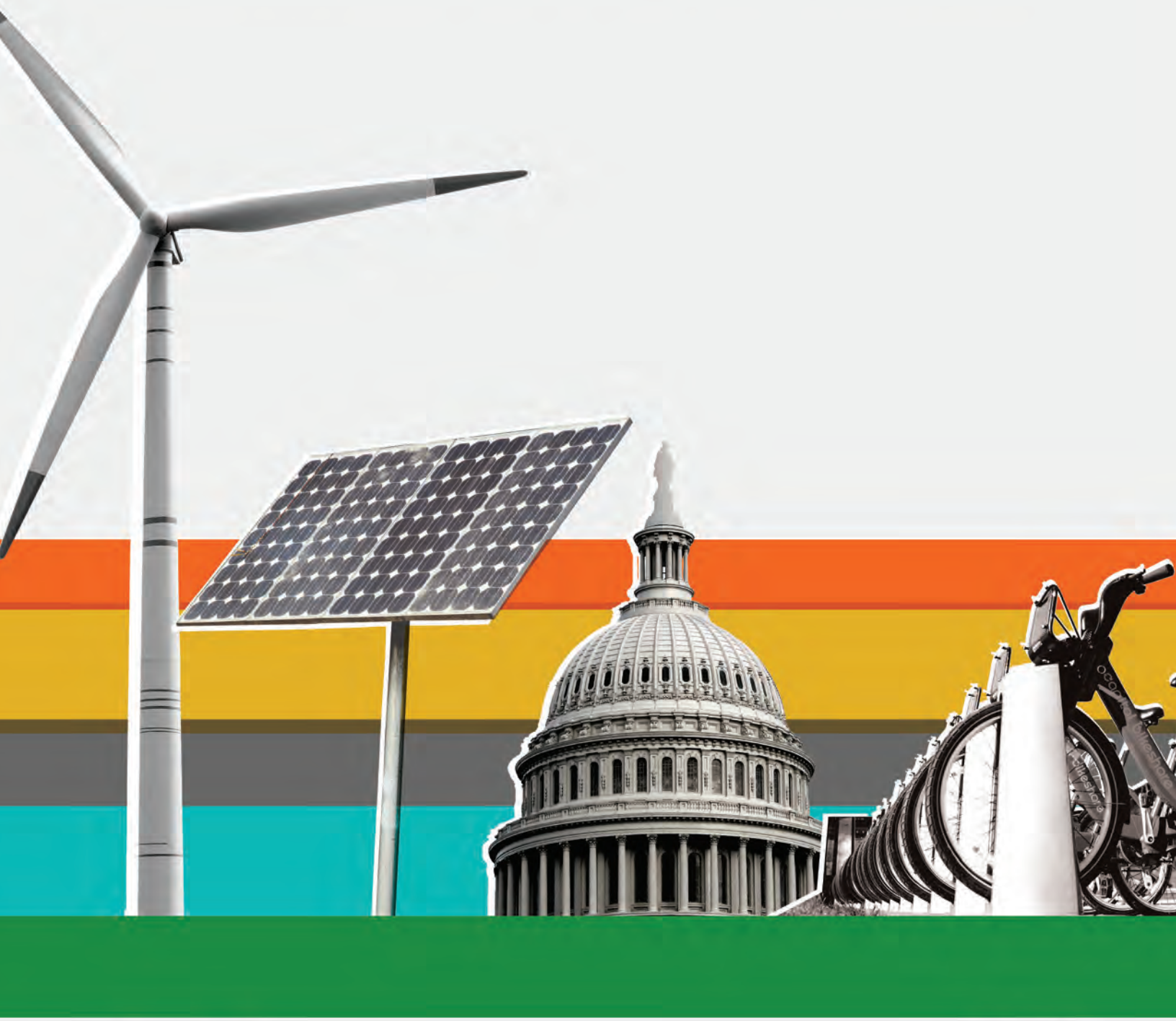
CLEAN ENERGY DC

THE DISTRICT OF COLUMBIA CLIMATE AND ENERGY PLAN

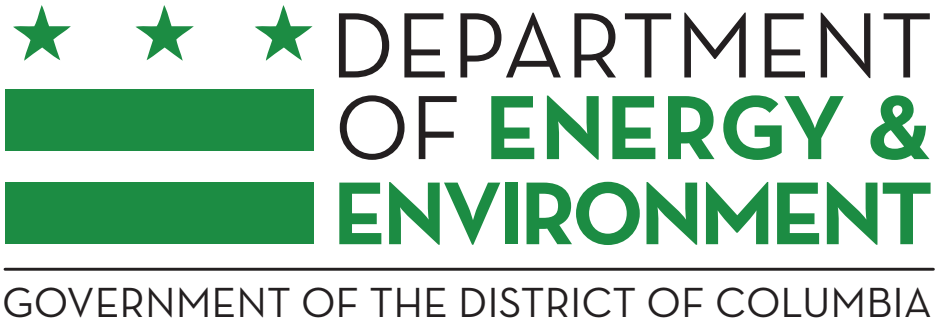


PRODUCED FOR:

DEPARTMENT OF ENERGY & ENVIRONMENT
GOVERNMENT OF THE DISTRICT OF COLUMBIA

DRAFT

OCTOBER 2016


DEPARTMENT
OF ENERGY &
ENVIRONMENT
GOVERNMENT OF THE DISTRICT OF COLUMBIA

EXECUTIVE SUMMARY

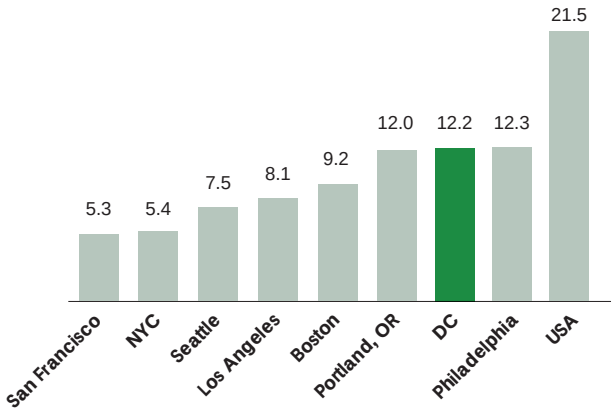
The District of Columbia (District) Department of Energy Environment (DOEE) is pleased to provide this climate and energy plan, entitled Clean Energy DC (Plan). This document embodies a bold and innovative vision for meeting the challenges brought by climate change and creating a sustainable energy system that can provide for the needs of the District in the 21st century.

WHY CLEAN ENERGY DC? ENERGY AND CLIMATE CHANGE

The Plan is DOEE's proposal to reduce greenhouse gas (GHG) emissions by 50% below 2006 levels by 2032, while increasing renewable energy and reducing energy consumption, as directed by the District's sustainability plan, Sustainable DC. Achieving the 50% reduction of GHG emissions will put the District on the path to reduce GHG emissions by 80% by 2050. Reducing GHG emissions 80% by 2050 was previously understood to be the mitigation effort required to avoid more than 2°C warming in global average temperatures relative to pre-industrial times. 2°C was also previously understood to be the maximum acceptable level warming, although this depends on what impacts one is willing to accept. As climate science has advanced, we now understand that an 80% reduction by 2050 is the minimum reduction needed, that cumulative GHG emissions (not annual emissions) are what matters for mitigating climate change, and that 2°C average global warming may drive warming to unacceptably risky levels. Therefore, although this Plan extends to 2032, additional planning that extends to 2050 will be needed to effectively mitigate the District's risk of serious climate change impacts and their effect on economic prosperity, wellbeing, and human life. This Plan takes a necessary first step for the District to respond to the global call to action compelled by 2015's Paris Agreement, and thus continue to align itself with other global climate leaders (Figure ES1 summarizes the GHG emissions performance of leading U.S. cities).

The success of the District's efforts to reduce GHG emissions depends on energy. Energy, through extraction and consumption of fossil fuel, is by far the largest source of GHG emissions. In the District, fossil fuels remain the dominant source of energy for electricity, for heating buildings through natural gas or fuel oils, and for motor vehicles. Phasing out fossil fuels

Figure ES1: GHG emissions per capita among leading U.S. cities, 2015 (in metric tons carbon dioxide equivalent)



Source: Carbon Disclosure Project's Citywide Emissions 2015 dataset, https://data.cdp.net/Cities/Citywide-Emissions-2015-Map/rdx8-qzui
DOEE's Greenhouse Gas Invetory figure for the District is lower at 11.9.

from the District's energy supply will be essential to achieving the city's climate change targets.

As discussed in DOEE's companion plan on climate adaptation, Climate Ready DC, the effects of climate change, including hotter temperatures, rising tides, and more severe storms are accelerating and already being felt in the District. While Climate Ready DC shows how the District can become resilient and adapt to such changes, this Plan shows what the District can do to reduce its GHG emissions through bold and innovative energy strategies. If Climate Ready DC is the District's defense, then Clean Energy DC is its offense. These two documents represent a holistic effort by the Government of the District of Columbia (District Government) as a leader in energy innovation and in fighting climate change, to ensure that the District maintains itself as a desirable place to live and work.

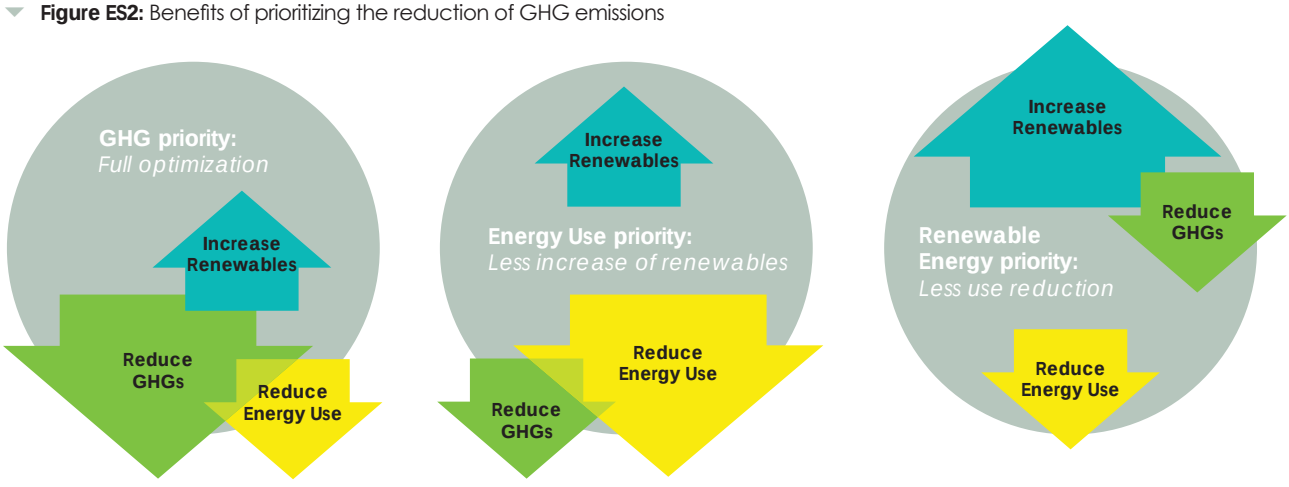
UNIQUE APPROACH OF CLEAN ENERGY DC

This Plan is unique: it serves as both a long-term GHG emission reduction plan and a short-term energy plan. Importantly, the Plan provides a roadmap to achieving the District's 50% GHG emissions reduction target. The Plan does so by identifying major District consumption sectors, such as buildings, energy supply, and transportation, and quantifying existing and proposed policies directly affecting GHG emissions in those sectors, such as anticipated building codes, the Renewable Portfolio Standard (RPS), and the District's transportation plan, moveDC. The quantification illustrates how much GHG emissions reduction can be achieved by implementing those policies, and provides insight on the scale of action needed to achieve the District's 2032 GHG reduction target.

While the actions outlined here are sufficient to achieve the GHG reduction target, they are not sufficient to fully achieve Sustainable DC's other 2032 targets to reduce energy use by 50% relative to 2012 and increase renewable energy to represent 50% of all energy used in the District. The consultant team discovered during the modeling process that achieving all three targets in unison will prove very difficult, if not nearly impossible. As a result, DOEE prioritized the GHG reduction target, one of the key Sustainable DC targets, and chose actions that can significantly reduce GHGs while simultaenously reducing energy use and increasing renewable energy.[1]

Prioritizing the GHG reduction target over the other energy targets also makes sense for optimization and synergy: Reducing GHG through innovative measures necessarily entails both reducing energy use and increasing renewable energy. However, reducing energy use may not result in an increase of renewable energy, and increasing renewable energy may not result in reduction of energy use, as visualized in **Figure ES2**.

Figure ES2: Benefits of prioritizing the reduction of GHG emissions



[1] Note that energy use refers to energy consumption.

The Plan projects that the recommended actions result in an estimated 18% energy use reduction below the 2012 baseline, and increase renewable energy use to make up 32% of energy used in the District in 2032, depending on how electricity suppliers comply with the RPS. In subsequent iterations of Clean Energy DC, the analytical framework of this Plan will be used to develop the roadmaps for fully achieving the renewable energy and energy use reduction targets.

PURPOSE AND CONTEXT OF THE PLAN

This is the first time that a GHG emission reduction target has been explicitly incorporated into a District energy plan. Although many in the District are eager to realize the ambitions of Sustainable DC's energy and climate targets, until now there has been no concrete framework to begin that realization. Clean Energy DC offers the analytical framework and measures that are needed to begin this work.

Several of the core actions are preliminary in nature, while supporting actions tend to be more readily implementable. For many core actions, designing an implementation path will require detailed analysis, including appropriate technical feasibility studies. The feasibility analysis for complex actions must be made on a case-by-case basis, and there is no single feasibility analysis that can be applied to all of the actions. Therefore, the optimal occasion for such analysis is during the design of the implementation plan. Designing the implementation plan will also include prioritizing and optimizing the recommended actions for interrelatedness and co-benefits. Given the high stakes of the implementation plan, DOEE will engage in robust and inclusive stakeholder consultation in order to develop a plan that is well-informed by appropriately detailed analysis and discussion. Equitable development will be an important feature of this Plan, and DOEE will engage with community stakeholders to shape the next steps collaboratively.

This Plan does not identify every action that could potentially reduce GHG emissions. DOEE expects that the collaborative process for subsequent iterations of the Plan will help identify more and better actions for reducing GHG emissions. One of the main purposes of the Plan is to identify the irreducible consumption sectors—buildings, energy supply, and transportation—and potential actions within those sectors that could lead to significant reductions. Such a list of actions would then allow the stakeholders and the public to better understand the magnitude of actions that would be required to achieve the GHG reduction target, and it would serve as the springboard upon which to evaluate and design each action for implementation. Because our analysis indicates that there are limited opportunities to obtain significant cuts to GHG emissions, it is critical to maximize the opportunities that are available, however difficult.

WHAT IS NEEDED? A TRANSFORMATION

Modeling for the Plan shows that reducing the District's GHG emissions by 50% by 2032 will require the District's maximum effort within its spheres of control and influence with respect to buildings, energy supply, and transportation. Sustaining that level of effort will require the ongoing support of the public and stakeholders, leading to a transformation in the way that the District buys, generates, and consumes energy. In addition, it will be essential to institutionalize and streamline a stakeholder process to ensure this high-level of effort can be sustained for subsequent iterations.

Clean Energy DC is being proposed at a time of great change in the energy sector: energy prices are volatile, renewable energy costs are continuing to decline, and energy innovation is accelerating, as is the rate of climate change. Within this fast-evolving energy-climate landscape, the Plan is intended to be open and iterative, a "living document," to ensure flexibility and adaptability on the road to achieving the Sustainable DC targets. The Plan will be subject to regular, frequent, and inclusive processes with stakeholders, leading to a Plan that will be driven by the support of the stakeholders and the public.

WHAT DOES THE PLAN PROPOSE?

The Plan has identified three major sources of the District's GHG emissions. These sources are buildings, energy supply, and transportation. For the plan to succeed, significant cuts to GHG emissions must be made from each of the three sources. Therefore, the Plan recommends a set of actions for each of the following sectors: Buildings (New and Existing), Energy Supply (focusing on electricity), and Transportation.

- **Buildings**, including 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 vehicles to zero-emission electric drivetrains (Chapter 5).

The Plan's core actions for these three sectors represent a pragmatic expansion of existing policies, such as the District's innovative construction codes, the Renewable Portfolio Standard, and moveDC—the District Department of Transportation's 25-year vision for the District's transportation system, which includes actions to increase travel by walking, biking, and mass transit. Not all of the actions were quantified for estimated reduction in GHG emissions, but significant existing and proposed policy items for each of these sectors were quantified. The Plan also includes many actions that would support or enable core actions, but would not themselves directly cut GHG emissions, such as infrastructure readiness for electric vehicles.

Each section provides a pathway to achieving the GHG reduction targets for each of the sectors, and identifies a suite of actions necessary to achieve them. As stated earlier, the Plan is not intended to provide detailed program design, specific policy language, or detailed feasibility analysis for each action: that work will be accomplished during the consultative stakeholder process following the issuance of the Plan. Several actions do, however, include language, details, research, and recommendations regarding design and implementation based on experiences in other jurisdictions.

The key actions necessary for achieving the targets are outlined below. The Plan includes 55 interrelated actions. Several core actions have been quantified, and there are actions not quantified in the Plan that provide essential support to the overall set of required actions. A full list of recommended actions is presented at the end of the Executive Summary.

BUILDINGS

NEW CONSTRUCTION

To achieve the 50% GHG emissions reduction target, 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 implement such a building code successfully, the District will need to provide incentives, education and training, and demonstrate leadership to build public support. Significantly higher energy performance from buildings under the new code is projected to help the District avoid 5.2% (430,000 tCO2e) 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 District must address the existing buildings. The District must 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 nearly one in five buildings to achieve an approximate 30% reduction in energy use, the District is projected to avoid 6.6% (544,000 tCO2e) of GHG emissions projected in 2032 under the BAU scenario.

ENERGY SUPPLY SYSTEM

CLEAN AND RENEWABLE ENERGY SUPPLY

To achieve the 50% GHG emissions reduction target, the District must increase the amount of renewable energy that can offset GHG emissions. To do so, the District should design its RPS to require an increasing proportion of renewable energy in its supply and promote ways of procuring energy that will actually result in GHG reductions. This must be joined by new RPS legislation that requires 100% of the District's electricity to be supplied from renewable sources by 2050, if the District is to achieve the target to reduce GHG emissions by 80% by 2050.

In addition to these changes to the RPS, the District should examine the following:

- Replace the current Standard Offer Service (i.e. the supply contracts for customers who do not choose competitive suppliers) with a mix of short-term and long-term contracts, including long-term power purchase agreements that maximize renewable energy to the extent practicable.
- Develop neighborhood-scale energy system and solar proliferation strategies.
- Take steps to improve the adoption and installation of solar panels and other renewable energy technologies.

ELECTRICITY SYSTEM MODERNIZATION

An electricity distribution system containing a high number of local renewable energy systems requires a modernized electricity system. Such a system will allow for the following:

- A substantial increase in the quantity of electricity generated within the District.
- Fully realized economic benefits of new local generation.
- Improved reliability and resilience.
- Minimizing costly ratepayer investments in traditional infrastructure, such as substations and feeders, that may be avoidable through the use of distributed energy resources (DER) and demand-side management, such as local generation, storage, efficiency, and demand response.
- Development of neighborhood-scale energy systems including microgrids.

This shift will require the development of regulatory frameworks, market structures, and utility incentives that support a shift toward high levels of DER and eventually facilitate distributed transactions, e.g., transactions between customer and the distribution system operator or even customer-to-customer transactions.

The Plan includes recommended actions to reconsider the way ratepayer investments are made, and to increase the use of cost-effective DER to reduce peak demand and manage load growth in new or congested neighborhoods. Some of this work is already underway through DOEE's participation and leadership in the Public Service Commission's Formal Case 1130, Modernizing Energy Delivery System for Increased Sustainability, and the recommended actions should be taken in coordination with DOEE's and other stakeholders' efforts in that case. Additional research as well as regulatory and legislative changes may be required to reduce barriers to DER integration, improve understanding of the District's energy supply and demand, develop cost-effective neighborhood-scale energy systems, and demonstrate the full value of a modernized electricity system.

TRANSPORTATION

ELECTRIC VEHICLE READINESS AND ADOPTION

Deep cuts to GHG emissions 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 Plan 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 DC

Implemented together, the actions recommended in the Plan will result in an estimated reduction in the District's GHG emissions of 51% by 2032 (relative to the 2006 baseline). As success in some areas of the Plan will depend heavily on success in others, the implementation of the Plan actions should be done in a coordinated and strategic manner. **Table ES1** 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 and energy innovation. The GHG reduction figures shown in Table ES1 are relative to projected GHG emissions in 2032 under business-as-usual assumptions.

Table ES1. Summary of core GHG reduction actions

Modeled GHG Reduction Actions	GHGs Reduced from 2032 BAU (tCO2e)	Percent GHGs Reduced from Total 2032 BAU*
CAFE Standard	473,000	5.8%
Mode Share Change	528,000	6.4%
Electric Vehicle Adoption	34,000	0.4%
New Construction Actions	430,000	5.2%
Existing Building Actions	544,000	6.6%
Neighborhood-Scale Energy	44,000	0.5%
PPA for Standard Offer Service	543,000	6.6%
Renewable Portfolio Standard	581,000**	7.1%**
RPS Local Solar Requirement	87,000**	1.2%**
Total GHGs Avoided vs. 2032 BAU	3,277,000	39.8%
Total GHGs Reduced vs. 2006 Baseline	5,664,000	51.0%

Note: All figures based on site energy use, and use GHG intensity factors that account for losses from generation. To maintain consistency with the 2006 GHG inventory, which provides the baseline for the 2032 GHG reduction target, the GHG intensity factors do not include transmission and distribution losses for electricity and fugitive emissions from natural gas. See section A1.2.2.1 in Appendix A1 for more detail.

*This column measures the percentage reduction in total GHG emissions from the 2032 level under the BAU scenario. For example, New Construction actions decrease total District-wide 2032 GHG emissions by 5.3%. Due to GHG declines between 2006 and 2015 as well as projected GHG increases between 2015 and 2032, the District must avoid 38.6% of projected GHGs in 2032 to decrease GHG emissions 50% relative to 2006.

**Assumes the District captures 57% of the total potential GHG reductions possible under the RPS. See section 2.2.1.2

MOVING FORWARD

DOEE will collaborate with stakeholders and the public to design an inclusive process to enable further evaluation and prioritization of recommended actions, and to design and implement those actions. This process will result in frequent modifications of the Plan, making it a "living document" to continually guide the District based on new information. This approach should ensure that the public will be empowered to review and shape the path forward, using this Plan as a springboard. As stated previously, this collaborative and iterative process of evaluation, implementation, and revision needs to be institutionalized to sustain the effort over many years. DOEE intends to formally update and revise the Plan as often as is warranted under this process. DOEE recognizes that the ongoing support of stakeholders and the public remains vital to the Plan's success. A meaningful process, including public education and outreach, is key to achieving success.

A PLAN THAT EVOLVES

The Plan must be implemented in a manner that balances bold action and leadership with responsiveness to the public, market conditions and technology. Therefore, this Plan is intended to be an iterative, living document that will continuously incorporate new insights and information based upon ongoing stakeholder collaboration, additional research and studies, and changing market circumstances.

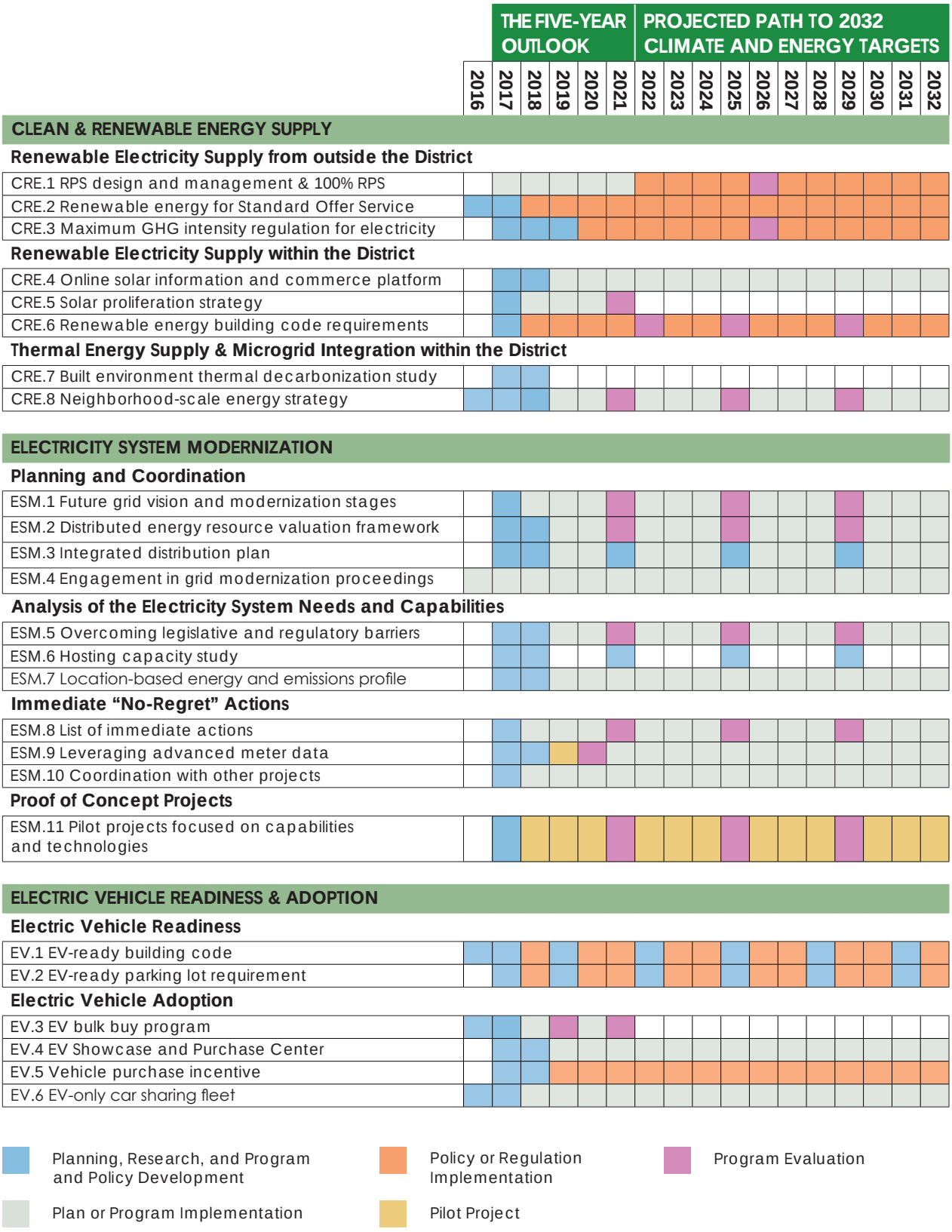
The Clean Energy DC Plan is intended to be closely coordinated with other District Government efforts. The actions proposed in its chapters are already aligned with several major District Government plans, including Sustainable DC (2013), moveDC (2014), and Climate Ready DC (2016). In addition, the District Government and other agencies are currently exploring important topics such as clean energy financing, carbon pricing, neighborhood-based energy modeling, microgrids, and reducing vehicle fleet emissions. At the time of this Plan, these research

projects and initiatives were still underway. Therefore, it is expected that, while the Plan reflects the District Government's latest research and thinking on these topics, new insights will be included in its subsequent iteration. The Plan should also reflect the innovative work performed under the leadership of the District of Columbia Public Service Commission, particularly in Formal Case 1130, the Office of People's Counsel, the Department of Transportation, the Office of Planning, the Department of General Services, as well as the District's water and wastewater utility, DC Water.

The Plan represents the first steps toward implementation, which will be fully informed by ongoing stakeholder engagement and further studies and evaluation. The Plan will be improved upon through iteration, and should put the District on the path to its ambitious but necessary climate change mitigation and energy targets, to realize the ultimate goal of making the District of Columbia the best city in which to live and work.

A FULL LIST OF RECOMMENDED ACTIONS

CLEAN ENERGY DC ACTION ROADMAP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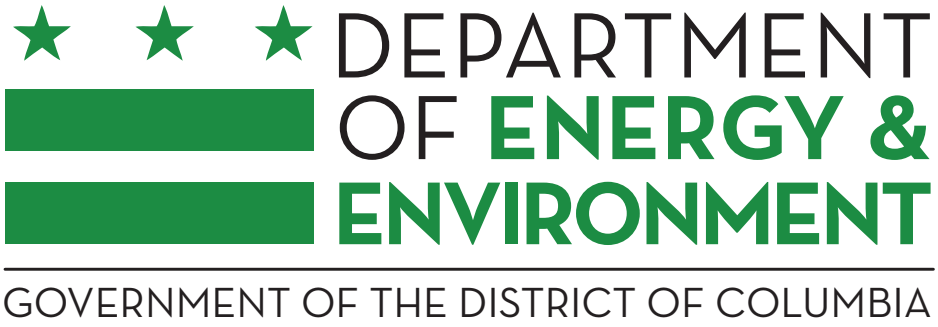
Pilot Project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LIST OF ACRONYMS

ACEEE	American Council for an Energy-Efficient Economy
ACPs	Alternative Compliance Payments
AMI	Advanced Metering Infrastructure
ASHI	American Society of Home Inspectors
BAU	Business-as-Usual
BEPS	Building Energy Performance Standard
Btu	British Thermal Units
CAEA	Clean and Affordable Energy Act
CAFE	Corporate Average Fuel Economy
CCB	Cross-Cutting Building Actions
CCCB	Construction Codes Coordinating Board
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
CPP	Clean Power Plan
CRE	Clean and Renewable Energy
DCHA	District of Columbia Housing Authority
DCHFA	District of Columbia Housing Finance Agency
DCPACE	District of Columbia Property Assessed Clean Energy
DCPS	District of Columbia Public Schools
DCRA	Department of Consumer and Regulatory Affairs
DCSEU	District of Columbia Sustainable Energy Utility
DCSUN	District of Columbia Solar United Neighborhoods
DDOT	District Department of Transportation
DER	Distributed Energy Resources
DGS	Department of General Services
DHCD	Department of Housing and Community Development
DOE	United States Department of Energy
DOEE	Department of Energy Environment
DRAM	Demand Response Auction Mechanism
DSM	Demand-Side Management
EB	Existing Buildings
EM&V	Evaluation, Measurement, and Verification
EPA	United States Environmental Protection Agency
ESM	Electricity System Modernization
EUI	Energy Use Intensity
EV	Electric Vehicle
FAR	Floor Area Ratio
FHA	Federal Housing Administration
GAR	Green Area Ratio
GBAC	Green Building Advisory Council
GCC	Green Construction Code
GHG	Greenhouse Gas
HUD	United States Department of Housing and Urban Development
HVAC	Heating, Ventilation, and Air Conditioning
ICLEI	International Council for Local Environmental Initiatives
IDP	Integrated Distribution Planning
ILFI	International Living Future Institute
IMT	Institute For Market Transformation
IECC	International Energy Conservation Code
IT	Information Technology
kBtu	Thousand British Thermal Units
KW	Kilowatt
kWh	Kilowatt-Hour
LBC	Living Building Challenge
LEED	Leadership In Energy and Environmental Design
MDV-SEIA	Maryland, DC, and Virginia Solar Energy Industries Association
MLS	Multiple Listing Service
MMBtu	Million British Thermal Units
MMTherms	Million Therms
MRIS	Metropolitan Regional Information System
MW	Megawatt
MWCOG	Metropolitan Washington Council of Governments
NBI	New Buildings Institute
NC	New Construction
NEEP	Northeast Energy Efficiency Partnerships
NESEA	Northeast Sustainable Energy Association
NZEB	Net-Zero Energy Building
PACE	Property Assessed Clean Energy
PJM	Pennsylvania New Jersey Maryland Interconnection Region
PSC	Public Service Commission
PV	Solar Photovoltaic Power
RCC	Regional Code Collaboration
RECs	Renewable Energy Credits
RFCe	ReliabilityFirst Corporation-East
RFP	Request For Proposal
RPS	Renewable Portfolio Standard
SOS	Standard offer Service
SRECs	Solar Renewable Energy Credits
tCO_2e	Tons of Carbon Dioxide Equivalent
UDC	University of District Columbia
VMT	Vehicle Miles Traveled

INTRODUCTION

1 INTRODUCTION

The District of Columbia Department of Energy Environment (DOEE) is pleased to provide this climate and energy plan, entitled Clean Energy DC (the Plan). This document embodies a bold and innovative vision to continue the action-oriented discussion and collaboration to meet the challenges brought by climate change, and to create a sustainable energy system that can meet the needs of the 21st century.

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As discussed in DOEE's companion plan on climate change adaptation, Climate Ready DC, the effects of climate change, including hotter temperatures, rising tides, and more severe storms, are accelerating and already being felt in the District. Greater impacts are expected in the future.[3] Left inadequately mitigated, the impacts of climate change will destabilize economic, social, and ecological systems the District (and everywhere else) relies on.[4] This will result in both direct and indirect economic and social costs (e.g., loss of human life) that significantly outweigh any costs required to mitigate climate change, even if we were to discount the economic and social benefits gained from investing in clean energy. According to research published in the journal Nature in 2015, unmitigated global warming will reduce global wealth per capita by 23% in 2100 compared to a scenario where climate change is mitigated.[5] A 2015 study by Citigroup found that average global warming of 2.5°C decreases global GDP $44 trillion by 2060, not including costs related to population displacement, infrastructure investments required to adapt to climate change, and several other costs due to climate impacts.[6] Conversely, Citigroup estimates overhauling the global power market to shift to clean, renewable energy and modernize electricity grids could reduce energy system costs by $1.8 trillion, in comparison to the costs of maintaining the current, fossil fuel-dominated power system (by 2040).

[2] United Nations Framework Convention on Climate Change, Report on the structured expert dialogue on the 2013-2015 review. http://unfccc.int/resource/docs/2015/sb/eng/inf01.pdf

[3] See the District's Vulnerability and Risk Assessment for information on specific vulnerabilities within the District: http://doee.dc.gov/node/1172370. Note that the District would experience additional impacts related to its reliance on economic and social systems in other locations that experience severe climate change impact (e.g., through trade).

[4] As summarized in the United Nations Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment report, Climate Change 2014: Impacts, Adaptation, and Vulnerability, http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf

[5] Burke et al., 2015, Global non-linear effect of temperature on economic production, http://www.nature.com/nature/journal/v527/n7577/full/nature15725.html

[6] Citi GPS: Global Perspectives and Solutions, Energy Darwinism II: Why a Low Carbon Future Doesn't Have to Cost the Earth, August 2015, http://climateobserver.org/wp-content/uploads/2015/09/Energy-Darwinism-Citi-GPS.pdf

While Climate Ready DC shows how the District can adapt to such changes, Clean Energy DC shows what the District can do to reduce its GHG emissions through bold and innovative energy strategies. If Climate Ready DC is the District's defense, Clean Energy DC is its offense. These two documents represent a holistic effort by the Government of the District of Columbia (District Government) as a leader in energy innovation and in fighting climate change, to ensure that the District maintains itself as a desirable place to live and work.

1.1 FACILITATING AN ENERGY TRANSFORMATION

Cities around the world have started to implement a range of plans and strategies to reduce GHG emissions and combat the risks and threats associated with climate change. 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.[7]

The success of the District's efforts to reduce GHG emissions depends on energy. Energy, through extraction and consumption of fossil fuel, is the most dominant source of GHG emissions. In the District, fossil fuels remain the dominant source of energy for electricity, for heating buildings through natural gas or fuel oils, and for motor vehicles. Because GHG emissions associated with fossil fuel combustion can continue to warm the climate for several hundred years after their release,[8] phasing out fossil fuels from the District's energy supply (often called decarbonization) will be essential to achieving its climate change goals. Therefore, to successfully mitigate the impacts of climate change, the District must assist in broadly changing the way energy is produced, delivered, and used across the District.

To this end, the Plan provides a five-year outlook that would put the District on a trajectory toward dramatically decarbonizing its energy system, and presents a longer-term path toward the District's 2032 targets. The Plan 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 Plan 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.[9] A system-wide transformation requires measures that shift both energy delivery and consumption, supported by enabling actions that facilitate and encourage broader system change. By focusing on a complete energy transition, the Plan aims to build on the District's existing goals and targets to form a complete vision of the strategies and

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

[8] 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

[9] Note that the term "energy use" is used throughout the Plan to refer to energy consumption.

actions necessary to meet the District's long-term climate and energy targets (Box 1). This Plan 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

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.[10/11]

50% by 2032

[10] 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

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

1.2 FOCUSING ON GHG REDUCTIONS

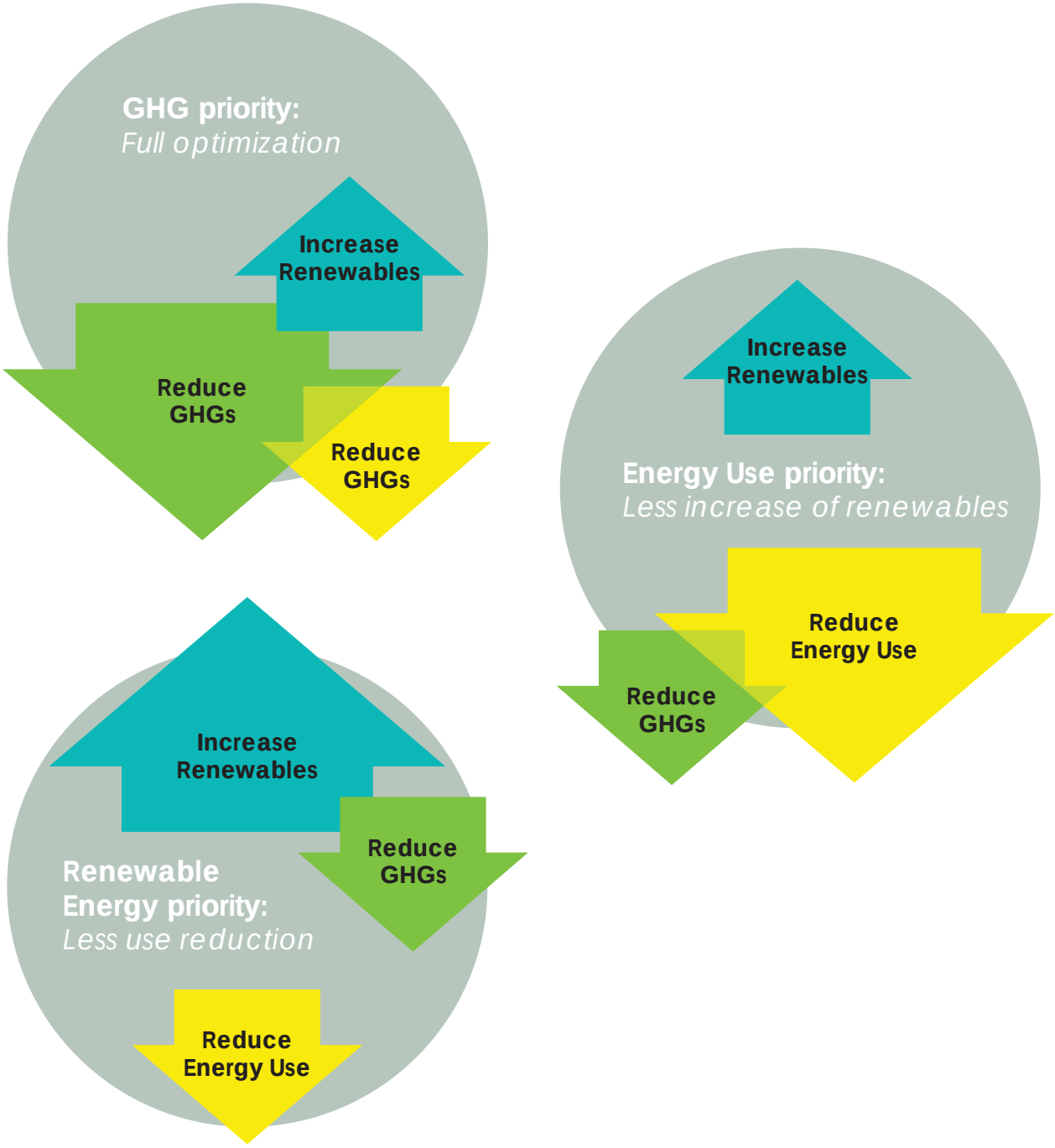
While the actions outlined here are sufficient to achieve the GHG reduction target, they are not sufficient to achieve Sustainable DC's goals to reduce energy use by 50% from the 2012 level and to increase renewable energy by 50% by 2032. The consultant team discovered during the modeling process that achieving all three goals in unison will prove very difficult, if not nearly impossible. As a result, DOEE prioritized the GHG reduction target, one of the key Sustainable DC energy and climate goals, and chose actions that can significantly reduce GHGs, while reducing energy use and increasing renewable energy.

Prioritizing the GHG reduction target over the other energy goals also makes sense for optimization and synergy: Reducing GHG through innovative measures necessarily will result in both reducing energy use and increasing renewable energy. However, reducing energy use may not result in an increase of renewable energy, and increasing renewable energy may not result in reduction of energy use, as visualized in Figure 2.

By establishing GHG reductions as the overarching focus, the Plan 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 Plan includes actions focused both on energy use reductions and renewable energy increases. The Plan projects that the recommended actions result in an estimated 18% energy use reduction below the 2012 baseline and increase the renewable energy utilization (percent of total energy consumption) to 32% in 2032. In subsequent iterations of Clean Energy DC, the analytical framework of this Plan will be used to develop the roadmaps for achieving those goals.

That said, the Plan's initial five-year outlook 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 Plan, 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.

Figure 2: Benefits of prioritizing the reduction of GHG emissions



1.3 A SET OF RECOMMENDATIONS

This is the first time that a GHG emission reduction target has been explicitly incorporated into a District energy plan. Although many in the District are eager to realize the ambitions of Sustainable DC's energy and climate goals, until now there has been no concrete framework to begin that realization. The Plan offers the analytical framework and specific measures needed to begin this work.

The recommended actions presented in the Plan are ambitious, and their collective impact will be significant. The team comprising DOEE staff and its consultants selected actions based on the following:

- Scale of action the District needs to take to achieve the District's GHG reduction target (as informed by modeling).
- Research of policies and programs in other jurisdictions.
- Relationship of the actions within the energy system transformation framework (discussed above).
- Effect of actions on the fundamental drivers of the District's energy and emissions performance (e.g., building codes, retrofits, electricity supply sources).

Several of the core measures are preliminary in nature, while supporting measures tend to be more implementable. For many core measures, designing an implementation path will require more detailed feasibility analysis, including appropriate technical and economic studies. The feasibility analysis for each measure must be made on a case-by-case basis, and there is no single feasibility analysis that can be applied to all of the measures. Therefore, the optimal occasion for such analysis is during the design of the implementation plan, rather than this Plan, whose purpose is to provide a roadmap for the overall vision. Designing the implementation plan will also include prioritizing and optimizing the recommended measures for interrelatedness and co-benefits. Given the high stakes of the implementation plan, DOEE will engage in robust and inclusive stakeholder consultation in order to develop a plan that is well-informed by appropriately detailed analysis and discussion. Equitable development will be an essential feature of any future implementation strategies.

In addition, this Plan does not identify every measure that could potentially reduce GHG emissions. Certainly, DOEE expects that the collaborative process for the subsequent iteration will help identify more and better measures for reducing GHG emissions. One of the main purposes of the Plan is to identify the irreducible consumption sectors—buildings, energy supply, and transportation—and actions within those sectors that could lead to significant reductions. Such a list of actions would then allow the stakeholders and the public to better understand the magnitude of actions that would be required to achieve the GHG reduction target, and it would serve as the springboard upon which to evaluate and design each measure carefully for implementation.

While the recommended actions 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.
- An engagement period with District stakeholders.
- Revisions based on comments from stakeholders

To help evaluate the potential impact of different actions and determine an achievable path to achieving the District's GHG reduction target, the consultant team developed a citywide energy and emissions model to simulate different policy scenarios. The model accounts for all energy and GHG emissions in the District and focuses on representing energy supply, buildings, and transportation (for additional detail on the model, see Chapter 2 and Appendix A1). The consultant team used the model to project future energy and emissions and quantify the potential impact of different policies and programs. A baseline of current energy use and emissions was established to determine principal sources of District emissions by sector and by fuel type, then projected out in a business-as-usual (BAU) scenario through 2032 (further described in Appendix A1). The consultant team then simulated a range of policy scenarios and reviewed the results with District Government representatives. These simulations were used to determine the scale of action required in different sectors (e.g., existing buildings, transportation) to reach the District's GHG reduction target. As discussed in Appendix A1, not all recommended actions could confidently be quantified. Rather, once the consultant team had identified the scale of action required, the team developed a portfolio of energy, buildings, and transportation actions that could be used to achieve the scale of action required to achieve the District's GHG target. The consultant team then collaborated with DOEE staff and other District Government agencies to review the modeling results and proposed actions, and ensure that the set of actions being proposed were strong enough to achieve the District's target but also plausible in the District's ability to implement them.

The model is not intended to be a predictive tool and does not account for costs or externalities other than GHG emissions. The Plan provides this roadmap through a package of policy and program recommendations that have been reviewed by District Government representatives and critiqued by stakeholders.

Moving forward with detailed program and policy design with stakeholder collaboration, then implementation, many of the recommended actions warrant further analysis and prioritization, including a greater understanding of the potential cost-effectiveness and relative feasibility of policy and program approaches and designs. This analysis, prioritization, design, and implementation work (some of which is underway, see section 1.5) will be conducted in coordination with District stakeholders, many of whom are identified in the Plan.

The resulting set of recommended actions is 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).

(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 Plan 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 Plan 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 Plan 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 Plan 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 Plan 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 Plan: 1) the establishment of a green bank and 2) carbon pricing. 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.[12] Action CCB.1 discusses key considerations and makes recommendation for the development of a DC Green Bank. Although included in the Buildings chapter, a DC Green Bank can support District action on the Energy Supply System as well.

Although not included in the actions below, carbon pricing provides an additional funding mechanism and can help foster a market transformation by 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. DOEE is currently investigating the potential role and design of carbon pricing, and it has not been included as a specific action at this time. The potential GHG reductions achievable through carbon pricing has also not been included in the Plan because it is still under investigation.

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

1.5 A LIVING DOCUMENT

Given the analysis above, DOEE and the consultant team concluded that the Plan would serve best as a living document intended to be revised to continuously incorporate new insights and information as knowledge develops and new issues arise. The purpose of the Plan is to provide the District with a path to achieving their 2032 GHG reduction target. The specific prioritization, design, and implementation of the recommended actions should be formulated through further analysis, including feasibility, and collaboration with key stakeholders.

Alongside the Plan, 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.[13]
- The design and implementation of effective deep green retrofit financing. [14]
- The role of carbon pricing and its potential implementation. [15]
- The role of microgrids. [16]
- The reduction of GHG emissions from government and commercial vehicle fleets. [17]
- The sustainability performance of single -family and small multifamily buildings. [18] and
- The District's successful adaptation to the impacts of climate change. [19]

The authors of the Plan reviewed draft and completed versions of some of 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.

In addition to the topics covered by the ongoing studies listed above, the scope of this Plan does not include actions related to reducing GHG emissions from waste, addressing other social and ecological impacts (e.g., urban heat island effect, local air pollutants), nor responding to climate change impacts. However, climate change adaptation-focused actions can be found in the Climate Ready DC Plan. These issues may be re-visited and analyzed in the Plan's next iteration.

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

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

[15] Forthcoming.

[16] Forthcoming. Forthcoming. Urban Ingenuity is leading the consultant team working on this report, and has provided GHG reduction estimates for two sites that have been included in the model used to support the development of the Plan.

[17] Forthcoming.

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

[19] Climate Ready DC Plan

TRANSITIONING TO A LOW-CARBON DISTRICT

2 TRANSITIONING TO A LOW-CARBON DISTRICT

2.1 THE DISTRICT'S ENERGY USE AND EMISSIONS PROFILE

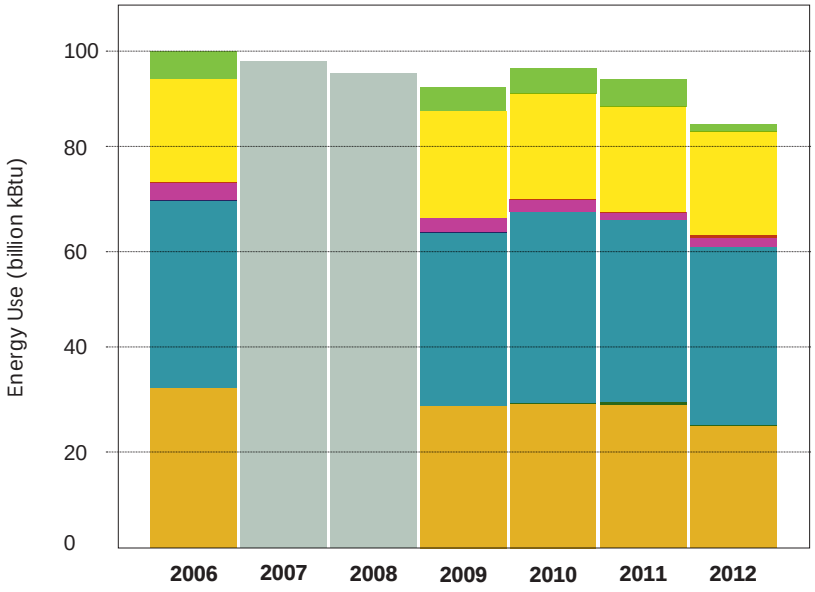
To identify the set of essential actions required for the decarbonization of the District of Columbia's (District) energy system, it is necessary to understand the District's current energy and emissions profile. Since the establishment of the 2006 greenhouse gas (GHG) emissions baseline, accurate energy 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 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 HISTORICAL ENERGY USE

Figure 3 summarizes the trend in energy used in the District between 2006 and 2012 by fuel type. All energy consumption reported in Clean Energy DC (the Plan) uses site energy based on building energy data from Department of Energy and Environment (DOEE).[20] To align with the District's GHG inventories, GHG emissions reported in the Plan are based on source GHG intensity factors that include losses from generation but not transmission and distribution (see A1.2.2.1 in Appendix A1 for details). 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, all of which explains why this Plan targets buildings, energy supply, and transportation. 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 **(Figure 4)**. 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.

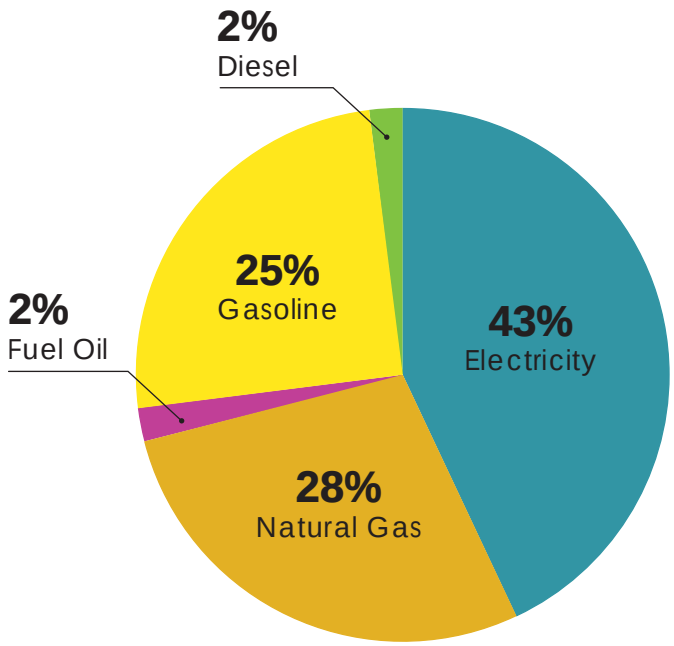
[20] Site energy use is the amount of heat and electricity consumed by a building as reflected in utility bills, whereas source energy accounts for the total amount of raw fuel required to operate a building. Source energy in incorporates all transmission, delivery, and production losses. Description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

Figure 3: Site energy use by fuel type, 2006 to 2012



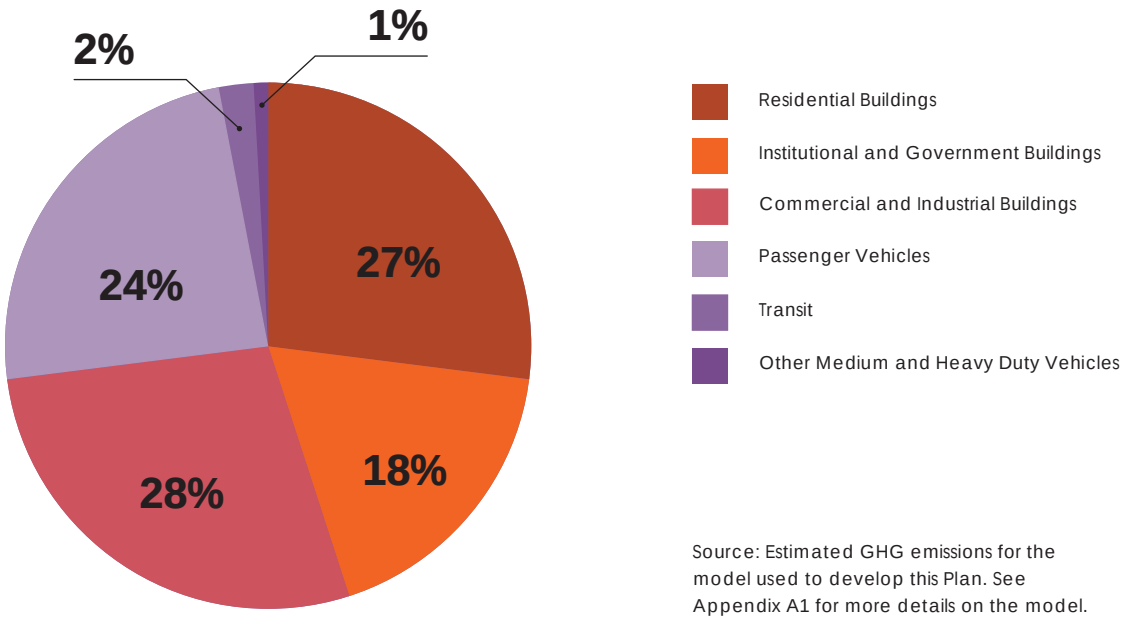
Note: Kerosene use is too small to show up on the graph, but reaches zero by 2012.
Source: GHG Summary Table maintained by DOEE. Data was not tracked for 2007 and 2008. This figure uses estimates based on a linear annual change from 2006 to 2009.

Figure 4: Proportion of site energy use by fuel type, 2012



Source: GHG Summary Table maintained by DOEE.

Figure 5: Estimated proportion of site energy use by sector, 2015



Source: Estimated GHG emissions for the model used to develop this Plan. See Appendix A1 for more details on the model.

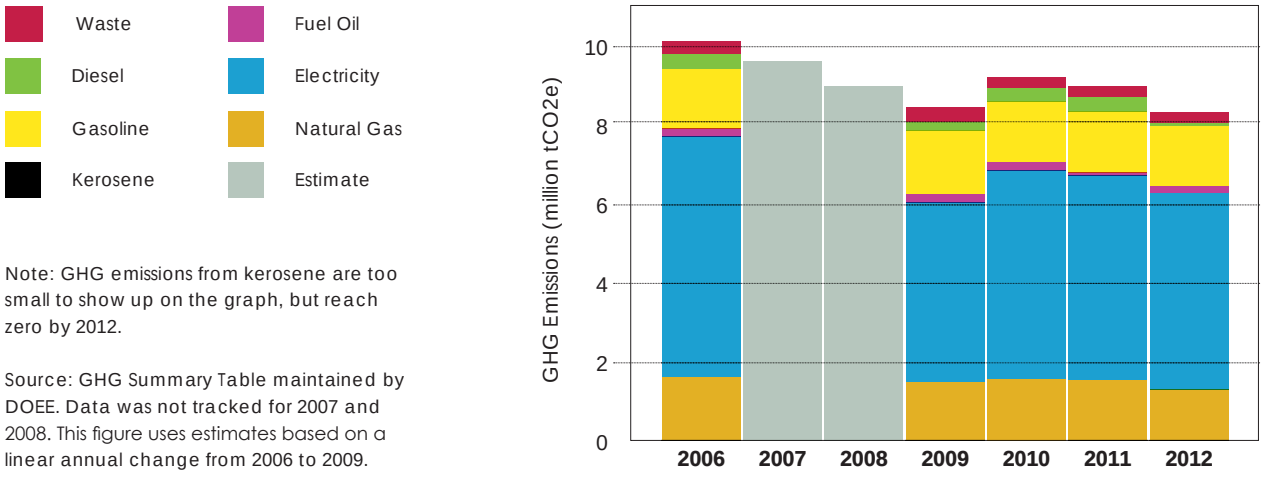
Developing the Clean Energy DC model allowed the District to estimate energy use by subsector for 2015 **(Figure 5)**.[21] It is clear that most energy is consumed by buildings (73%), with approximately equal portions consumed by residential (27%) and commercial and industrial (28%) buildings, with a bit less consumed by institutional and government buildings (18%). The remainder is attributable to transportation (27%), with the vast majority of energy consumed by passenger vehicles (24%), and much lower consumption for transit (2%) and other medium- and heavy-duty vehicles (1%).

[21] Previously, residential and commercial building energy consumption figures were categorized based on electricity rate categories. Because some multi-family residential buildings use commercial electricity rates, the District was not able to separate residential from commercial buildings.

2.1.2 HISTORICAL GHG EMISSIONS

Figure 6 summarizes the trend in GHG emissions in the District between 2006 and 2012 by source. 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.

Figure 6: GHG emissions by source, 2006 to 2012

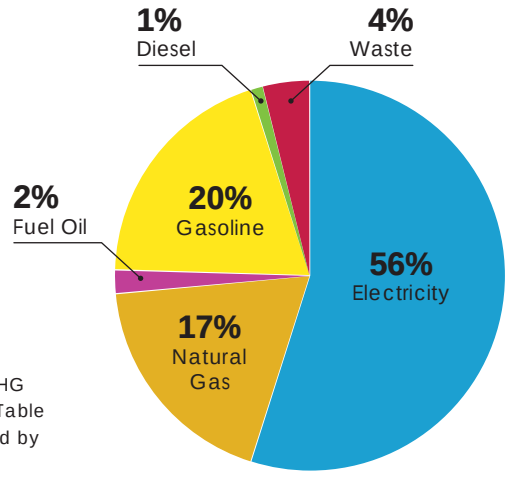


Note: GHG emissions from kerosene are too small to show up on the graph, but reach zero by 2012.

Source: GHG Summary Table maintained by DOEE. Data was not tracked for 2007 and 2008. This figure uses estimates based on a linear annual change from 2006 to 2009.

In 2012, buildings represented the most significant contributor to climate change, accounting for 75% of the District's total GHG emissions **(Figure 7)**. The transportation sector emitted comparatively little, accounting for approximately 21% of the District's GHG emissions.[22] 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 4% of the District's emissions are derived from solid waste. Though solid waste is not considered in the Plan, the District should continue to target this sector for emissions reductions whenever possible.

Figure 7: Proportion of GHG emissions by source, 2012



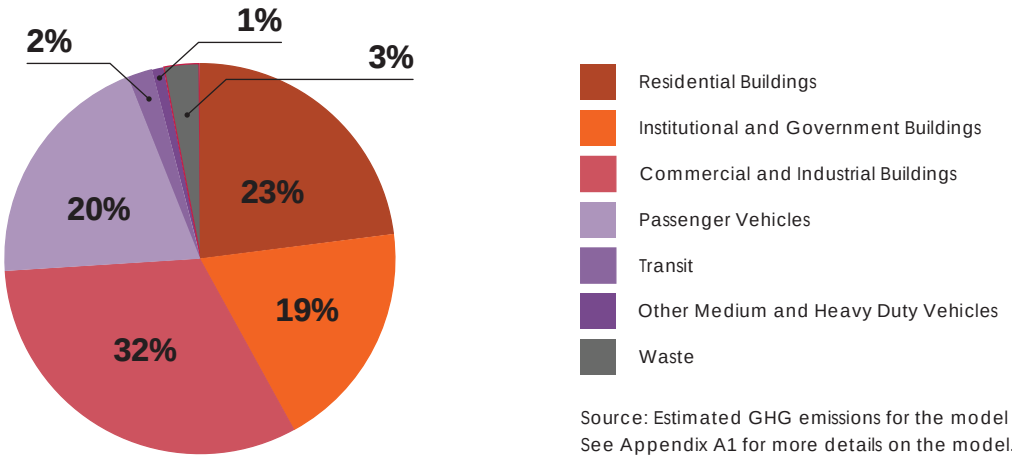
Source: GHG Summary Table maintained by DOEE.

[22] Based on all vehicle miles traveled in the District, regardless of origin or destination. Data supplied by the Metropolitan Washington Council of Governments.

As with energy use, developing the Clean Energy DC model allowed the District to estimate GHG emissions by subsector for 2015 **(Figure 8)** As with energy, most GHG emissions can be traced to buildings (74%), with most emissions coming from commercial and industrial buildings (32%), followed by residential buildings (23%) then institutional and government buildings (19%). The remainder is attributable to transportation (23%) and waste (3%). Within transportation, the vast majority of GHG emissions comes from passenger vehicles (20%), with smaller shares traced to transit (2%) and other medium- and heavy-duty vehicles (1%). To achieve its GHG target, the District will clearly need to shift away from fossil fuels for buildings (natural gas and fuel oil) and transportation (gasoline and diesel) while simultaneously decarbonizing its electricity supply. For buildings, this means shifting to non-fossil fuel sources for thermal energy. For transportation, this will require a significant transition to zero-emission vehicles, in addition to replacing vehicle demand with transit, walking, and cycling.

The District's total emissions dropped by 18% between 2006 and 2012. This decline can be attributed in part to the decreasing GHG intensity of the electric grid as coal power plants are retired and replaced with efficient 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 was calculated, which resulted in a significant decline in the total estimated diesel consumption between 2011 and 2012.[23] 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).

Figure 8: Estimated proportion of GHG emissions by sector, 2015



Source: Estimated GHG emissions for the model used to develop this Plan. See Appendix A1 for more details on the model.

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

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, the results of this model 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 it is instead designed to inform the selection and prioritization of different options. The model is also designed to allow the District to revisit the recommendations of the Plan as conditions change, to effectuate its design as a "living document."

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. More information on the model and assumptions can be found in Appendix A1.

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.[24] From these data points, two groups of actions are captured in the model:

(1) **New Construction Actions:** The model assumes that the Government of the District of Columbia (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.

(2) **Existing Building Actions:** The model also assumes that deep energy retrofits will achieve an average of 30% energy use reductions across 17.5% of the private building stock between 2020 and 2032, with shallower retrofits of 15% energy use reductions across 3% of the private building stock between 2017 and 2019. The District government implements a more aggressive retrofit program for its own building portfolio managed by the Department of General Services, affecting 34.5% of the buildings by 2032, with two thirds of these being net-zero retrofits. Altogether, nearly one in five buildings in the District undergoes some sort of energy performance retrofit. The actions recommended in Sections 3.2 and 3.3 support the District in achieving these retrofit rates and energy use reductions.

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

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 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.

First, the model simulates an estimated 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.[25] 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. This 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.[26] As discussed in further detail in Chapter 4, the District's RPS allows electricity suppliers to comply with the requirements using a combination of two approaches:

(1) Procuring renewable energy credits (RECs) or solar renewable energy credits (SRECS) for the solar requirement, which may be accomplished by one of the following:

- **(a)** Purchasing unbundled RECs or SRECs
- **(b)** Purchasing energy bundled with associated Generating RECs or SRECs (and retiring the associated RECs or SRECs)

(2) Making alternative compliance payments (ACPs) to the District based on the portion of the RPS requirement that cannot be satisfied with RECs and SRECs.

RECs used to comply with the RPS must represent electricity produced by renewable sources within the PJM Interconnection Region (PJM) or within a state that is adjacent to PJM.[27][28] Similarly, SRECs used to comply with the local solar RPS requirement must be located within the District or in locations served by a distribution feeder serving the District.

[25] 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

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

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

[28] The RPS further rules clarify that states within the PJM Interconnection Region currently include Delaware, the District of Columbia, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia and West Virginia, and states adjacent to the PJM Interconnection Region include Alabama, Arkansas, Georgia, Iowa, Mississippi, Missouri, New York, South Carolina, and Wisconsin. Public Service Commission of the District of Columbia, Report on the Renewable Energy Portfolio Standard for Compliance Year 2015, May 2, 2016, http://www.dcpsc.org/getmedia/901b3c18-4859-435d-ae1a-ca296584c26b/aharris_542016_831_1_FC_-_945_-_2016_-_E_-_REPORT.aspx.

ICLEI's Protocol requires a city to calculate GHG emissions based on the best information it has about the source of the electricity it consumes. Like several other jurisdictions, the District uses the GHG intensity of its regional grid, which is the Environmental Protection Agency's (EPA) eGRID factor for the ReliabilityFirst Corporation-East (RFC-East) subregion.[29] Because the RPS allows suppliers to comply using RECs from outside the EPA's RFC-East eGRID subegion, not all RECs used to comply with the RPS will lead to GHG emissions that the District can account for in its GHG inventory. Similarly, ACPs represent financial contributions to the District that are not directly associated with GHG reductions. 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, specifically, how much new renewable energy is generated through the expenditure of ACPs, and how much new renewable energy is added to the RFC-East eGRID subregion. The model (and Figure 9 in section 2.2.2.1) assumes that 57% of the RPS leads to GHG reductions that can be attributed to the District's GHG inventory under the ICLEI Protocol requirements.[30] The actual GHG impact of the RPS will depend on how it is designed and managed as renewable energy requirements increase, as discussed in Action CRE.1.

Under the assumption that 57% of RECs purchased for RPS compliance lead to attributable GHG reductions, the RPS is the largest single GHG reduction action in the Plan. In terms of the RPS's full GHG reduction potential (or lack thereof), under a 50% RPS the District can achieve GHG reductions between 44% (if suppliers meet the standard using only ACPs and RECs that do not affect the RFC-East eGRID factor) and 56% (if suppliers meet the standard using only RECS that affect the RFC-East eGRID factor). Even under the lowest GHG reduction case, the District Government would still use ACPs to fund renewable energy programs, such as the Solar for All program mandated by the District of Columbia Council, so the ACPs would conceivably result in GHG emissions reductions above the 44% 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. EPA'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.[31] While the District may benefit from the actions taken by other states under the CPP, its own RPS will also drive GHG emissions reductions, potentially further than what would be achieved through the CPP. To avoid double-counting these emissions reductions, the potential GHG reduction impact of the CPP has not been included in either the business-as-usual or policy model scenarios.

[29] The U.S Environmental Protection Agency's eGRID factor for RFC-East subregion for 2014 (accessed January 20, 2016). http://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

[30] This assumption is based on discussions with DOEE representatives and the finding that 57% of all non-hydroelectric renewable energy capacity built in the United States since 2000 is being used to comply with RPS requirements. Finding soured from: Lawrence Berkeley National Laboratory (LBNL) and National Renewable Energy Laboratory (NREL), 2016. "A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standards." https://emp.lbl.gov/sites/all/files/lbnl-1003961.pdf; Barbose, Galen. Lawrence Berkeley National Laboratory, April 2016. "U.S. Renewables Portfolio Standards: 2016 Annual Status Report." https://emp.lbl.gov/sites/all/files/lbnl-1005057_0.pdf

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

Four key actions relevant to energy supply are captured in the model:

Neighborhood-Scale Energy:

The model assumes that five neighborhood-scale thermal energy systems are installed between 2020 and 2028.[32] These systems are powered by wastewater thermal resources identified by DC Water and total 37 MW. The model also includes GHG reductions estimated from the development of two microgrids at Walter Reed Army Medical Center and St. Elizabeth's Campus.[33] Actions CRE.7 and CRE.8 are designed to support the development of these systems.

Power Purchase Agreement for Standard Offer Service:

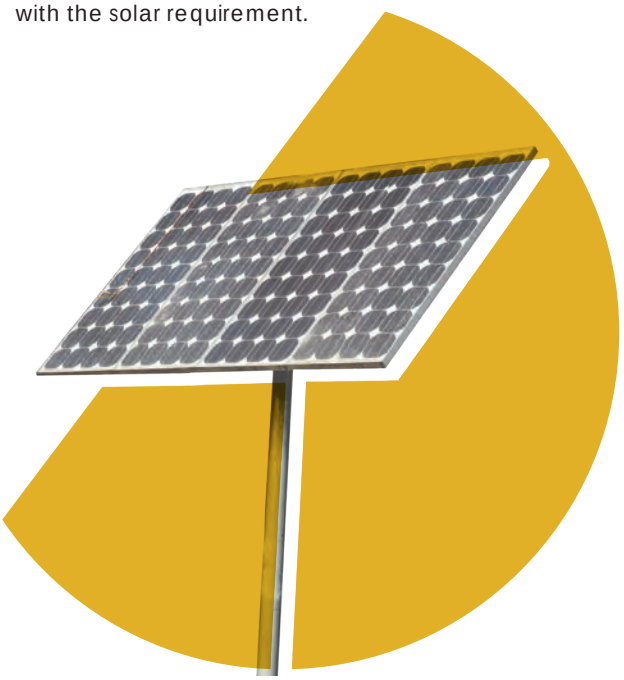
The model assumes that the current Standard Offer Service (SOS) will use a mix of short-term and long-term energy supply contracts, including a power purchase agreement (PPA), with one or more energy suppliers to provide renewable for 70% of the SOS beginning in 2018. The SOS is the electricity purchased 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.[34] To be conservative, the model assumes 10% of customers opt-out of the new SOS, which then supplies 21.6% of the District's electricity consumption (Action CRE.2). The new, renewable energy-driven SOS procurement should be phased in over three years, affecting an additional third of the SOS in each year.

Renewable Portfolio Standard:

The Plan assumes 57% of the RPS's maximum GHG reduction potential is captured by the District's 2032 requirement of 45% renewable electricity supplied from outside the District. The actual impact will depend on how electricity suppliers comply with the RPS.

Renewable Portfolio Standard Local Solar Requirement:

The Plan assumes 57% of the RPS local solar requirement's maximum GHG reduction potential is captured by the District's 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.



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

[33] The District is currently investigating and is actively engaged in maximizing the utilization of cost-effective microgrid opportunities. Once more information is available, the next iteration of the Plan can incorporate the potential impact of these opportunities.

[34] Public Service Commission. 2015. http://www.dcpsc.org/PSCDC/media/PDFFiles/Electric/electric_sumstats_cust_energyuse.pdf.

2.2.1.3 TRANSPORTATION

Finally, energy and emissions in the transportation sector are determined using estimates of vehicle miles traveled;[35] 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:

(1) **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. Because it is a federal regulation already in place, the CAFE Standard will achieve GHG reductions regardless of action taken by the District, but the level of its impact changes based on the mode share changes achieved by the District. It has been included in the GHG and energy use reduction modeling to make its impact explicit to readers.

(2) **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 Plan, as mode share is the focus of the moveDC Plan.

(3) **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 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 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.[36] 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 Plan, in order to best optimize the three related, but not always cohesive, targets (i.e., energy use reduction, renewable energy increase, GHG reduction). 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

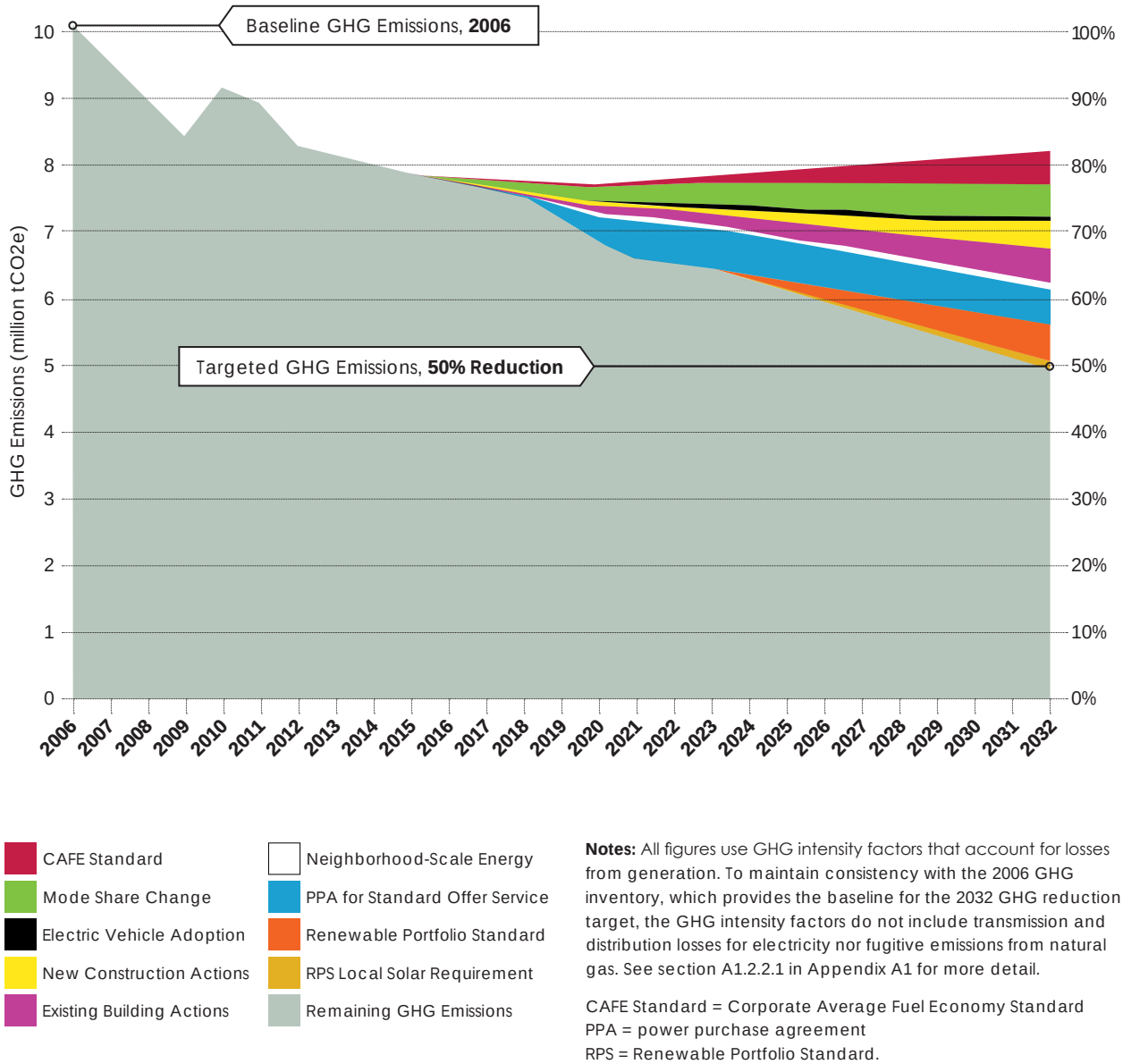
The model demonstrates that when implemented together, the actions recommended in the Plan will achieve an estimated 51% reduction in GHG emissions relative to 2006. As discussed in section 2.2.1.2 above, projected GHG reductions depend significantly on how electricity suppliers comply with the RPS. GHG emissions reductions may be as low as 44% below 2006 levels if suppliers comply with the RPS using ACPs and RECs that do not affect the RFC-East eGRID subregion's GHG intensity, or as high as 56% if suppliers comply using only RECs that affect

[35] This includes all vehicle miles traveled in the District, regardless of origin or destination.

[36] 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.

the RFC-East eGRID subregion's GHG intensity. **Figure 9** presents projected GHG reductions achieved by actions in different sectors. Notice that GHG emissions have declined since 2006. This is due primarily to coal plant closures that reduced the GHG intensity of electricity consumed in the District. Notice also that, absent additional efforts by external actors to clean the grid, GHG emissions are projected to increase between now and 2032 (the top line of the CAFE Standard wedge in Figure 9).[37]

Figure 9: Projected GHG reductions from recommended actions



Notes: All figures use GHG intensity factors that account for losses from generation. To maintain consistency with the 2006 GHG inventory, which provides the baseline for the 2032 GHG reduction target, the GHG intensity factors do not include transmission and distribution losses for electricity nor fugitive emissions from natural gas. See section A1.2.2.1 in Appendix A1 for more detail.

CAFE Standard = Corporate Average Fuel Economy Standard
PPA = power purchase agreement
RPS = Renewable Portfolio Standard.

[37] External forces will likely result in the GHG intensity of the grid declining, such as through the implementation of the federal Clean Power Plan, the EPA's mercury regulations, and declining renewable energy costs. To avoid overestimating GHG reductions, these forces are not included in the BAU projection. These forces will drive the same type of grid cleaning that the District's RPS will, so including both without a good understanding of interaction effects would results in double counting emissions reductions.

Accounting for the decline in GHGs since 2006 and the projected increase in GHGs going forward, the District must take enough action to avoid approximately 39% of the GHG emissions projected for 2032 if it wants to reduce GHG emissions by 50% relative to 2006. As noted above, the actions recommended in this Plan achieve that. **Table 1** summarizes the total GHG emissions avoided in 2032 relative to the BAU scenario and attributes these reductions to actions in different sectors.[38]

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	5.8%
Mode Share Change	528,000	6.4%
Electric Vehicle Adoption	34,000	0.4%
New Construction Actions	430,000	5.2%
Existing Building Actions	544,000	6.6%
Neighborhood-Scale Energy	44,000	0.5%
PPA for Standard Offer Service	543,000	6.6%
Renewable Portfolio Standard	581,000**	7.1%**
RPS Local Solar Requirement	87,000**	1.2%**
Total GHGs Avoided vs. 2032 BAU	3,277,000	39.8%
Total GHGs Reduced vs. 2006 Baseline	5,664,000	51%

Note: All figures based on site energy use, and use GHG intensity factors that account for losses from generation. To maintain consistency with the 2006 GHG inventory, which provides the baseline for the 2032 GHG reduction target, the GHG intensity factors do not include transmission and distribution losses for electricity nor fugitive emissions from natural gas. See section A1.2.2.1 in Appendix A1 for more detail.

*This column measures the percentage reduction in total GHG emissions from the 2032 level under the BAU scenario. For example, New Construction actions decrease total District-wide 2032 GHG emissions by 5.3%. Due to GHG declines between 2006 and 2015 as well as projected GHG increases between 2015 and 2032, the District must avoid 38.6% of projected GHGs in 2032 to decrease GHG emissions 50% relative to 2006.

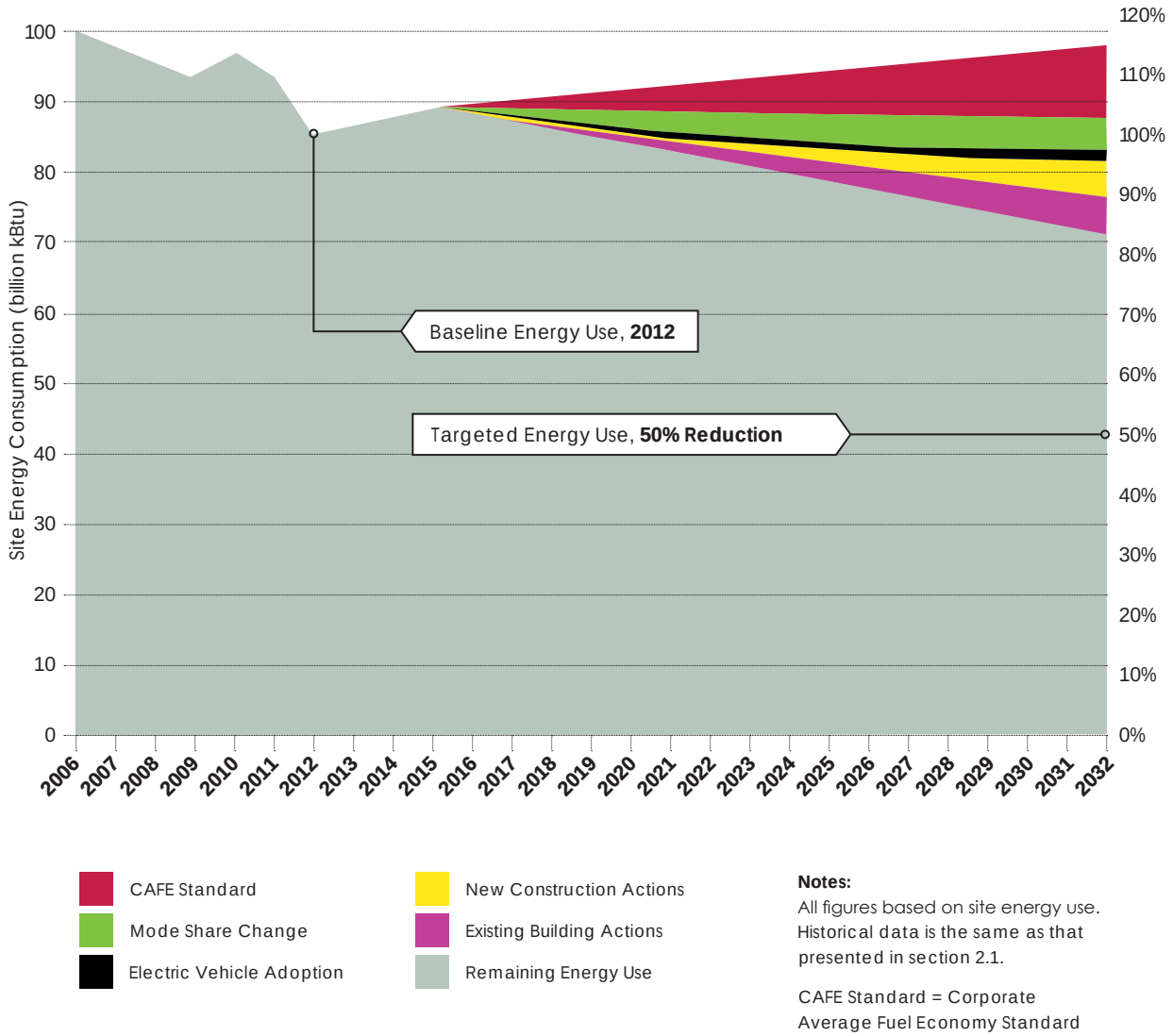
**Assumes the District captures 57% of the total potential GHG reductions possible under the RPS. See section 2.2.1.2.

[38] Assuming 57% of the maximum possible reductions from the RPS are captured by the District.

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 18% relative to the District's 2012 baseline. Figure 10 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 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 9 and Table 1 do not appear in Table 2, as they do not reduce energy use but only shift the source of that energy.

Figure 10: Projected site energy use reductions from recommended actions



Notes:
All figures based on site energy use. Historical data is the same as that presented in section 2.1.

CAFE Standard = Corporate Average Fuel Economy Standard

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	10.1%
Mode Share Change	4,969	5.1%
Electric Vehicle Adoption	1,573	1.6%
New Construction Actions	5,014	5.1%
Existing Building Actions	6,401	6.6%
Total Energy Use Avoided vs. 2032 BAU	27,749	28.5%
Total Energy Use Reduced vs. 2012 Baseline	15,295	18%

Note: All figures use site energy numbers. As explained elsewhere, all reported energy figures use site energy, while GHG emissions use source GHG intensity factors that account for generation losses, but not losses from transmission and distribution. See section A1.2.2.1 in Appendix A1 for more detail.

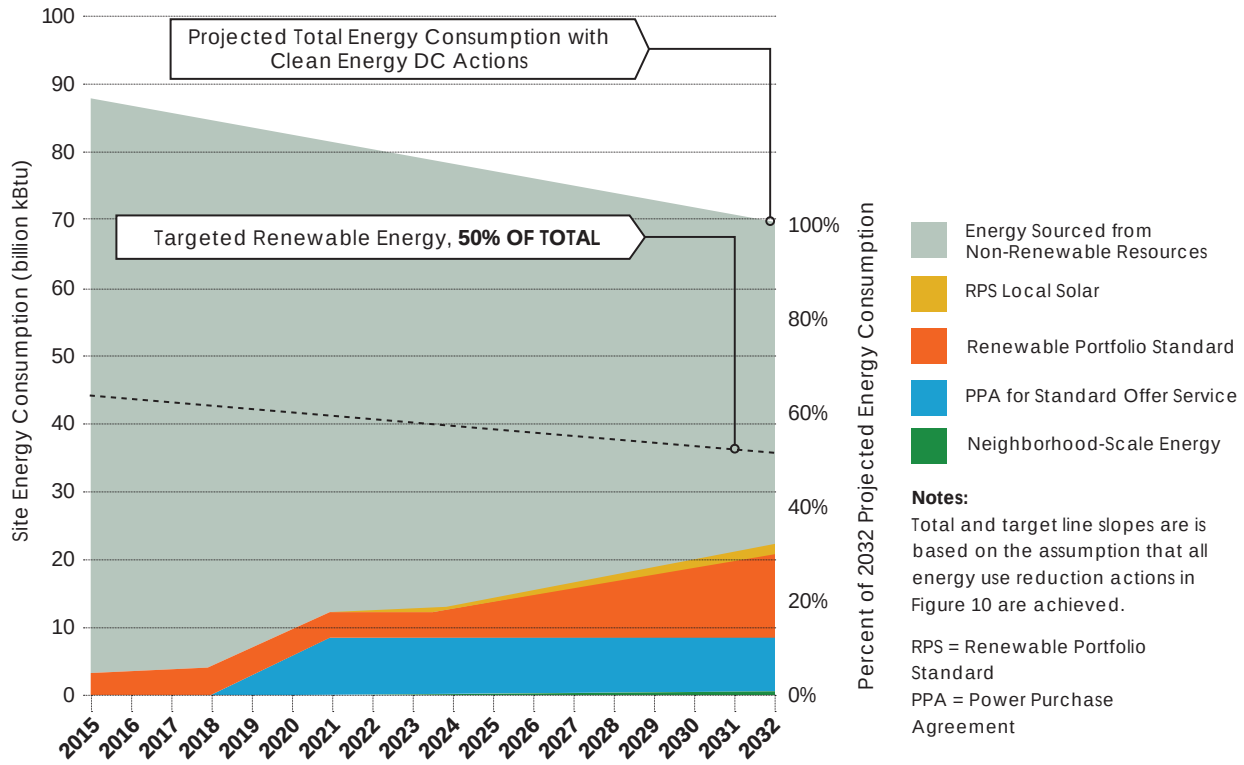
*This column measures the percentage reduction in total energy consumption that a single action area drives relative to the total BAU energy use in 2032. As with GHG emissions, projected growth in energy consumption between 2012 and 2032 dictates what the District must accomplish to achieve its 2032 energy use reduction target. Based on growth in energy consumption since 2012 (the baseline year), as well as continued growth in projected energy consumption, the District must avoid 56% of its BAU energy consumption in 2032 to reduce energy consumption by 50% relative to 2012.

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 11 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.

The model shows that the recommended actions will result in 32% of the District's total energy use in 2032 coming from renewable sources. While the actions do not fully achieve the 50% renewable energy target, they would significantly increase the amount of renewable electricity consumed in the District.

Figure 11: Projected utilization of renewable energy as a result of recommended actions.



Notes:
Total and target line slopes are is based on the assumption that all energy use reduction actions in Figure 10 are achieved.

RPS = Renewable Portfolio Standard
PPA = Power Purchase Agreement

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

Renewable Energy Utilization Wedge	Renewable Energy Utilization in 2032		Estimated generation capacity required in 2032 (MW)*
	million kBtu	*percentage of total energy use*	
Neighbourhood-Scale Renewable Energy	524**	0.8%	37**
PPA for Standard Offer Service	7,746	11.1%	563 - 1,448
Renewable Portfolio Standard	12,652	18.2%	920 - 2,365
RPS Local Solar Requirements	1,406	2.0%	362

Note: Based on site energy use. As explained elsewhere, all reported energy figures use site energy, while GHG emissions use source GHG intensity factors that account for generation losses, but not losses from transmission and distribution. See section A1.2.2.1 in Appendix A1 for more detail.

*Required generation capacities are based on assumptions about capacity factors: 47.4% for neighborhood energy wastewater thermal (based on DC ENERGIZED), 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 (based on GDS Associates for the District Department of the Environment, Renewable Energy Technologies Potential for the District of Columbia, 2013).

**This does not include the Walter Reed or St. Elizabeths neighborhood-scale energy systems because they are not fully renewable energy.

BUILDINGS

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 each section, that set of recommendations is summarized by an individual roadmap that can be used by the District of Columbia (District) to guide their implementation of the first five years of Clean Energy DC, 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.[39] 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 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.[40/41] By upgrading building codes, providing financial support, and offering educational and training opportunities for the design and construction industries, the Government of the District of Columbia (District Government) can move toward the achievement of a low-carbon built environment.

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

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

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

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.[42] 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.[43/44]

These high-performance buildings share a remarkably consistent set of design and technological characteristics,[45] 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.

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

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

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

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

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:

(1) **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.

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

(3) **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.

(4) **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.

(5) **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 Leadership in Energy and Environmental Design (LEED) for Schools-NC certification program to date.[46] The construction of other similar buildings will help increase the visibility and uptake of high-performance buildings.

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

(6) **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.

(7) **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%.[47] A study conducted within the District has indicated that the cost premium for highly energy efficient buildings is approximately 1% to 12%, [48] depending on building type, with a return on investment ranging from 5% to 12%. 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.

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.

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

[48] 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

3.1.2 RECOMMENDED ACTIONS

3.1.2.1 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 of single-family and small multifamily buildings in 2020, and for all new construction by 2026.

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 greenhouse gas (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 at the very latest. The District Government has not defined how to qualify a building as net-zero. The District is beginning work to develop this definition as a first step towards codifying such buildings in the future.

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 solar panels throughout all flat roof areas, except those needed for skylights, vents, HVAC equipment,[49] 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.

Regarding the use of solar panels, the District should consider clarifying zoning regulations pertaining to them, including classifying solar panels differently than other rooftop mechanical equipment to allow for reduced setbacks and thus more panel coverage.

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[50] and,
- Continue to mandate air performance sealing, and add any supplemental requirements determined appropriate based on experience implementing the 2012 code.

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 at the very latest.

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 at the very latest.[51]

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 (CO2) mandated as compression gas
- Lighting density: 0.3 W/ft2
- 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

[49] HVAC is heating, ventilation, and air conditioning.

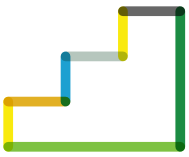
[50] Based on recommendations from DOEE's Single Family and Small Multifamily Working Group.

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

In addition to these performance requirements, the District should also include minimum requirements for post-occupancy performance, including 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.

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 at the very latest, with an objective to adopt net-zero codes earlier.

3.1.2.2 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.[52]

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 several coordinated components.[53]

[52] This recommendation is based on forthcoming 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.

[53] More details in forthcoming Greening the District of Columbia: Incentives and Policies to Achieve Deep Green Building Construction and Renovations.

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 DOEE and DCRA permitting time. The Office of Zoning should also allow net-zero energy projects requiring zoning relief a streamlined hearing process and reduced/eliminated fees from the Office of Zoning. 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.

Floor Area Ratio Increases: Third, the District Government should grant floor area ratio (FAR) increases for buildings that target net-zero energy standards. FAR is the ratio of a building's total floor area (gross floor area) to the size of the piece of land upon which it is built, so zoning limits on FAR are in effect limits on building height and massing. In many other jurisdictions, FAR bonuses in return for green features are common. However, the applicability of this incentive in the District will be limited by the fact that many buildings are already maxed out on floor area ratio and unable to go higher thanks to the Federal Height Act. In many parts of the city, the zoning code limits FAR and building height to levels far below the Height Act limits; in these areas, a FAR incentive could be very helpful.

Green Area Ratio Increases: Fourth, the District should utilize the Green Area Ratio (GAR) program to incentivize on-site renewable energy needed for net-zero energy buildings. GAR is an innovative environmental sustainability zoning regulation that sets standards for landscape and site design to help reduce stormwater runoff, improve air quality, and keep the city cooler.[54] The District should consider increasing GAR multiplier for solar panels to incentivize an increase in solar panel installations, as well as considering an increase in the overall GAR requirement in all zones.

PACE Financing: Futhermore, the District's Property Assessed Clean Energy (PACE) financing should be made available on an expanded basis to commercial and multifamily buildings to support net-zero energy improvements for new construction projects (See Action EB.5 for more). The PACE program should amend project underwriting criteria to provide accelerated approval for building improvements that are essential to achieving net-zero energy performance levels, independent of near term financial payback calculations, provided that they advance this broader public purpose. This underwriting incentive would provide a valuable program enhancement to project developers by offering guaranteed access to upfront capital to finance any additional marginal costs associated with net-zero energy upgrades.

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. [55]

[54] http://doee.dc.gov/GAR

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

Next Steps

- Use early 2017 to design the specific incentives identified above, and then implement the property tax abatement, accelerated permitting pathways, and floor area ratio and green area ratio bonuses in 2017 in conjunction with the updated construction and zoning 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).[56/57] 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.

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.

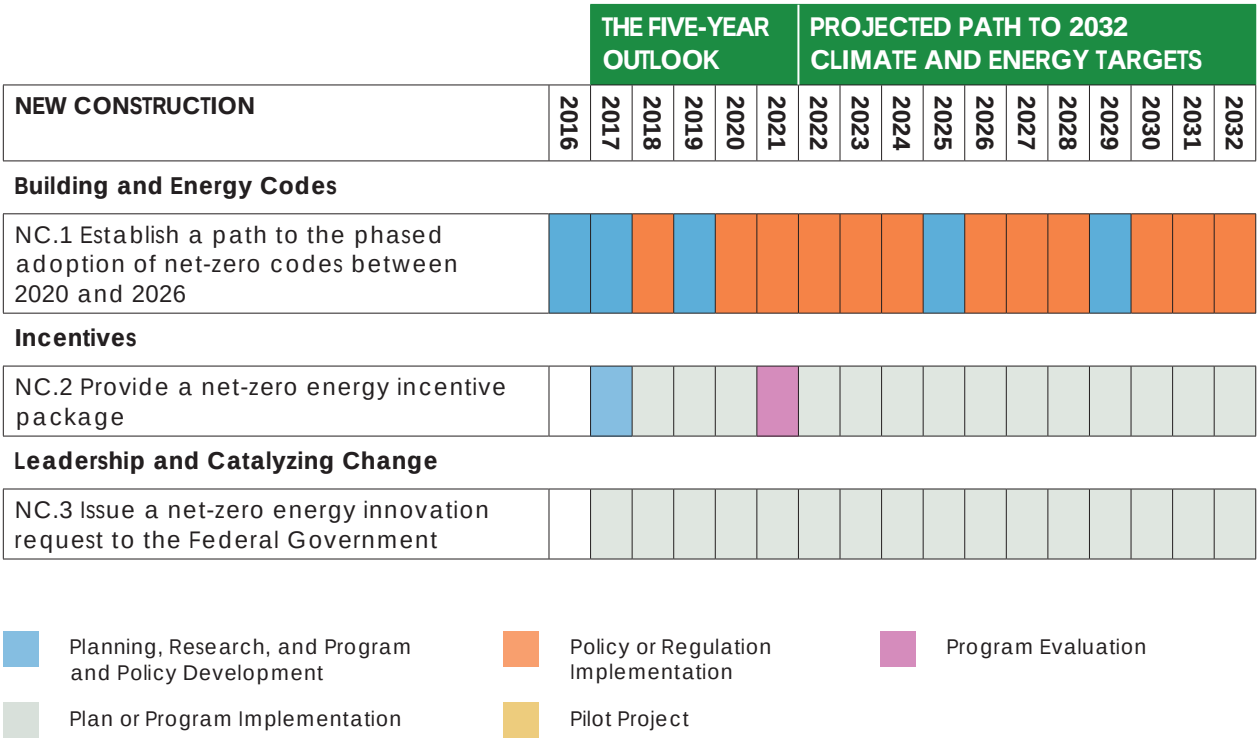
Next Steps

- In 2017, adopt a resolution to challenge the Federal Government to adopt the same or better standards for government buildings as those adopted by the District Government.

[56] 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

[57] 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

3.1.3 NEW CONSTRUCTION ROADMAP



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.[58] The dense urban makeup of the District of Columbia means that buildings account for an even higher portion of energy use and emissions. Approximately 74% of GHG emissions in the District result from the operation of District buildings, the majority in non-residential buildings.[59] The total District building stock comprises over 750 million square feet of floor area, of which 33% is commercial, 20% is institutional or governmental, 23% is multi-family residential, and 24% is single-family residential. In 2015, these buildings consumed over 65 billion kBtu of on-site energy, 55% of which came from electricity.[60] The District will meet the energy and emissions climate targets only by pursuing actions and programs that target existing buildings, especially commercial buildings.[61]

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.[62] This leadership shows accountability for District Government performance and underscores both the importance and value of managing building performance in real-time.[63] 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 EPA's 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 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.[64]

[58] 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.

[59] 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.

[60] See Appendix A1 for sources, and for a detailed breakdown of building floor area and energy use by use type and fuel source.

[61] Sustainable DC Plan, 2012

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

[63] 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.

[64] 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.

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), buildings that are less than 50,000 square feet once parking garages are excluded, and special cases where an exemption has been requested by the owner. Single-family residential spaces are also exempt; however, the 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.

However, 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.[65/66] As such, an update to the District's ordinance to include federal buildings could be effective in compelling federal government to report.[67/68/69]

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, DOEE offered a grant to New York University's Center for Urban Science and Progress (CUSP). CUSP'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 of data.[70] The CUSP team also developed an algorithm for evaluating relative quality of the data. [71] These resulting datasets have been used to guide the recommendations and analysis in this chapter, along with the model results discussed in Chapter 2 and Appendix A1. Indeed, this plan is perhaps the first energy plan in the country to draw on localized benchmarking data to inform its modeling and recomendations.

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

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

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

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

[69] 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

[70] 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.

[71] Kontokosta, Contantine, Bartosz Bonczak, and Marshall Duer-Balkind. 2016. "DataIQ – A Machine Learning Approach to Anomaly Detection for Energy Performance Data Quality and Reliability." Proceedings of the 2016 ACEEE Summer Study on Energy Efficiency in Buildings in Asilomar, CA. Washington, DC: American Council for an Energy Efficient Economy. http://aceee.org/files/proceedings/2016/data/papers/12_1139.pdf

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.[72] 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.[73] 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.[74] 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. Multiple studies in various jurisdictions do indicate that the transparency created by benchmarking does drive real-world reductions in energy-use.[75][76][77] No such research has yet been done in the District. Because of the uncertainty in this very new area of research, the danger of double-counting, and the fact that the District's benchmarking law predates this Clean Energy DC Plan (Plan), these savings potentials have not been incorporated into the model at this time. Nonetheless, the value of these policies should not be underestimated.

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.

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

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

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

[75] Palmer, Karen, and Margaret Walls. 2015. "Can Benchmarking and Disclosure Laws Provide Incentives for Energy Efficiency Improvements in Buildings?" Resources for the Future. Washington, DC. http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-15-09.pdf

[76] Meng, Ting, David Hsu, and Albert Han. 2016. "Measuring Energy Savings from Benchmarking Policies in New York City." Proceedings of the 2016 ACEEE Summer Study on Energy Efficiency in Buildings in Asilomar, CA. Washington, DC: American Council for an Energy Efficient Economy. http://aceee.org/files/proceedings/2016/data/papers/9_988.pdf

[77] Bannister, Paul, Lane Burt, and Adam Hunge. 2016. "Under the Hood of Energy Star and NABERS: Comparison of Commercial Buildings Benchmarking Programs and the Implications for Policy Makers." Proceedings of the 2016 ACEEE Summer Study on Energy Efficiency in Buildings in Asilomar, CA. Washington, DC: American Council for an Energy Efficient Economy. http://aceee.org/files/proceedings/2016/data/papers/9_480.pdf

3.2.3 RECOMMENDED ACTIONS

3.2.3.1 ENERGY EFFICIENCY INCENTIVES AND MANAGEMENT

EB.1 Increase access to building energy performance data for energy efficiency programs

Action: Improve the access of the District of Columbia Sustainable Energy Utility (the DCSEU), DC PACE, and any future DC Green Bank to building energy information to allow them to target buildings with the highest potential for energy savings.

Relevance: Like most demand-side management (DSM) programs across the nation, 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. As appropriate, this information should also be systematically shared with the DC PACE program and any DC Green Bank, to facilitate streamlined operations across all of the District's rebate, financing, public education, and technical assistance programs.

Details: Several sources of data would assist the DCSEU in improving the effectiveness of its programs and services, and in better utilizing financial leverage through existing District financing programs.

(1) **Benchmarking data:** DOEE publishes summary data on every building that reports benchmarking data, beginning with the second year of data for each building. However, DOEE also provides more detailed benchmarking data to the DCSEU and the DC PACE programs, which provides a snapshot of the annual energy performance and different characteristics of the District's built stock, along with contact information for building owners and managers. DOEE should continue to share the full set of benchmarking data with DCSEU and DC PACE under appropriate confidentiality agreements, while moving to make summary benchmarking data on each building available to the public more rapidly. While the annual benchmarking data is useful, monthly energy usage data would allow further insight into building energy consumption under different climatic conditions, system loads, and operating characteristics. It would also allow the isolation of the building base-load from its seasonal heating and cooling load, indicating 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.[78]

[78] 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.

(2) Utility Meter Information: As an independent organization, the DCSEU cannot access individual meter-level or building-level energy consumption data directly from District utilities, nor does it have access to information on 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 meter configuration information directly with the DCSEU would enhance its overall effectiveness in targeting the highest-potential energy savings projects. In addition, the District Government should find a way for the DCSEU to access to real-time utility data. Modern "smart" meters generate data points at intervals as small as every 15 minutes, and this "interval" data offers a wealth of insight into the energy efficiency opportunities in buildings. 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.[79] 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.

(3) Grid Information: In addition, the DCSEU's operations could be further enhanced by being notified by Pepco where the grid is experiencing stress at the feeder level. Targeting buildings on these feeder lines for energy efficiency would help stabilize the grid, maximize the value of energy efficiency, and create room for on-site renewable energy capacity, thereby supporting the District's efforts to modernize its electricity system (see section 4.2).

(4) 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. Much of the supplemental data being collected in New York City and being leveraged by their Retrofit Accelerator is audit and retrocommissioning data that is not currently available to the District Government. However, if a Building Energy Performance Standard (BEPS) program is adopted (see Action EB.6), that will generate detailed audit information for the worst performing buildings. Likewise, estimated but still highly useful audit data will be generated by citywide virtual energy audits (see Action EB.9).

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

These data should also be shared, under strict confidentiality protections, with DCSEU and the District's green finance programs.

(5) **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 faced difficulties in matching its benchmarking datasets 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 and DC PACE programs 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. Access should be shared, as appropriate, with District Government agencies who work in the existing building space. Use case and workflow evaluation and security are key 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 through ENERGY STAR Portfolio Manager.
- Starting in 2017, work with the Public Services Commission (PSC), the Office of People's Counsel (OPC), the DCSEU, and the utilities to investigate the best path to granting access to real-time, granular interval energy consumption information of utility customers to the DCSEU, under strong non-disclosure requirements, in addition to information regarding congested or highly-burdened feeder lines.

EB.2 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.

(1) **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.

They can also involve behavior-based programs. 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 from operational energy management in commercial and residential buildings, and incorporating that methadology into the evaluation, measurement and verification (EM&V) of the DCSEU's savings and incentive structure.

(2) **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. An easy and efficient way to do so would be to credit the DCSEU with all of or a portion of the energy savings, renewable energy capacity increase, and green jobs attributable to DC PACE and any future DC Green Bank projects so long as DCSEU was involved in the project, even if that involvement came from technical or marketing assistance rather than direct financial incentives.

(3) **Integration between the DCSEU and the District's green finance programs:** The District should establish a formal joint marketing and outreach program between the DCSEU and DC PACE program (and any future DC Green Bank), including dedicated funding. This joint marketing program should offer a suite of specific technical assistance services to customers that encourage building owners to implement deeper retrofits, with costs reduced both through available DCSEU incentives, and PACE financing for all capital costs associated with the energy project. By providing a mechanism for property owners to access deeper savings with no up-front cost barrier, such a marketing program will help to avoid instances where organizations a focus solely on the lowest hanging fruit or implement only those measures with dedicated rebates.

Additionally, to support this effort, the DCSEU should have a clear mandate to provide technical assistance to joint DCSEU and DC PACE customers by offering energy audits or other building level or project reviews that are tailored to the underwriting requirements of both the DCSEU incentives and the DC PACE program. Providing a single point of entry for customers, and handing off data that is directly applicable to DC PACE financing, will streamline project development and lower transaction costs for property owners and encourage increased uptake of both programs. In addition, the DCSEU would be able to receive credit for the energy use and carbon reductions for those DC PACE projects supported by the DCSEU analysis or incentives, regardless of who provided the majority of financing, or timing of project closing, in order to align incentives.

(4) 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.[80] 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.[81] However, additional changes are needed to properly incentivize the DCSEU to seek deeper, longer-term energy savings.

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.

(5) 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.[82/83] 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 might be required.

[80] 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/).

[81] 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

[82] 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

[83] 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.

(6) Tracking GHG reductions: Under the new contract, the DCSEU will have four performance benchmarks—reduce energy consumption, increase renewable energy generation capacity, target low-income communities, and create green jobs. It also will be required to track and report semiannually on its progress on reducing peak demand and addressing the District's largest energy users. In line with the Plan's strong focus on GHG emissions, it is important that the progress of the DCSEU towards reducing greenhouse gas emissions be tracked and reported as well. Given that natural gas is currently less GHG intensive than the electricity grid, but that the electricity grid is decarbonizing while natural gas cannot be decarbonized, it may not be appropriate at this time that GHG savings be a performance benchmark at this time. Without explicit recognition of the ultimate importance of long-term and permanent GHG reductions, using GHG savings as a benchmark could unintentionally incentivize fuel switching away from electricity and towards natural gas, which would be contrary to the long-term carbon reduction goals of the District. However, it is important that DOEE and the DCSEU are aware of the GHG impacts of each DCSEU project and the DCSEU portfolio as a whole, and the District should take steps to incorporate GHG savings into the data tracked by the DCSEU.

(7) Consider 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 GHG 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.

(8) 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 target was, and remains, to establish an innovative body that can experiment and make calculated bets by trying new approaches and maximizing energy savings and benefits to ratepayers and residents at the lowest practical cost. To achieve this target, 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 as well as for the existing funding shortfall relative to peer jurisdictions (see Action CCB.1).

- 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 at or below that in Maryland and in line with 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.

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.
- Add a requirement that the DCSEU track and report to DOEE semiannually the impact of its programs on reducing GHG emissions attributable to the District.
- 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.3 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.[84]

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.[85]

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.[86]

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.[87]

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 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. Finally, retrofits and incentives should promote one size fits all solutions, where appropriate, such as insulation, air sealing, boilers, water heaters, and LED lighting retrofits, to enable adoption at scale.[88]

Next Steps

- In 2017, design the specific incentives identified above.
- Work with the DCSEU to implement a package of incentives targeting deep energy use reductions by 2018.

[84] 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.

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

[86] Forthcoming Greening the District of Columbia: Incentives and Policies to Achieve Deep Green Building Construction and Renovations.

[87] Ibid.

[88] LED stands for light emitting diode.

EB.4 Coordinate and centrally track District efficiency and finance programs

Action: Coordinate existing demand-side management (DSM) incentive and financing programs and other economic development 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 (Action CCB.1), expanded PACE financing (see Action CCB.2), as well as all other DSM incentive and financing programs (such as those discussed in Action NC.2). In addition, these entities should coordinate with the finance and economic development programs offered by the District Government and District Instrumentalities, including but not limited to the District of Columbia Housing Finance Agency (DCHFA), the Department of Housing and Community Development (DHCD), DCRA, and the revenue bond program. Additionally, DOEE should explore ways to coordinate its energy programs with the green infrastructure and stormwater programs. The DCSEU should also receive a credit for a portion of the energy savings, green jobs and other benefits that these various programs generate when coordinating program delivery and/or funding with the DCSEU to functionally align the separate initiatives' incentives. A unified branding should also be developed to encourage the public to perceive them as a cohesive package, and provide a simpler and more comprehensive energy concierge service to guide customers through the process.

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.
- Undertake department-wide review of opportunities to coordinate and leverage joint financing between energy programs and air quality and stormwater programs.

3.2.3.2 POLICY AND PROGRAM RECOMMENDATIONS TO INCREASE ENERGY EFFICIENCY IN EXISTING BUILDINGS

EB.5 Lead by example in District Government operations

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

Relevance: As discussed in Action EB.3, 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 governmental building retrofit program should be phased-in over time, beginning with a deep energy retrofit process that spans 14% of District Government-owned buildings by square footage between 2017 and 2020. Buildings should also be considered as participants or anchors for neighborhood-scale energy systems and microgrids, particularly when in close proximity to new commercial developments or in conjunction with public infrastructure investments. Multi-family housing and school buildings may be particularly strong candidates. A minimum of 30% GHG emissions reductions should be the target. 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 4.5% of the District Government building stock between 2022 and 2024, and another 16% between 2029 and 2032.

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:[89]

- 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.

[89] 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.

Next Steps

- In fiscal year 2017, undertake and complete a strategic energy plan for reducing energy and water use across the DGS portfolio, focusing on the buildings with the largest potential for cost-effective energy savings, and estimating budgetary requirements of the recommendations in this action. The strategy should not just focus on energy use reductions in the District-owned buildings themselves, but also explore utilizing District-owned buildings to catalyze the deployment of neighborhood-scale energy systems.
- Implement a deep energy retrofit program on 14% of the District Government 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 4.5% of the District Government building stock between 2022 and 2024.
- Between 2024 and 2032, retrofit 16% of the District Government building stock to be net-zero.

EB.6 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.

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.[90/91] 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.

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

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

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. Research and analysis is currently underway to further refine this.

If building owners do not meet the performance standard, alternate compliance paths can include one or more of the following:[92]

- **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.[93] This would require the data to be shared, confidentially, with the DCSEU and green finance programs (see Action EB.1 for more).
- **Retrocommissioning:** Retrocommissioning is a systematic process wherein the existing base building systems (including the HVAC system,[94] 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.[95]
- **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. This idea is explored further in Action CCB.8.
- **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.

[92] 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.

[93] New York City Retrofit Accelerator, https://retrofitaccelerator.cityofnewyork.us/

[94] HVAC is heating, ventilation, and air conditioning.

[95] 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).

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 will be subject to annual benchmarking, which will be published via the Los Angeles Department of Building and Safety (LADBS) public database. Once every five years, building owners would 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.[96] Another example policy can be found in New York City's Local Law 88 and its requirements for lighting upgrades in large buildings.[97]

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.

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

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

EB.7 Drive energy efficiency at tenant build-out

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

Relevance: Lighting, controls, certain HVAC systems, and tenant-owned equipment (e.g., office/IT equipment, commercial kitchens) are routinely replaced at commercial 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.3 for additional detail).

Lastly, the U.S. EPA ENERGY STAR program is required by federal law to develop and launch a new rating system for tenant spaces by 2020. 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 ENERGY STAR's rating system for tenants upon its launch.

EB.8 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.[98]

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 2017, 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.9 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.

[98] 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

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 Agency for Planning, and the private sector.[99] 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.[100] 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.

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.5).
- 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).[101]

Next Steps

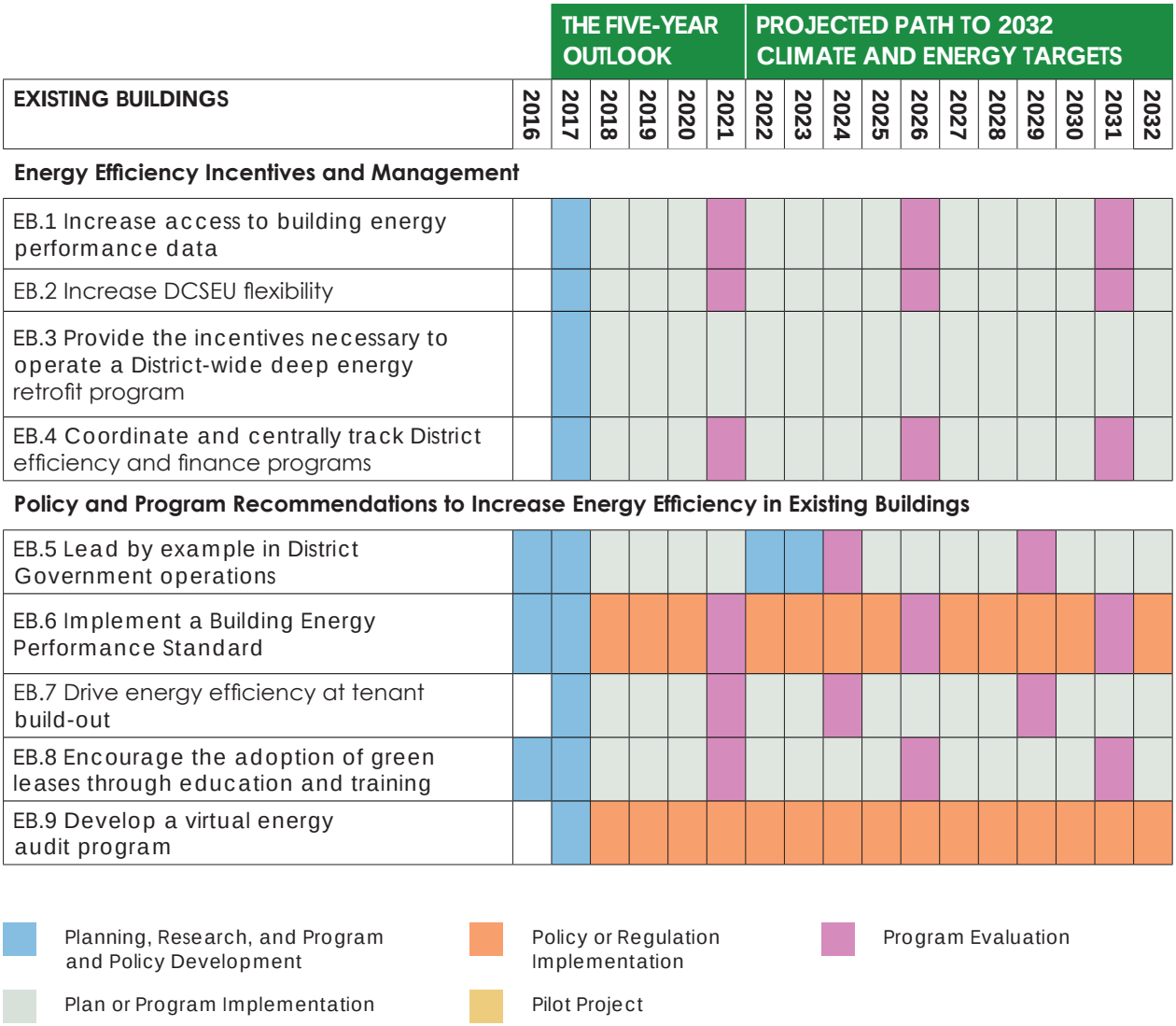
- Obtain approval for the use of customer utility data in a virtual energy audit program and develop agreements with utilities to access this data in 2017.
- Secure funding, then commission an organization to develop and manage an online virtual energy audit program by the end of 2017.
- Aim to provide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

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

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

[101] www.mris.com.

3.2.4 EXISTING BUILDINGS ROADMAP



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 INCREASING AND IMPROVING ACCESS TO FUNDING AND FINANCING

CCB.1 Establish a green bank and increase other funding for energy efficiency and renewable energy projects in new and existing buildings

Action: Increase the funding provided for energy efficiency and renewable energy projects in the District, including but not limited to creating a green bank and increasing funding for the DCSEU.

Relevance: The first approach to funding the District's energy transition should be the creation of a green bank. A green bank can support not only building energy efficiency, but also renewable energy development. 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 Plan 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.[102] As the 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. Green banks have proven to be a crucial model for 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.

While a green bank can offer larger loans, credit enhancement, loan loss reserves, and other financial tools, there remains a strong place for more traditional incentive/grant programs such those operated the DC Sustainable Energy Utility. The DCSEU has made great strides in reducing energy use, but the level of funding for the DCSEU falls short of funding levels of peer organizations that have achieved savings comparable with the DCSEU's performance benchmarks. 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 consider increasing the funding it receives from the SETF or other sources.

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

Details: The DOEE commissioned an analysis of the potential benefits and design of a green bank in the District, resulting in the District of Columbia Green Bank Technical Report.[103] The principal recommendations from this report include:

- 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 Board of Directors appointed by the Mayor and Council of the District of Columbia. Hire a team of dedicated staff to operate the green bank with expertise in investing in clean energy.
- Capitalize the green bank with up to $100 million of public money over time, to animate approximately $500 million in private investment.
- Provide an ongoing stream of dedicated public funding to a green bank on an annual basis.
- 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.
- Give the green bank the ability to issue bonds under various structures.
- Target specific funds to low-to-moderate income individuals and combine these funds with other instruments (e.g., on-bill financing).

The DC Green Bank should build on existing District tools for financing energy improvements, including DOEE's privately administered Property Assessed Clean Energy (PACE) financing program (discussed further in Action CCB.2), a government-enabled, tax-based financing tool that drives private capital into publicly beneficial projects that reduce energy use, improve infrastructure, and better the District's built environment. In addition, the District Government has many tools such as revenue bonds, private activity bonds, and affordable housing preservation funds that could be streamlined to maximize low carbon investment in collaboration with other District agencies. Making clean and efficient energy technology cheaper and readily attainable is a crucial component of transforming the District's energy usage. In addition to providing a mechanism to reduce carbon emissions, low-cost and long-term financing for energy efficiency and clean energy improvement projects is an important way to use public sector resources intelligently to drive private sector investment into the local economy, especially underserved communities, saving businesses and residents money, and creating local jobs for contractors and building service providers.

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

- PACE financing and incentives to accelerate renewable energy usage and deep energy efficiency retrofits.
- 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.[104]

[103] Forthcoming 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.

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

Adequate retrofit incentives are particularly critical to achieving the retrofit rates required in the Plan 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.[105] Some of these recommendations have already been integrated into Chapter 4.

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 available funding. First, the SETF surcharge has been fixed at $0.014 per therm consumed of natural gas and $0.0015 per kWh consumed of electricity.[106] 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) – the natural gas rate is aproximately 30% the electric rate. 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. Given the differences between natural gas and electric markets and efficiency opportunities, and the greater total source energy footprint of electricity when accounting for generation losses, a divergence may be appropriate, however, the size of the divergence should be examined.

Moreover, the District's goals for energy efficiency savings through the DCSEU and related programs place it among the savings achieved by leading programs in the United States. The DCSEU is charged with performance goals of reducing electricity and natural gas consumption by an amount approximately equal to 1% of citywide consumption, per year. Yet, as detailed in **Table 4** and **Table 5** below, excerpted from the American Council for an Energy-Efficiency Economy's 2015 state scorecard, the District's funding for the DCSEU is a fraction of what is being expended in these other states, measured per unit of revenues or per customer. As the tables also indicate, DCSEU achieves more savings per dollar spent than these other programs—a sign of both the DCSEU's efficiency, but also of the fact that the program is relatively young. As Demand-Side Management energy efficiency programs mature, they typically see declining savings per dollar spent, as the lowest-hanging fruit are addressed. Therefore, while the DCSEU has achieved greater savings each year based on a static budget, this trend cannot continue indefinitely.

Table 4: Spending and savings on energy efficiency in electricity in selected top states and the District, 2015[107]

State	2015 Spending on Energy Efficiency Programs *(percent of electric utility revenues)*	2015 Savings from Energy Efficiency Programs *(net incremental electric savings achieved as a percent of retail sales)*	MWh savings per thousand dollars spent
Rhode Island	**6.34%**	**2.91%**	2.688
Massachusetts	**6.16%**	**2.74%**	2.639
Vermont	**6.89%**	**2.01%**	2.034
California	**3.43%**	**1.95%**	3.657
Oregon	**3.45%**	**1.09%**	3.551
Maryland	**3.69%**	**1.01%**	2.244
District of Columbia	**1.01%**	**0.61%**	4.982

[105] Forthcoming.

[106] 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

[107] ACEEE Spending/Savings Tables, 2015. http://database.aceee.org/sites/default/files/docs/spending-savings-tables.pdf. (Readers of the full chart may find a few states with funding levels comparable to the DCSEU achieving much greater savings; however, those states tend to have significant industrial sectors, where larger savings are achievable for much lower relative investment than in the commercial or residential sectors.)

Table 5: Spending and savings on energy efficiency in natural gas in selected top states and the District, 2015[108]

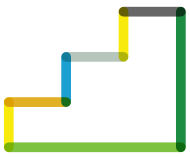
State	2015 Spending on Energy Efficiency Programs *(dollars per residential natural gas customer)*	2015 Savings from Energy Efficiency Programs *(net incremental natural gas savings achieved as a percent of retail sales)*	MMTherms savings per million dollars spent
Rhode Island	$84.48	**1.24%**	0.209
New Hampshire	$63.98	**1.12%**	0.302
Massachusetts	$185.50	**1.09%**	0.142
Vermont	$49.76	**1.01%**	0.409
District of Columbia	$37.21	**0.60%**	0.125

Furthermore, 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.[109] 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.

It is not necessary that all energy efficiency programs and renewable energy programs be run through a single entity, nor funded through a single source. What matters is that residential and commercial consumers see a single united brand, web presence, and simplified intake and concierge service to get their needs met—as detailed in other recommendations, including CCB.5 and CRE.4.

In order to meet its goals, the District Government should consider whether the best approach is to provide more funding to the DCSEU directly or through other avenues, whether to increase the SETF, and what alternate funding streams may be available.

Next Steps



- In 2017, pass legislation to establish the DC Green Bank as a new quasi-public, wholly-owned nonprofit corporation of the District Government that sits between the government and markets. Capitalize the DC Green Bank with up to $100 millionof public money over time and from a number of sources to animate approximately $500 million in private investment.
- In 2017, consider adjusting 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.

[108] ACEEE Spending/Savings Tables, 2015. http://database.aceee.org/sites/default/files/docs/spending-savings-tables.pdf

[109] 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.

CCB.2 Enhance the District's Property Assessed Clean Energy financing program through expanded utilization of the commercial offering and the addition of a residential offering

Action: Expand the District's existing Property Assessed Clean Energy (PACE) Commercial financing program and implement a PACE Residential program to cover 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. 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). Terms of repayment can be up to 20 years, which is much longer than conventional financing. Loans are paid twice yearly on property taxes rather than monthly like traditional loans, and remain 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, while and provide property owners with lower utility bills, enhanced property values, and improved building maintenance, resident comfort, health, and resiliency. Further, because PACE only uses the District's tax collection authority to enhance private capital investment, it requires no direct funding from the District. 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 (DC PACE) serves only commercial building owners, including some multifamily buildings. Much work remains to scale the use of Commercial PACE as a financial product within the local real estate market. DC PACE has committed to driving down interest rates further through market competition among private lenders. DC PACE is also working to better serve community-based organizations, such as locally-owned and disadvantaged small businesses, nonprofits and public service institutions, affordable housing, and houses of worship, which frequently have difficulty accessing solar and energy efficiency. As noted in recommendations in the Buildings chapter, a key component of scaling DC PACE will also be achieved through closer integration of DC PACE with the DCSEU and other District programs to link financing solutions to ongoing grants, incentives, data management tools, technical assistance, and marketing programs. In particular, the DCSEU's ability to develop and manage building level analytics should be integrated closely into DC PACE underwriting and approval processes to reduce total program costs and streamline the customer experience.

Moreover, PACE can and should be expanded to serve the entire residential market, including single-family homes. 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 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.[110]
- 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.[111]

[110] 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.

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

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.[112] 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 provided is intended to take the perceived risk out of this investment mechanism, thereby significantly increasing the availability of affordable clean energy financing to homeowners.

The District is already well positioned to implement a residential PACE program without any additional legislative action being needed. The Energy Efficiency Financing Act of 2010, the enabling legislation for the DC PACE financing program, provides the authority necessary to originate and administer both commercial and/or residential PACE programs. In addition, the existing DC PACE administrator has been procured to establish and administer a District PACE financing program, whether such a program serves commercial or residential customers. Furthermore, the current PACE legal instruments and collection mechanisms that have already been established to serve the commercial PACE properties can be adapted to serve residential PACE assessments with little to no modification. Therefore the core mechanisms for the establishment of a new residential PACE program are already in place in the District.

Next Steps

- Expand the current DC PACE program to cover all residential building owners in 2017.
- Issue a "standard offer" to commercial lenders and PACE originators to increase market competition among capital providers to the DC PACE program.
- Establish and fund a joint-marketing program for both DC PACE and the DCSEU.
- Provide pre-development support funding and subsidized energy audits, as well as credit enhancements to DC PACE projects and customers, directly or through establishment of a green bank.
- Develop specific guidance on the use of DC PACE financing within other DC government finance programs and incentives, including coordinated underwriting and pre-qualification for PACE and Low Income Housing Tax Credits (LIHTC) by DCHFA and DHCD, and issuance of tax exempt financing through the District's revenue bond program.

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

3.3.1.2 POLICY AND PROGRAM RECOMMENDATIONS

CCB.3 Increase code compliance in all buildings through Smart Code Enforcement

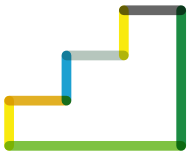
Action: Increase code compliance in both new and existing buildings through Smart Code Enforcement.

Relevance: While increasingly stringent building codes are being adopted across several U.S. states and cities, current code compliance rates in many jurisdictions 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.[113] 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.[114]

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.

[113] 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.

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

CCB.4 Incentivize and require submetering

Action: Phase in submetering requirements for new construction and major renovations into District Government building codes. 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.[115/116] 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.[117] 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 part of a broader set of operational-focused training offerings. As discussed in Action EB.2, the DCSEU should receive credit for any energy use reductions associated with such operational training programs, pending an appropriate methodology to account for savings. 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, 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

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

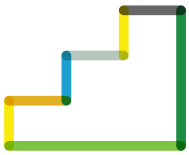
[116] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy. Energy Efficiency in Separate Tenant Spaces – A Feasibility Study. April 2016. http://energy.gov/sites/prod/files/2016/04/f30/DOE%20-%20Energy%20Efficiency%20in%20Separate%20Tenant%20Spaces_0.pdf (p.1)

[117] Ibid.

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.[118]

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.[119] By omission, residential units are not included. In order to realize the energy-saving benefits of submetering in residential spaces, the District Government should therefore legalize and regulate the practice of submetering in residential buildings. Coordination with OPC and the Office of the Tenant Advocate will be needed in order to enable residential submetering for billing purposes. 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



- 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. Pending the identification of an appropriate methodology, credit the DCSEU with energy use reductions associated with these sorts of training programs.
- As part of the next building code update, require submetering at new construction and major renovations for non-residential buildings, and include the latest national model codes and standards.
- By 2018, petition the Public Service Commission to open a formal case to consider changing its regulations to allow for submetering and billing in residential spaces, or introduce legislation to do so, while also regulating the interaction of submeter rates and rent increases so as to preserve housing affordability.
- Work with Industry to investigate, and if appropriate, enact a new law that requires tenant spaces in large new buildings to be submetered or separately metered.

CCB.5 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.

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

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

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 Plan. A central resource that provides information 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 sector 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.

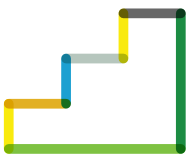
This platform should be integrated with the DCSEU's existing energy efficiency website.[120] The DCSEU site provides both information and the means to solicit additional information either by phone, online chat, or email. Additional existing DOEE and Department of Housing and Community Development (DHCD) 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
- DOEE and DHCD Lead Safe Program
- DHCD Single Family Residential Rehabilitation 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 early 2017.
- Determine the costs associated with website design, maintenance, and content development, as well as any staff time required in early 2017.
- 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.

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

3.3.1.3 EDUCATION AND TRAINING

CCB.6 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.

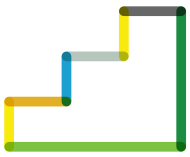
Details: An example of a local net-zero energy class with high attendance and positive results is the American Institute of Architects' in-depth net-zero energy curriculum offered in Portland, Oregon and Seattle, Washington. Both the ILFI and the NBI also provide net-zero energy education series and 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.7 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.8 Partner to support training and certification of building contractors and managers

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.

Building Operator training is also important—poor energy management can negate all the gains of energy-efficient systems. Modern, energy-efficient commercial buildings require specialized knowledge to operate. Moreover, if the District establishes a Building Energy Performance Standard (BEPS) that includes training and certification of building operators as an alternative compliance path (see Action EB.6), then local or regional availability of such training needs to be available. A good example is the City University of New York Building Performance Lab, which offers Building Operator Certification (BOC). The District Government and the University of the District of Columbia have begun exploring establishing a building science center that would provide training to building operators and facilities staff. The University of District Columbia (UDC) Community College also has the opportunity to provide two year degrees and certifications to District residents on building science and energy related topics. Other universities also have interest in this area.

Next Steps

- In 2017, identify and establish relationships with appropriate education and channel partners and launch education programming.
- Collaborate with a major university or other partners in the District to open a center for building science that offers training and certification for building operators.
- Aim to have the job training program operational by 2018.

CCB.9 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 and other potential partners to create a conference partnership in 2017, targeting an expanded conference in 2018.

CCB.10 Integrate energy performance information into residential transactions

Action: Support ongoing green appraisal and green multiple listing service (MRIS) initiatives focused on residential buildings, including adopting a home energy score for single-family and small multifamily homes.

Relevance: During the renting and buying process, owners and renters are faced with a myriad of choices when selecting a home. In addition to monthly rent costs, or monthly ownership expenses (mortgage, property taxes, and insurance), utility bills are key when determining housing affordability. However, utility efficiency and energy burden are often left out of the decision tree due to a lack of available data, or technical complexity. Professionals involved in home purchases (e.g., real estate agents, residential lenders and underwriters) often have limited understanding themselves of energy and other sustainability issues. Only by improving this understanding will buyers, renters, and professionals 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. One major addition needed is a simplified metric for increasing transparency of energy use. Adopting a standardized home energy score will be a powerful tool for owners and renters to make more informed decision about how their home or prospective home uses energy and compares with residential units with similar characteristics.

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.
- 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.[121]
- Adopt a transparent home energy scale for residential units. There are several examples of a home energy score, including the U.S. Department of Home Energy Score that is being adopted by cities across the country.[122] It is also crucial that this data be able to get into real estate listings, and systems like Northeast Energy Efficiency Partnership's Home Energy Labeling Information Exchange may be able to help.[123] For such a program to be successful, the following aspects are required:
  - Full cooperation from local utilities to access utility data and use it to develop scores.
  - Safeguards to ensure data confidentiality.
  - Easy availability to targeted customers (e.g., homeowners, renters).
  - Integration with regional multiple listing service website MRIS (for residential users).

Next Steps

- Partner with U.S. DOE's Better Buildings Home Energy Information Accelerator to work with other jurisdictions and companies on expanding access to home energy information and developing pipeline of homes using these tools. [124]
- Assign staff in DOEE and DCRA to take action on the recommendations listed above through 2017 and beyond.
- Conduct annual reviews of these efforts to gauge effectiveness and adjust actions accordingly.

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

[122] https://betterbuildingssolutioncenter.energy.gov/home-energy-score

[123] http://www.neep.org/initiatives/energy-efficient-buildings/green-real-estate-resources/helix

[124] https://betterbuildingsinitiative.energy.gov/accelerators/home-energy-information

3.3.1.4 LEADERSHIP AND CATALYZING CHANGE

CCB.11 Create or Leverage Existing Mid-Atlantic government leadership groups to accelerate market transition

Action: Work with partners in other leading jurisdictions to either create a new Mid-Atlantic Deep Energy Leadership Group, or leverage and expand an existing group, 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 Plan 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 actions by other MWCOG cities.

Collaborations with other cities in the Mid-Atlantic region such as Baltimore, Richmond, and Philadelphia should also be expanded. There is already a Mid-Atlantic Sustainability Network, organized by the U.S. EPA Region 3 office in Philadelphia, made up the sustainability officials from the largest cities in each metropolitan region, along with a representative from an intergovernmental group such as MWCOG where applicable. This group has traditionally dealt with issues such as urban heat islands and transportation, but could be expanded to address with building energy use. There may also be other groups that could be equally or more useful. Connections could also be facilitated by the Carbon Neutral Cities Alliance or a similar organization. By bringing cities together, action on several other elements of the Plan 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 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 2017, open conversations with existing groups such as the Mid-Atlantic Sustainability Network to determine suitability. If a suitable alignment cannot be found, work to establish a new coalition.
- During 2017, establish or expand the coalition and begin forming a common agenda.

CCB.12 Build examples of breakthrough design in government and/or publicly-financed buildings

Action: Require all significant new construction built or financed by the District Government to meet 2032 EUI targets. 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.[125] 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.

The District has particularly compelling opportunities to raise the bar on design standards when developing larger campus-style developments with multiple buildings on consolidated sites. In some cases, the property may stay in District hands (for example, the Washington Mystics arena at St. Elizabeth's). In other cases, such as the former Walter Reed Army Medical Center, private developers may assume control, but under the guidance of District agencies (such as the Office of the Deputy Mayor for Planning and Economic Development (DMPED)) or approval documents (a Small Area Plan that includes sustainability requirements). For all such sites, emphasis should be given to consideration of neighborhood-scale energy systems, with all master planning and design requirements oriented toward achieving the maximum GHG reductions possible.

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.
- 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 governmental net-zero energy buildings and neighborhood-scale energy systems is their improved resilience to power outages, in that they tend to maintain a more habitable internal temperature in the absence of power.[126] 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.

[125] 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.

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

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 CO2 based heat pumps) to promote the use of more desirable technologies.

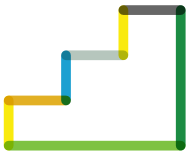
The overall costs of these higher performing buildings should also be similar to what the District itself would have built, providing the District Government the opportunity to share their financial success stories to help move the broader market. A study conducted within the District indicated that 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.[127] 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.[128]

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.[129] 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.com website is the current forum to find information on the District's existing cohort of high-performance buildings. However, more information on each building should be provided. The site would also benefit from being cross-referenced across other District Government sites, 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



- In 2017, 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.

[127] 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

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

[129] Matthiessen, 2012.

CCB.13 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/ft2/year of energy) should then be highlighted through the various forums recommended in this chapter.

Next Steps

- In 2017, 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.[130]

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

CCB.14 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 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 mid-2017, investigate potential partners and avenues for a Buildings of the Future tour.

CCB.15 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 renewable energy.
- 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 2017, 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.16 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.17 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).[131]

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 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 2017, 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.

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

CCB.18 Create a coordinated green jobs and workforce development platform

Action: Building on DOEE's existing Green Pathways website,[132] create a robust clearinghouse for training and workforce development opportunities and funding.

Relevance: At the national level, the growth of the green economy is expected to continue to outpace that of the whole economy, and green jobs are expected to grow faster and pay more compared to other jobs.[133] At a local level, there is perhaps an even greater opportunity for additional green job training programs given the District's steadfast commitment to climate, energy, and green infrastructure initiatives.

Details: While, as the Plan suggests, green training and workforce development could be improved and expanded, there are several existing programs. A centralized online platform, in coordination with the District's Workforce Investment Council, could help increase the impact of these programs.[134]

The online green jobs and workforce development platform would be a one-stop-shop for those interested in career pathways and training opportunities for jobs related to energy. There are currently a number of different organizations, government agencies and other stakeholders involved in green workforce development programs. These include DOEE-funded organizations, District of Columbia Public Schools (DCPS) Career and Technical Education programs, union and association training and apprenticeships, UDC and UDC Community College degrees and certification programs, the DCSEU, summer youth programs managed by DOEE (e.g., Green Zone Environmental Program), among others.

The platform would be a first step to improving coordination among these programs, the students enrolled, and the organizations that administer and fund the various trainings. The District could then build on this coordination to identify and address gaps and opportunities related to green jobs training. Among other things, the platform would provide career and salary information about green jobs, training, education, and employment opportunities, and resources for District residents and employees. The platform could also link companies with job seekers.

Next Steps

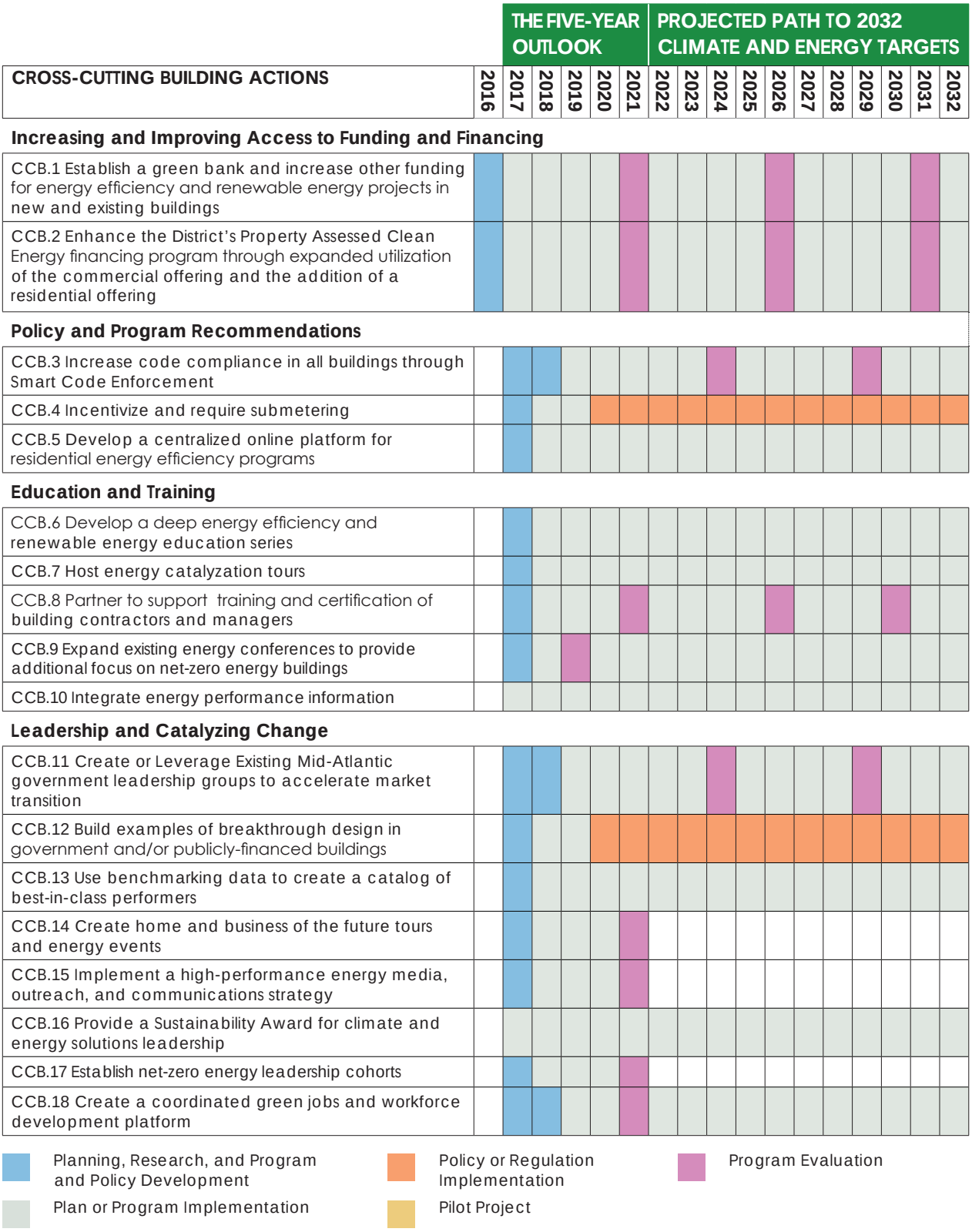
- In 2017, create a new position or expand an existing position at DOEE to coordinate green jobs and green economy initiatives.
- In 2018, create an online platform to provide a more seamless and comprehensive listing of green job training opportunities throughout the District, or commission an organization to do this through a competitive request for proposal.

[132] http://doee.dc.gov/greenpathways

[133] Analyzing Building Energy Efficiency Job Opportunities, July 2015, Jobs for the Future, https://c.ymcdn.com/sites/www.nibs.org/resource/resmgr/CWCC/BuildingEnergyJobOpps_2015.pdf.

[134] This action should be aligned with Actions CCB.5 and CRE.4.

3.3.2 CROSS-CUTTING BUILDING ACTIONS ROADMAP



ENERGY SUPPLY SYSTEM

4 ENERGY SUPPLY SYSTEM

In this chapter, recommendations are provided for two areas related to the District of Columbia's (District) energy supply system: actions to increase the supply of zero greenhouse gas (GHG) emission 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 each section that can be used by the District to guide their implementation over the five-year span of the Clean Energy DC Plan (Plan), 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'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.[135] In support of these targets, the Government of the District of Columbia (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 increasingly price competitive utility-scale 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

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

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).[136/137] Pepco (in its role as a Standard Offer Service provider[138]) and competitive electricity suppliers can comply with the RPS through the following two approaches:

(1) Procuring renewable energy credits (RECs) or solar renewable energy credits (SRECS) for the solar requirement, which may be accomplished by one of the following:

   (a) Purchasing unbundled RECs or SRECs

   (b) Purchasing energy bundled with associated Generating RECs or SRECs (and retiring the associated RECs or SRECs)

(2) Making alternative compliance payments (ACPs) to the District based on the portion of the RPS requirement that cannot be satisfied with RECs and SRECs.

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, electricity suppliers. 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. The RPS requires that RECs come from electricity produced by renewable sources within the PJM Interconnection Region (PJM) or within a state adjacent to PJM.[139] Similarly, SRECs used to comply with the local solar RPS requirement must be located within the District or in locations served by a distribution feeder serving the District.

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.[140] Other suppliers would have to do the same. As discussed in Chapter 2, only RECs that affect the GHG emissions factor used by the District in their GHG inventory (from the EPA's RFC-East eGRID subregion) can be counted toward GHG emissions reductions according to the GHG accounting protocol used by the District, and alternative compliance payments may not always create a predictable amount of new renewable energy generation nor associated GHG reductions.[141/142] Therefore, how electricity suppliers comply with the RPS has a significant impact on renewable energy utilization and GHG emissions reductions.

[136] Renewable Portfolio Standard Expansion Amendment Act of 2016. , DC Act Number A21-0466, signed July 25, 2016. This act is under congressional review and is expected to become law on November 29, 2016.

[137] 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

[138] Recall that the Standard Offer Service (SOS) is the electricity purchased for those District ratepayers who do not choose a competitive supplier for their electricity. This purchase is currently made by Pepco under oversight of the PSC, but the issue of reforming the SOS is currently being investigated by the PSC in Formal Case 1017.

[139] The RPS further rules clarify that states within the PJM Interconnection Region currently include Delaware, the District of Columbia, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia and West Virginia. Public Service Commission of the District of Columbia, 2015 Report on Renewable Energy Portfolio Standard, January 30, 2015.

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

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

[142] Funding from ACPs is used to fund District Government programs focused on increasing renewable energy generation in the District, but how much renewable energy can be added per dollar from this funding is uncertain.

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.[143] However, neither the fugitive methane emissions from natural gas, not these reductions, are quantified in the Clean Energy DC model at this time (see Appendix A1 for more information).

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 the Department of Energy and Environment (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.[144] 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 possible in District.[145] 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.[146] 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.[147] 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 (SETF), and via programs such as the District of Columbia Sustainable Energy Utility (DCSEU) and Solar for All.[148/149] 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 neighborhood-scale energy systems including microgrids with emphasis on renewable energy.
- The development of solar generation to serve 100,000 low-income households.

[143] 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

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

[145] 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

[146] 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.

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

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

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

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

- The creation of opportunities to arrange power purchase agreements and install renewable energy systems on government and institutional buildings. [150]

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 under the District's Renewable Portfolio Standard.[151]
- 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 subsidizes the cost of installing a solar PV system.

With these programs combined, a 5 kW 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.[152]

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 produce more energy than it consumes.[153] 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.[154]

Modernizing the District's electricity infrastructure also means developing ways to manage an increasing number of on-site intermittent renewable generation and sophisticated tools for building efficiency and demand response. In this regard, microgrids offer the tools to integrate and optimize distributed energy resources (DER). The availability of flexible microgrid options, as a DER manager, will greatly enhance the District's ability to successfully develop a large number of DER and maximize their benefits to the consumers and the grid. The Plan discusses electricity system modernization and integrating DER further in section 4.2.

Finally, the District is also home to community-based solar power advocacy groups, such as DC Solar United Neighborhoods (DC SUN), that work to expand solar access by educating citizens about the benefits of solar, helping them coordinate bulk solar purchases, and working to strengthen the District's solar policies and programs.[155] DC SUN and similar groups have played an instrumental role in the installation of solar systems in the District.

[151] 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).

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

[153] Sustainable DC, 2012, p.54

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

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

4.1.1.3 GOVERNMENT LEADERSHIP

In addition to the policy actions above, the District has demonstrated considerable leadership in renewable energy procurement. The DC Department of General Services (DGS) sources 100% of its own operational electricity from renewable sources. This has been accomplished through the purchase of renewable energy credits, as well as via three 20-year power purchase agreements signed in 2015 and 2016.[156] Power purchase agreements (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.[157] PPA contracts can help finance the development of projects in instances where it might otherwise be unfeasible.

The first PPA, signed by the District in 2015, is one of the largest wind PPAs ever entered into by a U.S. local government. The PPA sources wind power from Pennsylvania to provide approximately 30% to 35% of the DGS' electricity load.[158] The two solar PPAs are for 11.4 MW of local solar PV systems that are being installed on the roofs and parking lots of District Government-owned facilities.[159] The solar PPAs represent the largest on-site solar project undertaken by a U.S. city, and will supply an additional 3.5% of DGS's electricity load.

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, renewable energy power purchases now comprise 13.2% of all electricity sold in the District.[160] 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.[161]

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.

In addition to the actions below, the District can support clean and renewable energy development through the development of a DC Green Bank, as outlined in Action CCB.1, as well as with PACE financing, as outlined in Action CCB.2.

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

[157] 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

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

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

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

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

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 GHG reductions and set a 100% requirement for 2050

Action: Undertake a collaborative study to determine how best to design and manage the Renewable Portfolio Standard (RPS) to drive increasing investments in new renewable electricity generating capacity and maximize GHG reductions. Pass additional RPS legislation to require 100% renewable energy by 2050 at the very latest.

Relevance: In 2016, the District Government adopted a 50% RPS for 2032, including a requirement for 5% of electricity consumed in the District to come from local solar systems.[162] The new RPS builds on an earlier requirement for 20% of electricity to come from renewable sources by 2020,[163] with at least 2.5% from qualifying local solar PV and thermal systems by 2023 (expected to be approximately 200 MW).[164]

As nearly 75% of GHG emissions in the District come from buildings that get the majority of their energy from electricity,[165] the RPS has an important role to play in achieving the District's 2032 GHG reduction and renewable energy utilization targets.[166] 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, as discussed previously,[167] the RPS allows electricity suppliers to comply with the RPS without the associated renewable energy actually affecting the GHG intensity of electricity that supplies the District or, for GHG accounting purposes, affects the GHG emissions intensity of the EPA's RFC-East eGRID subregion. As such, RPS compliance with RECs does not necessarily result in GHG reductions that can be attributed to the District under standard protocols.[168] Suppliers can also comply by making ACPs. These are financial transactions that do not directly result in GHG reductions. ACPs are, however, used to fund renewable energy generation in the District, including the Solar for All program, so do indirectly support renewable energy utilization and GHG reductions. There is not enough data at this time to determine how funding collected through ACPs translates to new renewable energy generation, making it difficult to project how much GHG reductions could be attributed to ACPs.

Moving forward, to maximize the effectiveness of the RPS and achieve the District's 2032 targets, the District Government should take steps to drive electricity suppliers to comply in a way that drive GHG reductions in the District, and should adopt a higher future RPS requirement that ultimately decarbonizes the grid. Recognizing legitimate concerns about the RPS's cost implications, the District should undertake a study in cooperation with key stakeholders to determine how best to design and manage the RPS going forward so that it drive significant GHG reductions while cost-effectively providing reliable power to residents and businesses.

[162] Renewable Portfolio Standard Expansion Act of 2016.

[163] 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

[164] 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

[165] 2011 District of Columbia Greenhouse Gas Inventory, http://doee.DC.gov/sites/default/files/dc/sites/ddoe/publication/attachments/GHGinventory-1205-.pdf

[166] Sustainable DC, 2012

[167] See sections 2.2.1.2 and 2.2.2.1.

[168] Recall the District uses ICLEI's U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions to calculate its community GHG inventory.

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).[169] This change in the RPS can play a significant role in achieving the District's 2032 GHG target. It is also a positive step toward the energy supply system change required to achieve the District's 2050 GHG reduction target of 80% lower emissions, which will require a significantly higher portion of the District's electricity coming from renewable sources, possibly as high as 100%. This evolution in the stringency of the RPS – from 20% to 50% and eventually to 100% - represents a profound shift in the District's electricity supply, and requires new thinking in how to design the RPS to drive GHG reductions and modernize the electricity system to handle increased distributed energy resources (the latter of which is discussed in section 4.2).

At the same time, the PSC and other stakeholders have raised legitimate concerns about the cost impacts the RPS could have on ratepayers. In their Report on the Renewable Energy Portfolio Standard for Compliance Year 2015, the PSC found that the total costs of ACPs tripled between 2014 and 2015 ($6.3 million vs. $19.9 million), due primarily to a shortage in local solar capacity and thus SRECs to comply with the local solar requirement.[170] Overall RPS compliance costs increased from $27.4 million in 2014 to $38.5 million in 2015.[171] These costs are passed onto the ratepayers, and the PSC estimates compliance costs could double for 2016. The PSC continues to support the increased deployment of renewable energy, but has asked the District Government to consider how the RPS can be redesigned to limit the economic impact on ratepayers, and makes some specific suggestions.[172] As a first step, the Renewable Portfolio Expansion Amendment Act of 2016 requires the PSC to submit a report to Council by March 1, 2017 that estimates the amount of solar in the District that could qualify for SRECs but cannot be purchased by suppliers, and recommends how the PSC could adjust annual solar requirements based on these findings.[173] This is part of a careful consideration of the implementation of the new Solar for All program, which is intended to reduce by half the electricity bills of 100,000 low-income households by 2032 through solar projects.

The District must increase renewable energy generation and shift toward zero emission electricity to achieve its GHG reduction target. The District must also ensure residents and businesses have access to reliable, affordable electricity. The District Government must, therefore, figure out how to design and manage the RPS in a way that achieves all these objectives. This will require new analysis and collaboration with key stakeholders.

Collaboratively Determining How to Design and Manage the RPS: Moving forward, the District should convene a collaborative dialogue with key stakeholders over the next five years. Key stakeholders include but are not limited to the PSC, Pepco, the Office of People's Counsel, and DOEE. The objective of the dialogue should be to determine how the RPS can be designed and managed to increasingly drive GHG reductions while maintaining system reliability and ensuring equity and affordability. The dialogue should focus on both the existing 50% requirement for 2032 and a new 100% requirement for 2050 at the very latest. To make it effective, the District Government should support participants with funding to research and analyze key issues that must be understood to achieve the dialogue's objective.

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

[170] Public Service Commission of the District of Columbia, Report on the Renewable Energy Portfolio Standard for Compliance Year 2015, http://www.dcpsc.org/getmedia/901b3c18-4859-435d-ae1a-ca296584c26b/aharris_542016_831_1_FC_-_945_-_2016_-_E_-_REPORT.aspx

[171] In 2014, suppliers paid $21.1 million for RECs and $6.3 million for ACPs. In 2015, suppliers paid $18.6 million for RECs and $19.9 million for ACPs. Comments of the Public Service Commission of the District of Columbia to the Committee on Transportation and the Environment on B21-412, "Solar Energy Amendment Act of 2015" and B21-650, "Renewable Portfolio Standard Expansion Amendment Act of 2016", May 26, 2016, https://cdn2.hubspot.net/hubfs/298813/2016/2016_Blog_Images/PSC_Comments_on_RPS_5-26-16.pdf?t=1474637760598

[172] p.2, Comments of the Public Service Commission of the District of Columbia to the Committee on Transportation and the Environment on B21-412, "Solar Energy Amendment Act of 2015" and B21-650, "Renewable Portfolio Standard Expansion Amendment Act of 2016".

[173] B21-0650 - Renewable Portfolio Standard Expansion Amendment Act of 2016, http://lims.dccouncil.us/Legislation/B21-0650

The following items should be considered when setting out the initial agenda for this group:[174]

- Projected costs of meeting the current local solar requirement versus procuring renewable energy from outside the District that still drives GHG reductions that can be accounted for by the District.
- Increase compliance that will reduce GHGs attributable to the District through RECs bundled with the actual purchase of renewable energy or through RECs from the RFC-East region.
- Collaboration with electricity suppliers to finance new renewable energy generation.
- The role of power purchase agreements in increasing compliance that results in new renewable energy capacity and fewer ACPs.
- Coordination with other PJM states through existing PJM committees to increase the number of cost-effective renewable energy generation opportunities (with a particular focus on utility-scale solar and wind) and minimize challenges regarding competition for RECs as states increase their RPS requirements.
- Study of realizable solar PV capacity, refining previous technical potential studies, given all constraints in the District.[175] This study could also estimate the cost-effectiveness of installing different levels of this realizable potential.
- 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 renewable energy demand.
- Study of new renewable energy supply between now and 2032 (in conjunction with Action CRE.3). Study the REC-eligible regions for RPS and in the EPA's RFC-East eGRID subregion (which determines the GHG intensity of electricity in the District). Focus on utility-scale wind and solar.
- 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[176]) as the priority non-renewable resource to be maintained during the transition to 100% renewables, without hampering the development of forward-looking, innovative and resilient energy strategies.
- 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 decreasing compliance through ACPs may affect funding for the District's renewable energy programs, including Solar for All.
- The level and type of investments needed to modernize the electricity system to achieve the District's objectives. 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.[177]
- The potential to mitigate grid and cost impacts through coordinated demand reduction, energy storage, supply diversity, advanced demand response (i.e., can adjust or shift demand both down and up as necessary), and regional coordination.

[174] This list of recommendations is 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 DOEE and Pepco.

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

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

[177] Electricity system modernization is further discussed in section 4.2.

- How the RPS can be designed to drive only strategic, medium-term investments in fossil fuel-based energy sources like natural gas, to meet peak demand and support grid resilience.
- The potential for energy storage (both within and outside of the District) to increase the proportion of electricity consumed from renewable sources.
- How to balance regulatory stringency with flexible and alternative compliance options.
- Periodic review of RPS to account for costs, grid impacts, and technology and market developments.

These studies should build on the PSC's report to Council on March 1, 2017, and be aligned with existing and future initiatives focused on improving grid resilience, protecting critical infrastructure from power outages, building community microgrids, and integrating local electrical and thermal generating capacity (e.g., FC1130 Investigation into Modernizing the Energy Delivery Structure for Increased Sustainability).

To properly guide and conduct this work, DOEE requires direction from District Government leadership regarding the purpose of the RPS with respect to GHG reductions. Specifically:

- Does the District Government want the RPS to drive renewable energy generation and GHG reductions irrespective of location, in recognition that climate change is a global problem and GHG emissions must be reduced globally?
- Or, does the District Government want the RPS to drive renewable energy generation and GHG reductions in locations that result in GHG reductions that can be attributed to the District under the ICLEI Protocol?

A 100% RPS Requirement: Looking beyond 2032, 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 at the latest, and designing the requirement based on the findings from the collaborative dialogue discussed above. This will align the District with states that are increasingly focused on eliminating fossil fuels from their electricity system, including Hawaii (100% by 2050) and Vermont (75% by 2032).[178]

Next Steps

- In 2017, convene a working group to lead and facilitate a dialogue between key stakeholders regarding how to revise the design and management of the RPS to hit the District's GHG target while maintaining reliability and affordability.
- Direct District Government staff to carefully consider, by February 2017, the conflicting implications of complying with the new RPS law, as compliance affects both GHG emission reductions and funding for the District Government's renewable energy program.
- By 2020, adopt a 100% RPS requirement for 2050.
- Periodically review key aspects of the RPS every three to five years and work with appropriate PJM committees through the PSC and the Office of People's Counsel.

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

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

Action: Sign power purchase agreements with renewable electricity suppliers to supply electricity for the Standard Offer Service in the District.

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 three PPAs in 2015 and 2016 to supply approximately 33.5% to 38.5% of the District Government's electricity demand with wind and solar energy. The District Government realized a drastic reduction in energy costs due to the three 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 could actualize substantial savings for customers.

Details: The Standard Offer Service (SOS) is the electricity purchased for 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 rolling three-year power supply contracts on an annual basis 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 in the District was consumed under the SOS, mostly by residential ratepayers.[179] 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. The remainder comes mostly from nuclear power and some renewable energy. [180]

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 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), and provide a hedge against future energy market volatility, including fossil fuel price increases. Compared to procuring non-renewable electricity from the PJM, renewable energy-driven PPAs for the SOS would allow the District customers to buy more renewable energy and reduce the city's GHG emissions more effectively.

[179] Public Service Commission. 2015. http://www.dcpsc.org/PSCDC/media/PDFFiles/Electric/electric_sumstats_cust_energyuse.pdf

[180] Fossil fuel sources included 36.6% from coal, 23.0% from natural gas, and 0.3% from oil. Nuclear provided 35.8%. The remainder was provided by captured methane gas (0.3%), hydroelectricity (1.0%), solar (0.1%), solid waste (0.6%), wind (2.1%), and wood or other biomass (0.2%). 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

[181] 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.

Rather than continuing with the current method of buying electricity for the SOS, the District could supply all or part of the SOS through a mix of contracts including PPAs with renewable energy suppliers and spot market purchases. These contracts would need to be phased in over three years to avoid overlap with existing SOS supply contracts. The modelling done for the Plan assumes 70% of the PPA is met by various sources of renewable energy with the remaining 30% from the spot market. This would help the District shift a large portion of its electricity supply to renewable, zero-emission sources.[181] 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. Depending on the phase-in period and contract terms, the District could then steadily increase the portion of electricity sourced from renewable energy generation as renewable energy costs decline and opportunities for new generating facilities increase.

Long-term renewable energy PPAs may result in lower electricity rates than the current SOS, as has been the case with the District Government's renewable energy PPAs discussed in section 4.1.1.3. Determining the cost impact requires additional analysis, part of which is underway. If cost savings materialize, the District Government should share the savings both to reduce SOS customers' electricity costs and to 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.[182] However, energy procurement generally entails risks, and further analysis on procurement strategies and risk mitigation will be needed.

Next Steps

- In 2017, begin investigating PPA contract opportunities that can satisfy the rate and load requirements outlined by the District's SOS program, and be phased in over a three year period to align with existing PPA supply contracts.
- Set a target to supply at least 70% of the Standard Offer Service through renewable energy PPAs.
- Aim to sign the first PPA agreement by 2018.
- Where the PPA results in lower electricity rates, use a portion of the savings to fund additional renewable energy and energy efficiency programs.

[182] 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

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 unit of energy). Design legislation to steadily increase 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 generation dominated by 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.[183] 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%.[184] In 2016, Oregon announced a similar program to phase out coal-based electricity by 2030.[185] Under the same legislation, the state increased its RPS to require 50% of all electricity sold to customers to be sourced from 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 yet to enact any legislation.[186] 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 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.[187] It is unknown at this time how much of the coal-generated electricity was delivered to the District.

The District does not have electricity generation plants within its borders, and so it is not regulated by the federal Clean Power Plan (CPP). A GHG emissions standard for electricity supplied to the District would, however, have a similar effect as the CPP 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 decline due to the CPP, enacting an emissions standard will give the District greater control over the effort to "clean" the regional grid. Additionally, the District can reduce the emissions intensity of electricity sooner than states regulated under the CPP, which does not begin until 2022 and will not achieve the mandated emissions intensity reductions until 2029.

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

[184] Ibid.

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

[186] 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

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

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 renewable sources. Shifting from coal-fired generation to efficient 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 a fossil fuel-based infrastructure, which would be 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. 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

- In 2017, begin investigating the potential impacts of the maximum GHG intensity regulation on system capacity, reliability, flexibility, and the cost-effectiveness of energy. As part of this, Direct DOEE to develop energy supply scenarios out to 2050 that achieve the District's 2050 GHG target or eliminate GHG emissions altogether (in conjunction with Action CRE.1).
- 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.
- Pending further analysis, announce a plan to legislate the maximum GHG intensity regulation as soon as possible.
- 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 residents 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 government incentives and programs, 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 resouce should be integrated in some way with Mapdwell's Washington, DC Solar SystemTM mapping tool, which depicts the solar potential of every building in the District; the mapping should also attempt to account for roof age, shading, green roofs, and roof decks or other auxiliary roof uses by developing this functionality or integrating with private tools from companies such as SolarCity or Sunrun that account for these factors. 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.[188/189] For example, the EnergyTrust website aggregates and plainly communicates information on incentives, tax credits, financing options, system requirements, purchase and installation steps, 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.

This online platform need not be built from the ground up, nor done by the District alone. Existing websites and local partners exist that the District can work with to develop and market this proposed solution. DC SUN, in particular, may be a good partner given their experience in the District, their understanding of how to overcome certain barriers to local solar adoption, and their existing website. The DCSEU may also be a good partner considering their mandate and experience managing their existing energy efficiency website. Management could also be coordinated by a similar third party organization, or even the District itself. One important consideration is the way in which current solar developers and installers will fit into the commerce platform.

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

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

Next Steps

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

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.[190] 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 of solar PV installations on other nearby buildings.[191] 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.[192] 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 install 140 solar PV systems 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 39.6 MW of solar capacity certified as of May 1, 2016 (19.2 MW of which is located within the District),[193] approximately 17.7 MW of additional solar generation per year will be needed to reach the 2023 RPS solar requirement under the Plan's set of recommended actions.

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

[191] 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

[192] 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

[193] Includes all solar systems eligible for the RPS solar requirements. 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

Details: A solar proliferation strategy is a one-time effort to grow solar generating capacity on both private and District Government-owned buildings and open spaces in a short period of time.[194] It is a direct marketing and education campaign that targets buildings suitable for solar and offers free roof and solar assessments. Residents and businesses can self-identify as interested in the solar assessment, then, if interested in getting more information or installing a system, be connected to solar installers and financing options.[195]

This campaign could be launched to coincide with the release of the District's Centralized Solar Information and Commerce Platform, using revenues generated through ACPs, and implemented with and through local partners. 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.

The proposed solar proliferation strategy involves four phases. Before moving forward with this program, DOEE should engage with local solar organizations regarding the best way to design and implement this program, as these organizations will have valuable, locally-specific knowledge and information. Based on this engagement, the District Government may find that the best approach to accomplishing this strategy is to partner with appropriate organizations to design, manage, and implement it.

Phase 1: Identify local partners and organizations with which to work: Successfully implementing this strategy will require support from local organization and coordination with solar installers, financing providers, and marketing and outreach companies.

DC SUN, along with other similar organizations, would be a valuable partner in designing and implementing this program. DC SUN is actively engaged in increasing solar adoption throughout the District, and thus has a good understanding of the key barriers that must be addressed and opportunities that can be seized. DC SUN may also have information for identifying target buildings, and it can support the communication materials and strategies, as well as the on-the-ground implementation of the outreach and marketing efforts. As a partner in this initiative, DC SUN may also benefit from the data and information generated about buildings with lower-cost solar potential and continuing to build a working relationship with District Government and DCSEU staff focused on increasing solar installations. Other local partners that may be valuable to the success of this program include the Maryland, DC, and Virginia Solar Energy Industries Association (MDV-SEIA),[196] Groundswell,[197] and the Solar Foundation.[198]

The other three types of organizations – solar installers, financing providers, and marketing and outreach companies – will be key to implementing the strategy and translating the implementation into new solar adoption. The marketing and outreach company should be appropriately selected based on the overall design and objectives of the program. The strategy should not directly align the District Government with any specific solar installers or financing providers. Rather, the District Government should put out a call for appropriate organizations that can serve potential customers to install solar systems. DC PACE and a new DC Green Bank should be involved as financing options. This information can be provided online, such as on the centralized solar platform recommended in Action CRE.4.

[194] The proposed design of this program is partly based on the successful Solar-Check program in Osnabrück, Germany. http://www.osnabrueck.de/gruen/klimaschutz/solardaecher/solarcheck.html

[195] The District Government must maintain neutrality in this process.

[196] MDV-SEIA represents the interests of photovoltaic and solar thermal equipment manufacturers, installers, distributors and component suppliers serving Maryland, the District of Columbia, and Virginia. Members design, sell, integrate, install, maintain and finance solar energy equipment for residential, commercial and institutional customers throughout the region. http://mdvseia.org/

[197] Groundswell is a nonprofit that organizes community power to bring economic equity to the energy sector. They are currently heavily focused on developing community solar projects in the District and in Baltimore, MD. Groundswell operates throughout the Mid-Atlantic (Washington DC, Maryland, Virginia, Pennsylvania, Delaware, and New Jersey). http://groundswell.org/

[198] The Solar Foundation is a nonprofit, nonpartisan organization dedicated to advancing solar energy use worldwide. The Solar Foundation serves as the Technical Assistance Provider for SolSmart, a new national designation program (funded by the U.S. Department of Energy SunShot Initiative) designed to recognize communities that have taken key steps to address local barriers to solar energy and otherwise foster the growth of mature local solar markets. The District is currently in the process of receiving a SolSmart designation. http://www.thesolarfoundation.org/

In addition to identifying interested solar installers, the District Government should consider using a bulk buy process to decrease panel costs. 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.[199] More information and support for District Government can be obtained from Boulder staff, as well as DC SUN, which has coordinated bulk buy programs, and federal staff involved in the SunShot Initiative's soft costs program.[200]

Phase 2: Determine the subset of buildings to target: Next, identify a subset of the District's building rooftops with the highest solar potential and that are relatively easy to access. The primary targets should include multifamily buildings, condominium buildings, small businesses, residential solar co-ops, and nonprofit organizations.

Several existing resources can facilitate the quick identification of initial buildings to target. For example, the District Government procured updated LiDAR data from 2015 from Mapdwell's Washington, DC Solar System™ map to estimate the solar potential of all buildings in the District.[201] This is a good starting point, but may not take into account roof age and other limiting factors (e.g., green roofs, decks, refined shading analysis). Private solar companies like SolarCity and Sunrun offer remote analysis tools that may be able to fill in some of these gaps, if the District can work with them while still maintaining neutrality in the marketplace.

The District may or may not want to consider several other factors in determining the subset of buildings to target. While these factors can drive a more refined set of buildings to target, the value gained from the additional information (e.g., fewer site visits resulting in identification of an unsuitable building) may not be worth the time and expense required to gather this information. As such, the District should look for an existing solar mapping tool that provides some of this information, but likely should not dedicate significant time to gathering and sorting through this information. Rather, some of this information should be identified during a self-selected site visit, while other information can be layered on to the solar potential map as it is developed (e.g., related to the neighborhood-scale energy strategy, Action CRE.8, grid hosting capacity study, Action ESM.6, and location-based energy use profile, Action ESM.7). These considerations include:

- 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 (requires collaboration with Pepco) and the opportunity for new technology, including microgrids, to mitigate grid issues.
- Ability of the building to accommodate energy storage infrastructure.
- Opportunities to coordinate with upcoming construction projects to reduce installation costs.
- Alignment with the District's neighborhood-scale energy strategy (when developed).
- Expected future lifespan of buildings and roofs.
- Achieving equity goals by targeting low-income households.
- Opportunities to install larger solar systems (e.g., community-scale).
- Access to federal land, given the large area of land owned by the Federal Government in the District.
- Status of building ownership.

Phase 3: Design and implement a targeted marketing campaign: Once target buildings have been identified, the selected marketing and outreach organization should develop a marketing campaign to directly engage with owners of identified buildings. This campaign should clearly and simply communicate the benefits of solar systems and the program being offered, and summarize available incentives and support.

[199] Discussion with Boulder planning staff, February 29, 2016

[200] 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/1QC5Lxl

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

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.[202] 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 marketing campaign should identify opportunities to increase the impact of this initiative by publicizing, promoting, and branding installations as they occur.

Once fully implemented, the District may wish to consider expanding the targeted customer base to include residents 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.[203] 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. DC SUN already has a list of District residents interested in solar that do not have suitable roofs.[204]

Phase 4: Facilitate installations: After a targeted building owner has received a free assessment and wants to move forward, the District Government's final step is to connect the building owners with the solar installation and financing information they need by connecting them with the appropriate organizations.

For properties eligible for DC PACE financing, including both the existing commercial program and the proposed residential program, the District Government should encourage property owners to utilize the PACE financing program as a way to install solar with no out-of-pocket costs. After all, the original use case for the PACE concept, when it was first proposed nationally, was rooftop solar systems on single-family homes. PACE-secured PPAs represent another pathway to expanding access to solar energy for traditionally underserved segments of the real estate market, including houses of worship, nonprofit institutions, small businesses, and affordable housing.

Leveraging Lessons from and Repeating the Program: Any data, information, and lessons generated through the implementation of this program should be used to design future solar programs.

Next Steps

The District can begin the four phases of this recommendations 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).

- In early 2017, assign DOEE staff to manage the strategy.
- Convene local solar groups to develop strategies to encourage solar deployment and implement those strategies.
- Appropriately select organizations to design and manage the marketing campaign and/or other phases of the strategy. Then similarly select organizations to perform outreach, education, technical assistance, and customer-support for underserved sectors, especially low-income, elderly, disabled residents, as well as a range of nonprofit organizations and multifamily buildings.

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

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

[204] Comment on Plan draft by DC SUN, September 15, 2016.

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, including a community-scale energy system. Update codes to require a certain percentage of building energy consumption to be met with on-site renewable energy generation. Review existing regulatory barriers.

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 would also support grid resilience objectives. A requirement to install renewable energy systems on new buildings and existing buildings undergoing substantial retrofits will also support ongoing efforts to study and to realize neighborhood-scale energy systems, including 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 between 5% and 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.[205]

In addition to building codes, the District Government will need to review existing regulations, including zoning laws, to identify barriers that will impede reasonable development of on-site solar generation.

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 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' suitability for solar generation 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.

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

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

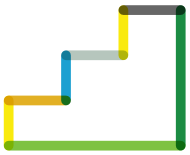
net positive building goals. The stringency and timeline of this proposed code update can be determined by means of a feasibility study that assesses any cost implications and determines the appropriate approach to compliance. Such a process should engage with the local building industry to harness existing knowledge and foster broader buy-in.

While emphasizing solar deployment, it is also essential to recognize the potential limitations of a building-by-building approach. The most well-intentioned owner, combined with the most progressive building code, will still fail to realize a new building's PV potential if that amount of power cannot be integrated with the local distribution system. Solving this problem requires action beyond the scale of the building – either through neighborhood-scale energy systems, including microgrids (see Action CRE.8), or through broader grid modernization (see section 4.2).

These actions follow in the footsteps of other leading jurisdictions. Vancouver (Canada) requires one- and two-family homes (duplexes) to be solar-ready,[206] and all rezoning applicants with properties larger than two acres to conduct a feasibility study to assess the relative cost of constructing an on-site or connecting to a nearby low-carbon thermal energy plant.[207] 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).[208] Several national, state-level, and municipal governments in Europe have also adopted ordinances that require buildings to install solar thermal systems.[209]

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 that land use policies (e.g., building heights and shadow implications) and bylaws are aligned with building- and district-scale renewable energy actions. Finally, like other building code updates, the District should conduct more detailed analysis to understand the potential cost impacts and develop the specific code language.

Next Steps



- Within the next year, direct DOEE 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 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.

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

[207] Energy sources include but are not limited to process/waste heat recovery, sewage heat recovery, geoexchange (open loop, closed loop, surface water exchange), air source heat pumps, bio-energy (biomass combustion, biogasification, anaerobic digestion), and other nearby district energy systems.Vancouver Rezoning Policy for Sustainable Large Sites, http://former.vancouver.ca/commsvcs/BYLAWS/bulletin/R019.pdf

[208] 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

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

4.1.2.3 THERMAL ENERGY SUPPLY & MICROGRID INTEGRATION 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 operate. 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, the thermal energy is provided through one of three means: electricity, natural gas, or fuel oil. Thermal energy demand for buildings, particularly the demand for air conditioning, is expected to increase as summer temperatures will rise due to climate change.[210] As of 2013, natural gas represented approximately 40.5% of total building energy use in the District, while fuel oil represented 2.5%. [211]

Low carbon energy sources and systems that can be used to elicit this shift include electricity, biofuels, and low carbon neighborhood-scale energy systems, and necessary types of building equipment include baseboard heaters, heat pumps, and hydronic systems. Given the long-term importance of 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, and 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. [212]

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.
- 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.

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

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

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

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 for thermal energy and electricity and preparing the District to capitalize on opportunities to install neighborhood-scale energy systems.[213]

Relevance: Neighborhood-scale energy systems can be a cost-effective way of reducing GHG emissions, reducing energy costs, and improving resilience. Developing a neighborhood-scale energy strategy could ensure that the District can capitalize on cost-effective opportunities, as one component of larger shift to low-carbon and renewable energy. Neighborhood-scale energy also has the potential to improve resilience and efficiency by centralizing neighborhood-scale modular systems. Neighborhood-scale energy systems, particularly microgrids, can generate electricity, better manage energy demand, and could lower energy costs.

The District's current neighborhood-scale energy facilities are operated by the General Services Administration as well as several District universities.[214] New neighborhood-scale energy systems and microgrids have also been proposed for the Walter Reed Army Medical Center and St. Elizabeth's Campus redevelopments, the SW Ecodistrict, the Kingman Park neighborhood, and dozens of other sites.[215] DOEE is expected to release a citywide microgrid feasibility study in the near future, identifying dozens of potential microgrid opportunities. 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.[216] 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, both the use of low carbon energy sources, and efficiency gains from shifting to neighborhood-scale energy, can significantly reduce GHG emissions.

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.[217/218] 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 could open up additional opportunities.

[213] 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.

[214] 2014 Comprehensive Energy Plan for the District of Columbia (unreleased), pp.36-37, 159.

[215] Sustainable DC, 2012, p.19; DOEE 2016 Microgrid Report (unreleased).

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

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

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

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 the demand for neighborhood-scale energy and reduce the capital cost to build the system (e.g., community planning to increase adoption, adjusting infrastructure planning timelines to decrease costs).

While studying the availability of local zero emission thermal energy supplies, the District should investigate new renewable electricity generation that can be incorporated at or near the same sites. Integrating neighborhood-scale thermal energy and local electricity generation allows the District to identify greater energy efficiency improvements and GHG reductions that could not be realized by a sole focus on thermal energy; it can also lead to development of microgrids that support the grid and increase the grid's ability to handle new distributed energy resources (electricity system modernization is discussed in section 4.2). Two such microgrids currently under development have been included in the modeling for the Plan.[219]

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. 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 that the District is prepared to capitalize on neighborhood-scale energy opportunities when they become available. Importantly, the District needs to ensure that neighborhood-scale energy systems are designed to achieve increasing improvements in energy efficiency and conservation.

The neighborhood-scale energy strategy should be led by DOEE, involve DC Water, and engage relevant internal and external stakeholders. These stakeholders may include the PSC, Department of General Services, 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, District Department of Transportation, the DC Chamber of Commerce, the DC Building Industry Association, and others. Participation by the District Department of Transportation can help align infrastructure planning and development activities to share construction costs.

[219] The model incorporates existing estimates of the GHG reduction potential of the Walter Reed and St. Elizabeths sites. More information is provided in section A1.2.2.3 of Appendix 1. Given that the District is actively engaged in maximizing cost-effective microgrid opportunities. With this additional information, the next iteration of the Plan can better quantify and incorporate these opportunities.

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

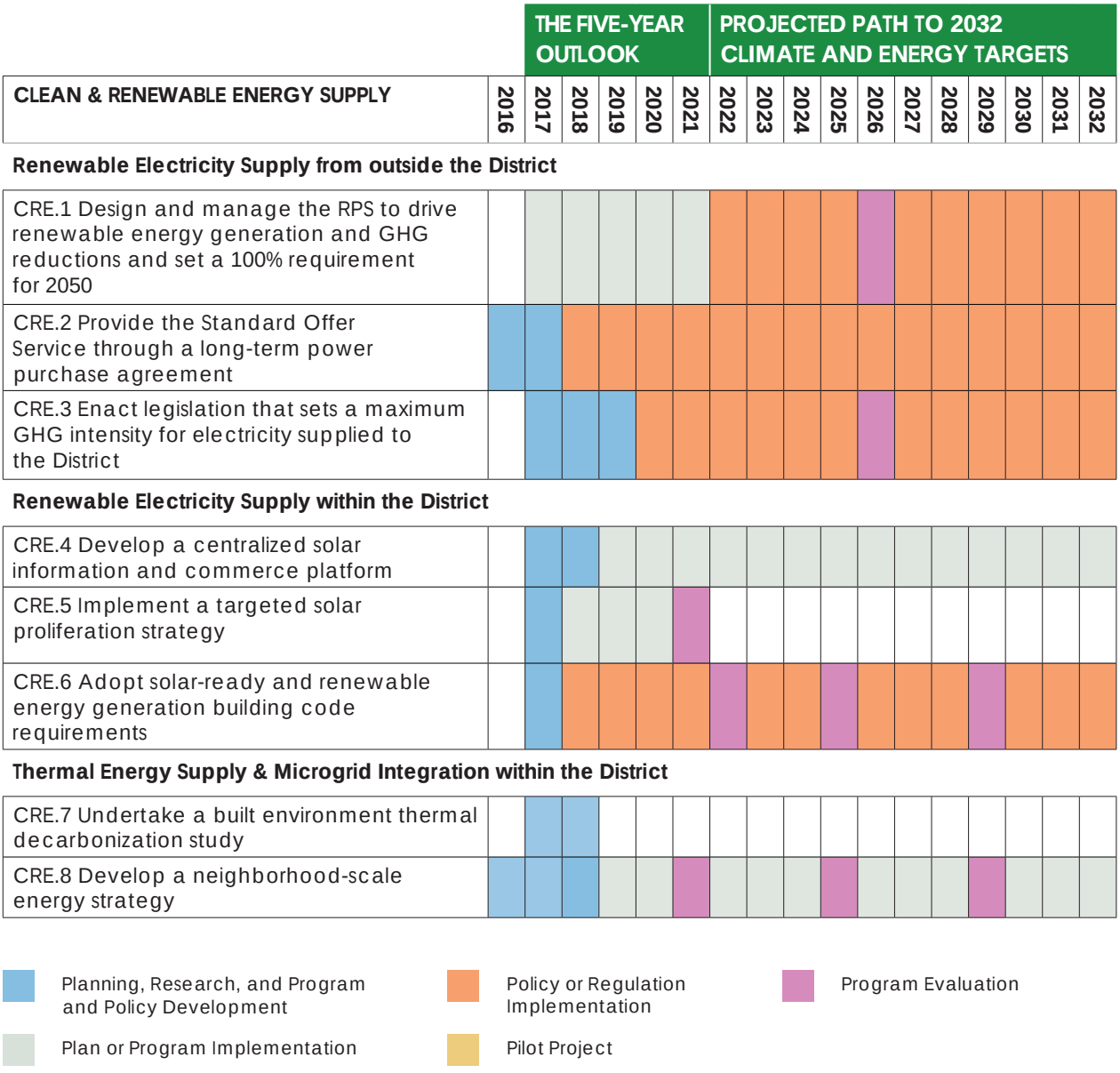
- Identifying thermal energy and electricity demand opportunities based on new construction, anticipated growth, and current thermal energy demand compatible with neighborhood-scale energy.
- Performing a strengths, weaknesses, opportunities, and threats (SWOT) analysis of the potential role of the District with regards to the promotion and proliferation of low-carbon neighborhood-scale energy systems.
- Working with the PSC (including through Formal Case 1130), local utilities, the Office of Planning, and the Zoning Commission and the DC Council to establish a modernized regulatory and legislative framework to allow for appropriate development of viable neighborhood-scale systems including microgrids that can accommodate various scenarios and maximize the benefits of on-site energy assets to consumers and the grid.
- Incorporating neighborhood-scale energy strategies into the District's Comprehensive Plan amendment process, specifically the Environmental Protection, Infrastructure, and Resilience Elements. Establish a requirement that developments in certain categories/sizes and zoning overlay districts must undertake a feasibility analysis for neighborhood-scale energy systems, including microgrids.
- Requiring all major transfers of public land to private ownership or mixed finance structures to assess neighborhood-scale energy options for resiliency and sustainability.
- 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 District Government policies regarding specific energy sources, e.g., regarding biomass).
- Investigating phasing strategies to facilitate the long-term implementation of neighborhood-scale energy systems that incorporate both thermal energy and electricity supplies, considering future infrastructure planning (to reduce total costs), development plans, anchor loads, and other capital planning.
- Using District Government buildings 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 and electric energy demand and low carbon supply and recommending feasibility analyses and other planning studies for further investigation.
- 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 approaches, including microgrids.
- Identifying a pilot project and developing a framework for developing projects (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

- In 2016, begin discussions with DC Water regarding the opportunity to collaborate on neighborhood-scale energy initiatives,[220] with a particular focus on wastewater thermal.
- The District Government should actively participate in near-term pilot projects, in parallel with the suggestions of Action ESM.11 related to grid modernization pilot projects.
- Add amendments to the Comprehensive Plan to emphasize neighborhood-scale energy strategies, and require any project over 500,000 gross square feet with a zoning overlay district to evaluate neighborhood-scale energy, including microgrids, in planning.
- Within the next two years, direct DOEE staff to assemble a group of key neighborhood-scale energy stakeholders (for both thermal and electric energy) 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 that 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, review to ensure that planning and policy tools can support and will not hinder neighborhood-scale energy development.

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

4.1.3 CLEAN & RENEWABLE ENERGY SUPPLY ROADMAP



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 energy to meet the District's targets, both from outside and within the District of Columbia. This will require strategically phasing out fossil fuels, then coupling with 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 reliability. Indeed, Pepco in its 2016 rate case projects an expenditure of $1.52 billion in new capital projects between now and 2020 to ensure reliability.[221] While these investments are costly, avoiding them will result in a less reliable grid, with higher electricity costs for consumers.[222/223]

The grid is also challenged by extreme weather and flooding events associated with climate change. 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 impact on these important pieces of infrastructure will be significant for the businesses, governments, and residents that depend on this infrastructure.[224] 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 zero and two events of less than 100 minutes per year.[225] 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.[226] 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.

Further, as in many jurisdictions, the District's electric grid is inefficient in terms of system utilization, 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 underused and therefore 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.[227] This shift can be supported and enabled by distributed energy resources (DER), but DER must be successfully integrated into the grid. More discussions on DER are provided in the next section.

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

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

[223] 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

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

[225] Sustainable DC Plan, 2012

[226] Sustainable DC Plan, 2012

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

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). 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 can both increase renewable energy generation and support more efficient and cost-effective management of the electricity system. DER includes energy efficiency (both at the levels of consumers and the grid), demand response, distributed storage, distributed generation (e.g., solar panels, thermal energy recovery systems), microgrids, and electric vehicles.[228] 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 driven significant growth in the demand for DER over the past several years. Continuing this growth will require innovative, 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.

Integrating DER into the existing grid presents new 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., hydroelectric dams, coal-fired power plants, and nuclear power plants) that is transmitted through regional distribution networks to end-users. Integrate high quantities of DER technology into the existing grid will impact grid performance and operation. 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.[229] Such interactions can lead to reliability problems, and challenge existing utility models, regulatory structures, and decision-making processes around the design and operation of the grid.[230] As such, utilities and regulators should consider current and future growth in DER when planning or making investment or regulatory decisions; otherwise, they risk making costly grid investments that are incompatible with the future operation of the grid.

The growing focus on DER and distribution planning also offers considerable benefits over traditional electricity system planning and management. 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. [231] This trend is likely to continue: the cost of DER is declining as technology improves; soft costs (e.g., installation costs) are declining as business model improves; and increased production improves economies of scale. At the same time, the price of electricity from wind and solar photovoltaic (PV) generation has fallen dramatically over the past decade, making solar and wind the most affordable source of power in some areas even when compared to fossil fuels.[232]

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

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

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

[231] 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

[232] 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/

DER can facilitate peak demand reductions and obtain associated cost savings. Peak demand refers to the maximum quantity of electricity a customer demands at a given time. Peak demand often results when a business is using all of its equipment, or when residents demand high amounts of electricity for cooling on a hot summer day. An electric grid must be able to supply enough power to satisfy peak demand, however high and for however long. Certain DER technologies can reduce peak demand, which will help the grid operator and consumers to predict and adjust their energy demand. thereby saving significant costs.

Local energy storage technologies also allow customers to receive 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.[233] By extension, these increases in efficiency reduce the need for additional generating capacity and associated grid infrastructure, lowering costs for customers.

Finally, DER can accelerate 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 came from renewable sources, more than half of which was distributed solar.[234] A combination of DER and modernized grid equipment will help ensure affordability, efficiency, reliability, resilience, and security of the District's electricity.

In sum, the various pressures and changes facing the grid require the District to engage in a process of changing, improving, and upgrading the electricity system, or what is broadly referred to as grid modernization. Making these changes in a 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 grid for decades to come. This section of the Plan 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 or incentives, and regulatory structures to achieve a balance of an affordable, sustainable and resilient electricity system.[235] 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.[236]

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.[237]
This holistic grid modernization approach to DER integration becomes increasingly important as the supply and use of DER increases.

[233] 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

[234] 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/

[235] 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 Plan, and "grid modernization" is often used for brevity.

[236] 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.

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

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.[238] 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 material 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'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 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.***

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

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 PSC's 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."[239] 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. The recommended actions in this section should be integrated with DOEE's intervention in FC1130, as a component to build experience and capacity of the District Government with respect to these issues.

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.[240] 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 Clean Energy DC and Climate Ready DC.

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 Plan. 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 envision what this future electricity grid can and should look like. To some extent, this process is already underway via the PSC's FC1130. However, it is important to include such work as part of this Plan to emphasize its importance and to provide guidance

[239] Public Service Commission Order 17912.

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

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.[241] 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 should 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.

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?[242]

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.[243] 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.

[241] 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_Whitepaper_Final.pdf

[242] 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

[243] 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.[244/245] 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 during 2017.
- Review and update the grid vision during the development of the next iteration of Clean Energy DC, 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 analytical 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.
- 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.[246]

[244] 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

[245] 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

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

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[247]
- California's proposed Locational Net Benefit Analysis[248]
- The Distributed Energy Resource Avoided Cost Calculator (DERAC)[249]
- New York's proposed Benefit-Cost Analysis (BCA) Framework[250]
- EPRI's The Integrated Grid Benefit-Cost Framework[251]
- Analysis Group's The Value of "DER" to "D"[252]

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 or other energy supply system stakeholders. 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 PSC and stakeholders in 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 iteration of Clean Energy DC.

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

Action: Work with the PSC, Pepco, and stakeholders to develop an integrated distribution plan designed to strategically and cost-effectively support the modernization of the grid to its envisioned future state. Integrate neighborhood-scale energy planning into broader real estate and economic development planning processes.

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.[253] These are investments into infrastructure that will last for decades into the future, and thus require careful planning and analysis to ensure that investments will serve the District's future needs. Without anticipating future integration with DER, these costly investments risk becoming stranded assets.

[247] 2014, https://www.aee.net/aeei/resources/benefit-cost-analysis-der.html

[248] 2016, http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M161/K474/161474143.PDF

[249] 2011, https://www.ethree.com/documents/DERAvoidedCostModel_v3_9_2011_v4d.xlsm

[250] 2015, http://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/c12c0a18f55877e785257e6f005d533e/$FILE/Staff_BCA_Whitepaper_Final.pdf

[251] 2015, http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002004878

[252] 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

[253] Formal Case 1139 – Application, Direct Testimony and Exhibits of Potomac Electric Power Company Witnesses Velazquez and McGowan http://phx.corporate-ir.net/phoenix.zhtml?c=62854&p=irol-newsArticle&ID=2140909

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.[254]

In addition, as mentioned in the previous section (4.1) on Clean and Renewable Energy Supply, a system that can manage DER, like a microgrid, may enhance the grid's ability to integrate a large number of solar PV systems, storage, and sophisticated demand-side management assets, increasing the opportunity to realize the resiliency benefits of these energy assets. Therefore, a neighborhood-scale energy system should be considered and, if appropriate, planned for in areas that are targeted for a large number of solar PV systems and storage, as well as a large number of buildings with sophisticated demand-side management capabilities.

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 could be inadequate for a grid with a high penetration of DER.[255] By contrast, IDP involves the following:

- Explicit consideration of energy-efficiency and load-management programs, as well as neighborhood-scale energy systems, 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.[256]

As noted by the District Government, stakeholder comments on the FC1130 proceedings indicate that there may be an emerging consensus by a majority of stakeholders regarding the importance of a more holistic approach to distribution system planning.[257]

To succeed with IDP, the District Government needs a framework to guide the system planning process. Two states have recognized the need for IDP through legislation—California and Hawaii—while regulators and utilities are tackling IDP in other states.[258/259] The District can learn lessons from other jurisdictions, while recognizing regulatory differences. As such, the District Government should work with the PSC, Pepco and other stakedholders to review the experiences in other jurisdictions to identify concepts and frameworks that may be useful for the District. To begin, the District can build on concepts outlined in grid modernization literature.[260] Possible IDP processes include:

- 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 District's demand forecasting and procurement proceedings.
- Identifying which capital projects are likely candidates for deferral or avoidance through the procurement of DER alternatives.[261]

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

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

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

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

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

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

[260] 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

[261] Adapted from: De Martini and Kristov, 2015, Distributed Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operationand Oversight; 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.

Unlike jurisdictions like New York, California, and Hawaii, the District imports nearly all of its electricity. Therefore, the IDP process must also plan to increase the supply of renewable energy procured from outside the District. Given their recent growth and rapidly declining costs, the District should consider opportunities to procure more energy from utility-scale wind and solar generation, while considering the impact to the grid.

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 (done by 2018), collaborate with the PSC and Pepco to develop a new electricity system planning framework based on IDP.
- Continue to work with the PSC, Pepco, and other stakeholders to update the IDP and the Plan.
- Provide support and technical assistance to real estate developers and neighborhood organizations, enabling them to begin analysis of neighborhood-scale energy options.
- Conduct a District-wide screening analysis for neighborhoods or areas that could most benefit from neighborhood-energy scale systems, and consider proposing zoning overlay districts for those areas to develop such systems that could provide public benefits.

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 led by the PSC through FC1130 Investigation into Modernizing the Energy Delivery Structure for Increased Sustainability.[262] The PSC process invites input from, and collaboration with, stakeholders, and will continue to oversee appropriate procedures and make decisions affecting grid modernization through its proceedings.

Details: As noted above, the District Government is already actively engaged in 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 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[263/264] FC1050 will likely have implications for streamlining DER installations, 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).

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

[263] FC1050 Investigation of Implementation of Interconnection Standards in the District of Columbia, http://www.dcpsc.org/esr/FC1050_IllSinDC.asp

[264] 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

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 incentives, 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 changes: changes that can be pursued right away, and those that will require additional time or information to implement, such as additional 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.[265] Once identified, the District Government should implement actions that support a movement into the next stage of the grid modernization process.

An example of changes 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 (done by 2018), 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 (for intermittent renewable sources) 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 (intermittent renewable sources) given existing and already-planned facilities.[266] A hosting capacity study of the District's distribution grid will provide critical

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

[266] Electric Power Research Institute, 2015, The Integrated Grid: A Benefit-Cost Framework

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 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

- Support Pepco for a hosting capacity study 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.[267] 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).

[267] London Heat Map, http://www.londonheatmap.org.uk/Content/HeatMap.aspx

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.

Next Steps

- Undertake an initial mapping analysis in 2017 to support energy use reductions and DER increases.
- Institute the mapping analysis as a regularly used tool through the implementation of the Plan 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 infrastructural, organizational, operational, financial, regulatory, and technological features and components that appear to be absolutely necessary for realizing 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.[268] 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.
- 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 certain grid data, while considering grid security.[269/270/271]

The District Government should align this action with the development of integrated distribution planning (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 can implement immediately, including in collaboration with the PSC and Pepco.

[268] 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

[269] 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

[270] Electric Power Research Institute, 2015, The Integrated Grid: Realizing the Full Value of Central and Distributed Energy Resources

[271] Testimony of Dr. Jeffrey Taft, Chief Architect for Electric Grid Transformation, Pacific Northwest National Laboratory before the U.S. Committee on Energy and Natural Resources, March 17, 2015

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.[272] Pepco has now exchanged over 99% (>296,000) of the District's traditional meters with smart meters.[273] 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 yet to begin to exploit 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 notmade this function available.

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 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.

[272] Pepco-District of Columbia: Smart Grid Project, https://www.smartgrid.gov/files/Pepco-District-Columbia-Smart-Grid-Project-2015.pdf

[273] Fact Sheet, Pepco, http://www.pepco.com/uploadedFiles/wwwpepcocom/PepcoDCFactSheet.pdf

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

- In 2017, assemble an inventory of ongoing projects that may affect or be affected by grid modernization and institute a regular process whereby such projects can be identified.

[274] 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

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 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, similar to how generators bid into markets, by making the process easier, more consistent, and less risky.[274]

Other examples of pilot projects can be found in Australia, which will place select neighborhoods on microgrids powered entirely by solar and storage.[275/276] 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.

[274] 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

[275] 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

[276] 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/

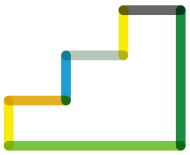
Pilot projects on a range of technologies and grid modernization concepts should be considered, including:

- 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
- 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.[277] 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.[278] 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

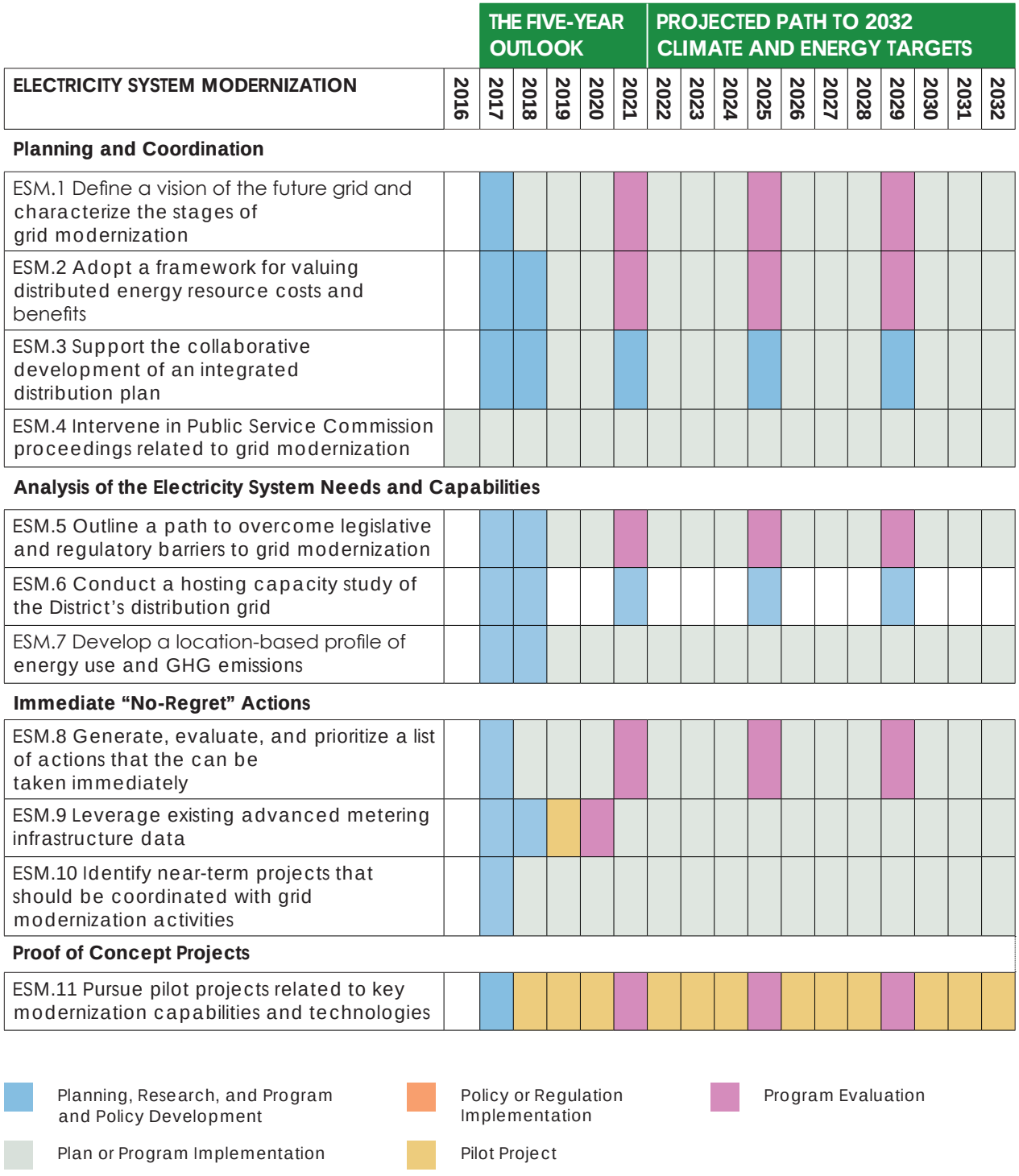


- Pursue the development of a pilot project at Mt. Vernon Square.
- Using the results of other grid modernization actions, identify and pursue pilot projects that will help the District and its stakeholders understand the process and potential outcome of grid modernization.

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

[278] 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



TRANSPORTATION

5 TRANSPORTATION

This chapter outlines the actions necessary to reduce the greenhouse gas (GHG) emissions that result from the District of Columbia's (District) 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.[279]

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.[280] 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. Based on the model, achieving the mode share target would be one of the most effective ways for the District to reduce GHG emissions by 2032. The set of transportation-focused actions is summarized in a roadmap at the end of the chapter.

As the Government of the District of Columbia (District Government) begins prioritizing the recommended actions, designing the specific policies and programs, and developing implementation plans in collaboration with stakeholders, it should ensure that Clean Energy DC is aligned with and augmented by other transportation actions emerging from ongoing and existing work.

[279] moveDC, http://www.wemoveDCorg/index2.html

[280] Sustainable DC Plan, p.12

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%.[281] 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.[282] 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.[283] 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.

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.[284] 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.[285] 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.[286] 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 public charging infrastructure. Low- and zero-carbon electricity production is also more established and cheaper than hydrogen production, and has an established transmission and distribution network. By contrast, zero-emission ethanol vehicles depend on the development of cost-

[281] This does not include people who commute from outside the District. moveDC – Multimodal Long-Range Transportation Plan, 2014, p.5. Note, however, that the VMT calculations in the Clean Energy DC model includes VMT for all vehicles driven in the District, regardless of origin or destination.

[282] 2014 Comprehensive Energy Plan for the District of Columbia (unreleased), pp.4, 24.

[283] 2011 District of Columbia Greenhouse Gas Emissions Inventory, http://doee.DC.gov/sites/default/files/dc/sites/ddoe/publication/attachments/GHGinventory-1205-.pdf.

[284] 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.

[285] 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

[286] International Energy Agency, 2016, Tracking Clean Energy Progress 2016, http://www.iea.org/publications/freepublications/publication/TrackingCleanEnergyProgress2016.pdf

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 (EV). 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.[287]

To transition 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.[288] 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.[289] 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.[290/291] 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.[292]

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. [293/294]

[287] California Air Resources Board, 2009.

[288] 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

[289] National Capitol Region Transportation Planning Board (NCRTPB)

[290] Commuter figures from NCRTPB.

[291] Personal vehicle reliance information from 2014 Comprehensive Energy Plan for the District of Columbia (unreleased), p.180.

[292] Discussion with DOEE staff, March 18, 2016.

[293] Transportation & Climate Initiative - Northeast Electric Vehicle Network in Action, http://www.transportationandclimate.org/northeast-electric-vehicle-network-action

[294] Metropolitan Washington Council of Governments, Electric Vehicle Planning Initiative – Documents, http://www.mwcog.org/committee/committee/documents.asp?COMMITTEE_ID=272

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).[295] However, the District has a 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).[296] Current actions include:

- An exemption for vehicle title fees (available to any vehicle with a fuel economy over 40 mpg).[297]
- A tax incentive to convert petroleum-fueled vehicles to electricity (and other qualifying alternative fuels).[298]
- Exemptions from high occupancy vehicle lane restrictions and any time-of-day and day-of-week driving restrictions.[299]
- Tax incentives for residential and public charging infrastructure.[300]

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.[301] 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 assumes and requires a decarbonized electricity grid. Actions focused on this objective are included in the Plan's Clean & Renewable Energy Supply section.

[295] Lutsey, N., Searle, S., Chambliss, S., Bandivadekar, A., 2015, Assessment of leading electric vehicle promotion activities in United States cities. Washington DC, USA.

[296] 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.

[297] DMV (2016) Green Driver State Incentives in Washington DC, http://www.dmv.org/washington-dc/green-driver-state-incentives.php

[298] 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

[299] DMV (2016) Green Driver State Incentives in Washington DC

[300] GoElectricDrive Incentive Locator – District of Columbia, http://www.goelectricdrive.org/select-country/united-states/itemlist/category/120-district-of-columbia

[301] 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 is already in place.[302] 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.[303] 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. [304]

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.[305] The code requires all one-to-two 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 charging.[306/307] 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.

[302] 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.

[303] 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).

[304] Conversation with DOEE Staff on Feb 10, 2016.

[305] 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.

[306] San Francisco requirements from Lutsey, N., Searle, S., Chambliss, S., Bandivadekar, A., 2015.

[307] City of Vancouver, 2012, Electric vehicle charging requirements, http://vancouver.ca/home-property-development/electric-vehicle-charging-requirements.aspx.

The experience of these and other jurisdictions indicates that it is particularly difficult to get EV charging infrastructure installed at multi-family residential buildings.[308] 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.[309] 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. Of course, the cost impact of EV charging infrastructure and cost-reduction strategies should be considered in implementing this action.

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.
- 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 the Building and Land Regulations Administration in coordination with 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

[308] California Department of Housing and Community Development, 2014

[309] 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.

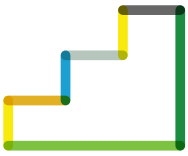
(e.g., in parks and shopping centers) play a valuable role in facilitating a long-term transition to EVs. Parking lot charging stations increase consumer awareness of and comfort with EV technology, which can help increase adoption. Requiring parking lots to install EV chargers and/or infrastructure 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.[310] 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.[311] 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.[312] 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.

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 the Building Code Advisory Committee and Building and Land Regulations Administration in coordination with DOEE staff focused on EV infrastructure planning and Pepco.

[310] 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.

[311] Ibid.

[312] 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.

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 limits the possibility of any new vehicle dealerships.[313] 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).[314] 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.[315]

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 Plan'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. The program can be operated by the District or by another organization that is found through a competitive bid RFP process. Consumers will also benefit from lower EV pricing, while participating automakers can enjoy substantially lower acquisition fees, marketing costs, transaction costs, and failed leads. [316]

[313] Discussion with DOEE staff, March 18, 2016.

[314] RMI Outlet, 2015.

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

[316] 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

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 automakers and local organizations 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 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 the District to contract a qualified 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, high occupancy vehicle 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.[317] 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).[318/319]

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.[320] 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.[321] 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.[322] California has the highest market share at around 3.5% in 2015.

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.

[317] Overview of EV strategies in other regions from Lutsey, N., Searle, S., Chambliss, S., Bandivadekar, A., 2015.

[318] 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

[319] 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

[320] Lutsey, N., Searle, S., Chambliss, S., Bandivadekar, A., 2015.

[321] 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.

[322] Lutsey, N., 2015, Transition to a Global Zero-Emission Vehicle Fleet: A Collaborative Agenda for Governments.

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.[323]

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.[324] 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.[325/326] Montreal's existing car sharing programs welcomed the announcement, including Car2Go, which already has fully electric fleets in Amsterdam, San 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.[327]

Key to the success of this program is the availability of public charging infrastructure and the ability to encourage enough membership.[328/329] 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.

[323] ZipCar, Car2Go, and Enterprise CarShare, as well as Getaround and Relayrides.

[324] 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/.

[325] 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-.

[326] 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.

[327] 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/.

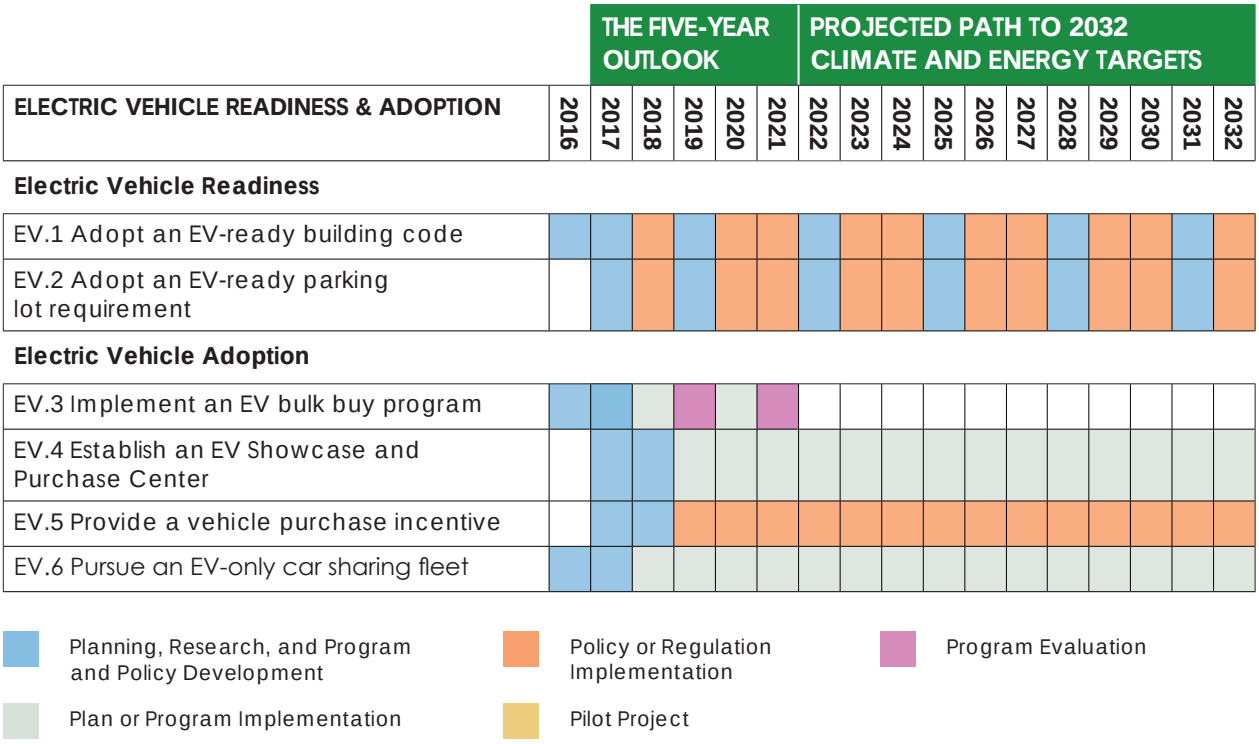
[328] Importance of public infrastructure from Madger, J., 2015.

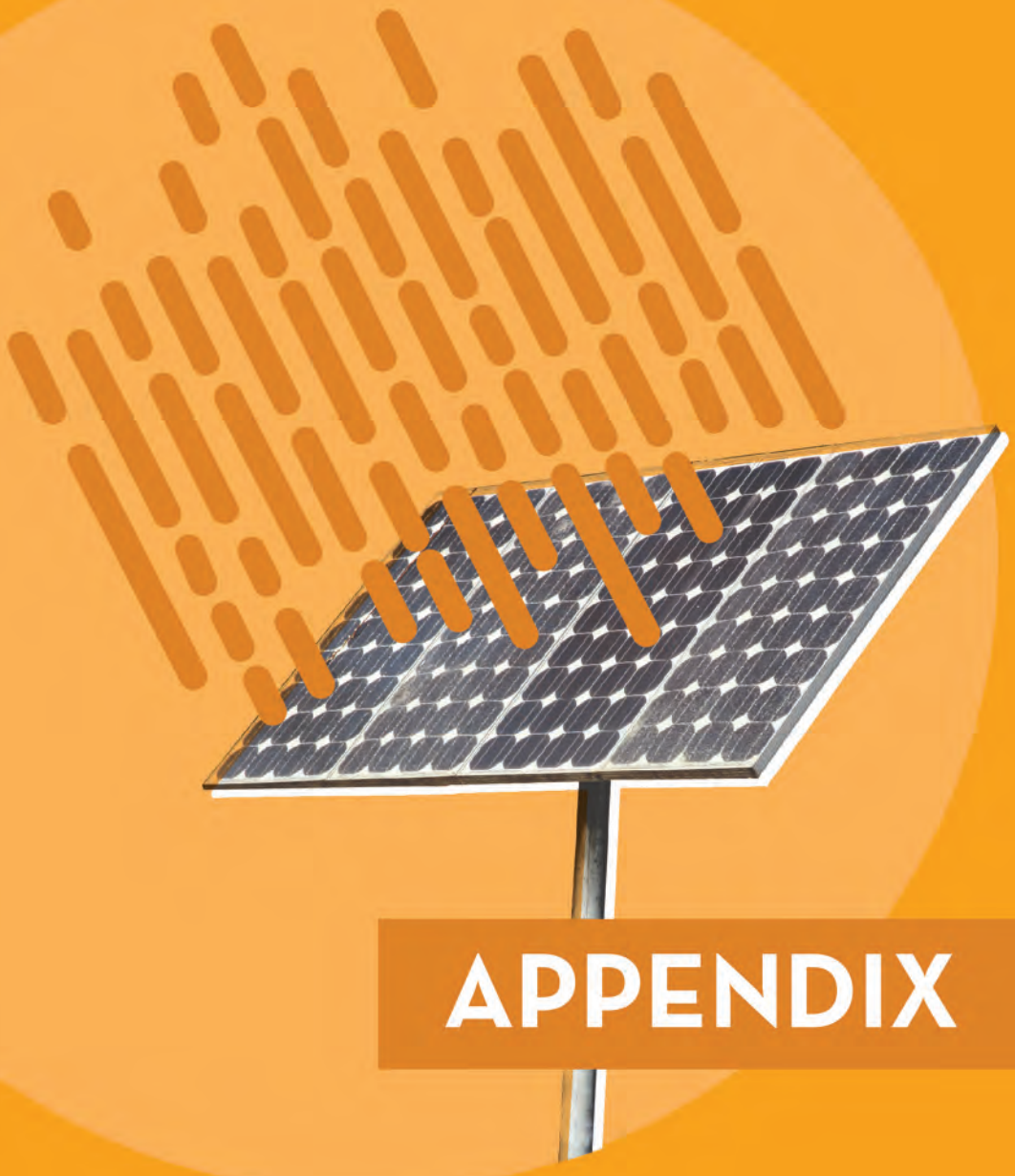
[329] Importance of encouraging adequate membership from Werber, C., 2015.

Next Steps

- In 2016, 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 2018.

5.1.3 ELECTRIC VEHICLE READINESS & ADOPTION ROADMAP





APPENDIX

APPENDIX A1: MODEL OVERVIEW AND ASSUMPTIONS

A1.1 MODEL PURPOSE AND OVERVIEW

The consultant team developed an Excel-based energy and GHG emissions model for the Plan. The model accounts for all energy and GHG emissions in the District and focuses on representing energy supply, buildings, and transportation. The consultant team used the model to understand current energy and emissions, estimate future energy and emissions, and quantify the potential impact of certain actions targeting different aspects of the District's energy system. The structure, equations, and data inputs have been discussed with and vetted by DOEE staff.

The Plan is intended to inform the District on how it can achieve its climate and energy targets (section 1.1). Given this purpose, the model was used to quantify actions in different ways. The team quantified specific programs and policies where actions are more directly quantifiable, such as the RPS and new construction codes. For actions that do not as easily lend themselves to direct quantification, the team focused on determining the scale of action required to achieve the District's climate and energy targets. This was then used to help inform policy and program development as well as collaboration with District Government representatives and others. The team took this approach primarily where a more comprehensive suite of policies and programs is required to achieve significant energy and emissions reductions, such as the programs, policies, regulations, and incentives required to drive the market transformation necessary to improve the performance of existing buildings. Some of these actions are not readily quantifiable, but are critical to enabling the District's success nonetheless. In this way, the team used the model as an analysis and engagement tool to foster a common understanding of what it will take the District to achieve its targets. The District Government has been given a copy of the model and, going forward, can use it to evaluate whether the District is on track to meet its targets.

The model also is not intended to be a predictive tool and does not account for costs or externalities other than GHG emissions. The intent of the Plan is to provide the District with a roadmap to achieving its 2032 GHG reduction target, the most achievable and arguably most important of its 2032 targets. The Plan provides this roadmap through a package of policy and program recommendations, with additional information and recommendations regarding the design and implementation of such actions based on available research and experiences in other leading jurisdictions. The specific design and implementation of many of these actions will take further analysis, including to understand the potential cost-effectiveness and relative feasibility of program and policy approaches and designs. This analysis, design, and implementation work (some of which is underway, see section 1.5) will be conducted in coordination with District stakeholders, many of whom are identified in the Plan.

A1.2 MODEL ASSUMPTIONS AND DATA SOURCES

The team used the model to project a business-as-usual (BAU) estimate for energy consumption and GHG emissions based on assumed developments and activity in energy supply, buildings, and transportation. The team then simulated actions in each of these areas to develop a set of policy scenarios, resulting in a set of actions that reduce GHG emissions, reduce energy consumption, and increase renewable energy, as presented in section 2.2.2. The sections below summarize the assumptions behind the BAU projection and policy scenario.

A1.2.1 BUILDINGS

Energy and emissions in the building sector are based on square footages, energy use intensities (EUI), and fuel mixes. The sector is split into a set of building types to align with how buildings are categorized in District Government data sources, account for differences in energy consumption characteristics, and allow users of the model to target specific actions to different building types.

A1.2.1.1 BUSINESS-AS-USUAL ASSUMPTIONS

Building square footage changes as a result of changes in the building stock due to new construction, demolitions, and building rehabs. Table A.1 summarizes the square footages for each building type in 2015 as well as growth assumptions for each modeled building type. Building square footages are extracted from the District Government's Office of Tax and Revenue's Computer Assisted Mass Appraisal Database (CAMA). Annual construction rates are based on data maintained by the Office of Planning. New square footage growth rates represent annual net growth in square footage in the District that results either from developing on undeveloped sites or redeveloping sites with a net increase in square footage. These rates are based on employment, household, and population projections for 2010 to 2045. Square footage replacement rates represent new construction that results in new square footage that replaces old square footage. This involves removing square footage associated with an older energy performance (from the existing building stock) and replacing it with square footage at an energy performance based on the building code in force. These rates are based on the 2010 to 2045 projections referenced above, as well as the breakdown of development types (e.g., new construction, demolition, renovation, rehab) tracked in the Office of Planning's Development Activity Database (updated October 2015).

Building energy and emissions are driven by square footage, energy use intensities (EUI), fuel mix, and fuel GHG intensities (discussed in section A1.2.2.1). Table A.2 summarizes each building type's EUI and total energy consumption by fuel type for 2015. Site energy use was chosen because changes in site energy use can most easily can be affected by local policies and quantified in the model, and because losses in generation are accounted for in the GHG accounting, discussed in further detail below. Each building type's EUI was determined through a combined bottom-up top-down approach using multiple data sources. The purpose of the approach is to calculate total energy consumption by fuel type using square footage and EUIs (bottom-up) so that it matches estimated total energy consumption for buildings in the District (top-down). Total energy consumption by fuel type was sourced from 2013 data from Pepco via DOEE in January 2016. More recent accurate building energy consumption data was not available. The team determined EUIs first from 2014's Private Building Benchmarking Dataset as cleaned by the Center for Urban Science and Progress at New York University.[330] Where additional data was needed to match the bottom-up and top-down figures, the team

[330] Benchmarking and Data Quality Analysis of Energy Disclosure Data for Washington, DC, October 28, 2015.

sourced data from nearby states (preferably in the same climate zone as designated by the Commercial Buildings Energy Consumption Survey), then from national sources as needed (primarily data from the 2012 Commercial Buildings Energy Consumption Survey). Single-family residential energy data is not included in these sources, so was sourced from data used for a previous iteration of the Plan.

Table A.1: Summary of building stock square footage and growth and development assumptions

		Annual Construction Rates	
	Gross Square Footage in 2015	New Gross Square Footage Growth	Gross Square Footage Replacement
Residential (total)	**358,205,024**	-	-
Low-rise residential (1-4 units)	186,532,207	0.20%	0.09%
Multifamily (5+ units)*	171,672,817	1.05%	0.45%
Institutional and Government (total)	**151,582,127**	-	-
Education and Other Institutional (non-gov)	31,620,942	0.78%	0.33%
Federal Government	81,398,472	0.00%	0.00%
District Government	29,720,568	0.00%	0.00%
Embassy	8,842,145	0.00%	0.00%
Commercial and Industrial (total)	**249,205,839**	-	-
Office	171,578,263	0.97%	0.42%
Hotel	23,543,628	0.78%	0.33%
Other Commercial and Industrial	47,463,319	0.78%	0.33%
Hospital and Other Medical	6,620,629	0.78%	0.33%
Total	**758,992,990**	-	-

*Includes buildings designated under the District of Columbia Housing Authority.

A1.2.1.2 BUILDING CODE ASSUMPTIONS

The model uses building codes to affect the energy performance of new and rehabbed buildings. Two sets of building codes are applied: one targeting single-family and small multifamily buildings (residential buildings under 10,000 ft2) and one commercial and large multifamily buildings. Both codes are updated for 2017, 2020, and 2026. For single-family and small multifamily buildings, the impact of new codes is felt two years after code adoption (e.g., code adopted in 2017 impacts energy use of new buildings in 2019). For commercial and large multifamily buildings, the impact of new codes is felt three years after code adoption (e.g., code adopted in 2017 impacts energy use of new buildings in 2020). Each code adoption impacts building energy performance by reducing the EUI of the building type. The code adoption cycle is summarized in Table A.3.

Table A.2: Summary of building energy use

	Site Energy Use Intensities (EUI) in 2015 (kBtu/ft2)				Estimated Site Energy consumption in 2015 (million kBtu)			
	Total	Electricity	Natural Gas	Fuel Oil	Total	Electricity	Natural Gas	Fuel Oil
Residential					**23,742**	**7,773**	**14,769**	**1,200**
Low-rise residential (1-4 units)	48.6	9	35	4.6	9,064	1,679	6,529	856
Multifamily (5+ units)	85.5	35.5	48	2	14,678	6,094	8,240	343
Institutional and Government					**16,079**	**9,570**	**6,435**	**73**
Education and Other Inst'l (non-gov)	101.4	60	41	0.4	3,206	1,897	1,296	13
Federal Government	108.5	64	44	0.5	8,832	5,210	3,582	41
District Government	103.4	64	39	0.4	3,073	1,902	1,159	12
Embassy	109.4	63.5	45	0.9	967	561	398	8
Commercial and Industrial					**24,256**	**17,844**	**6,134**	**279**
Office	88.9	75.5	12.5	0.9	15,256	12,954	2,145	157
Hotel	103	57.5	45	0.5	2,425	1,354	1,059	12
Other Comm. and Industrial	110.9	53	56	1.9	5,264	2,516	2,658	90
Hospital and Other Medical	198.1	154.1	41	3	1,311	1,020	271	20
Facilities Excluded from Analyses*					**1,262**	**700**	**562**	**0**
DC Water	n/a	n/a	n/a	n/a	762	700	62	0
GSA Central Heating Plant	n/a	n/a	n/a	n/a	500	n/a	500**	0
Total					**65,711**	**36,121**	**28,039**	**1,552**
Total Site Energy Use from DOEE					**65,820**	**36,147**	**28,120**	**1,552**
Total Missing Site Energy Use					**480**	**281**	**220**	**0**
Percent Missing Site Energy Use					**0.70%**	**0.70%**	**0.80%**	**0.00%**

*These facilities are not included in policy simulations because the Plan assumes building actions do not affect their performance. **Natural gas use at the GSA Central Heating Plant includes only natural gas consumed in the process of generating steam for Federal Government buildings, so as to avoid double counting GHG emissions captured by these buildings' energy consumption.

Table A.3: Assumed code adoption cycle

Adoption Year	Single-Family and Small Multifamily Buildings	Commercial and Large Multifamily Buildings
Current	Based on EUIs for 2012's International Energy Conservation Code [331]	
2017	Assumed to be 17% more efficient than current codes [332]	
2020	Net-zero code adopted (EUI=0)	High-performance code update
2026		Net-zero code adopted (EUI=0)

[331] Pacific Northwest National Laboratory, 2013, Energy and Energy Cost Savings Analysis of the IECC for Commercial Buildings https://www.energycodes.gov/sites/default/files/documents/PNNL-22760.pdf

[332] Correspondence with DOEE staff, September 21, 2016.

The high-performance code update for commercial and large multifamily buildings is assumed to get new buildings halfway between the EUI required under the 2017 code update and the net-zero codes adopted in 2026. Net-zero codes are assumed to have an EUI of zero, and any renewable energy associated with these buildings is not added to the model. This approach was taken to recognize the full GHG emissions impact of net-zero codes without overestimating the contribution of these codes to renewable energy given that net-zero building EUIs are still uncertain and the specific energy source requirements to comply with net-zero energy codes in the District is not yet determined. DOEE is able to update these assumptions as net-zero energy codes are further researched and developed. The model assumes code compliance of 85% for all codes except the first three years of net-zero codes, which have compliance rates of 70%, 75%, and 80%, respectively.[333] Based on the structure of the model, an 85% code compliance rate means the District achieves 100% of the code's energy use and GHG reduction potential from 85% of the affected building square footage, and no energy use or GHG reduction from the remaining 15%. In reality, the 15% non-compliant buildings would very likely still achieve some energy use and GHG reduction from partial code compliance. This means the GHG reductions attributed to new construction may be slightly underestimated.

A1.2.1.3 EXISTING BUILDING ASSUMPTIONS

The model uses retrofits and building energy performance standard to affect the energy performance of existing buildings. The retrofits assumed in the model are intended to provide the District a sense of the scale of action required in the existing building sector to achieve their 2032 GHG reduction target, while still being realistic to achieve and sustain across the full building stock for over a decade. Table A.4 summarizes the retrofit assumptions used across private buildings, the majority of the District's building stock. Altogether, this set of retrofits affects approximately 19.5% of the square footage in the District, or nearly one in five buildings.

Table A.4: Retrofit assumptions for private buildings

Years	Annual Square Footage Affected by Retrofits	Average Energy Use Reduction
2017 through 2019	1.00%	15%
2020 through 2023	1.00%	30%
2024 through 2032	1.50%	30%

The model assumed the District Government implements a more aggressive retrofit program, as summarized in Table A.5. The program involves deeper energy use reductions sooner and across a higher portion of the building stock. The retrofits are intended to improve performance, as well as provide leadership and demonstrate building energy efficiency capabilities to the private sector, both in achieving deeper retrofits and net-zero codes.

[333] Recall, compliance targets are typically 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.

Table A.5: Retrofit assumptions for District Government buildings

Years	Annual Square Footage Affected by Retrofits	Average Energy Use Reduction
2017	1.00%	30%
2018	3.00%	30%
2019 through 2020	5.00%	30%
2022	1.00%	30%
2023	1.50%	100%
2024	2.00%	100%
2029 through 2030	3.00%	100%
2031 through 2032	5.00%	100%

The model assumes the Federal Government retrofits 20% as much square footage as the District Government at the same average energy use reduction, and that embassies are not affected by retrofits.

Two other actions are captured in existing buildings that drive down energy consumption and GHG emissions. First, the model includes a building energy performance standard (BEPS). BEPS covers all buildings required to comply with the District's benchmarking requirements and requires the worst performing buildings (for each building type) to improve their energy performance every five years. The energy use reductions included in the model are based on modeling done in support of a project focused on determining how best to design BEPS for the District. The model uses the midpoint energy use reduction estimate of two potential BEPS designs. Both designs require buildings triggering BEPS to improve their performance through a suite of mandatory improvements and either an Improvement Path (requiring a 15 point increase in ENERGY STAR Score) or a Prescriptive Path (requiring retrocommissioning, an energy audit, and action of items with a payback under three years). The difference between the two designs is the threshold of buildings that trigger and are required to comply with BEPS: the bottom 20th percentile or the bottom 40th percentile of buildings in each building category based on ENERGY STAR Score. This is not the final proposed design recommendation for BEPS. The resulting penetration rates and average energy use reductions used in the model are summarized in Table A.6. The data used to generate these values was taken from 2014's Private Building Benchmarking Dataset.

Table A.6: Summary of energy use reduction and penetration inputs used to represent BEPS

Building Type*	Percent of Total Square Footage Affected by BEPS (between 2020 and 2032)	Average Energy Use Reduction
Multifamily (5+ units)	19.60%	13.30%
Education and Other Inst'l (non-gov)	40.30%	14.60%
Office	21.50%	13.60%
Hotel	35.00%	15.10%
Other Comm. and Industrial	6.8%**	15.70%
Hospital and Other Medical	5.8%**	10.90%

* District government buildings are also subject to BEPS and are captured in the other building types.

** The small percentage of Other Comm. and Industrial (n=27) and Hospital and Other Medical (n=6) buildings triggering BEPS results from the low number of buildings covered by the 2014 benchmarking dataset and the approach of capturing the worst performing buildings based on their relative performance.

Second, the model assumes that a portion of existing buildings go through a rehab each year, triggering the requirement to comply with the most recent building codes for the portion of the building undergoing a rehab. The portion of buildings undergoing a rehab each year is based on the Office of Planning's Development Activity Database (updated October 2015), which tracks buildings (but not square footage) undergoing development each year (e.g., new construction, demolition, renovation, rehab). Given that the Development Activity Database does not track exactly what portion of each building undergoing a rehab, and thus the aspects of the building triggering code compliance are unknown, representatives from DOEE and the consultant team agreed to assume that the rehabs result in the average building improving their energy performance by half as much as if the entire building was required to meet the latest code.

A1.2.2 ENERGY SUPPLY

A1.2.2.1 ENERGY GHG FACTORS

GHG intensity factors are applied to energy use by fuel type to calculate total GHG emissions. To maintain consistency with the District's 2006 GHG inventory, which provides the baseline for the District's GHG reduction target, the GHG intensity of electricity accounts for losses from generation, but not from transmission or distribution. The model uses the RFC-East subregion factor from the EPA's eGRID database of regional GHG intensities.[334] Similarly, the GHG intensity of natural gas does not include fugitive emissions from transmission and distribution. Future iterations of the District's GHG inventory may include transmission and distribution losses from electricity and fugitive emissions from natural gas. If so, earlier GHG inventories would be updated to reflect the change and ensure the District is using consistent measurements to measure and evaluate progress towards their GHG reduction target.

If accounting for transmission and distribution losses for electricity, the GHG intensity used in the model would be 5.82% higher, using the EPA's grid gross loss factor for the Eastern Grid.[335] Under the BAU assumptions, GHG emissions in 2032 would be 3.1% higher than presented in Figure 9. Under the policy scenario used for this Plan, GHG emissions in 2032 would be 2.7% higher than presented in Figure 9. These numbers cannot be compared against the 2006 GHG baseline, however, so are not used in the Plan.

With 2016's Carbon Disclosure Project report, the District began reporting leakage estimates from the local distribution system as required by the new Global Community Protocol for GHG accounting. However, without any local info, the District used a national default rate based on guidelines from the Intergovernmental Panel on Climate Change. The resulting GHGs from leakage totaled approximately 0.2% of total GHG emissions. DOEE is working with Washington Gas to determine local leakage estimate and the District will continue reporting on these emissions and update previous inventories accordingly.

The GHG intensity (tCO2e/kBtu) of all energy types stays constant in the BAU scenario (Table A.7) for everything except electricity. In BAU simulations, the GHG emissions intensity of electricity declines until 2020 due to the increasing renewable energy requirements under the Renewable Portfolio Standard (RPS). The model does not assume additional declines due to the federal Clean Power Plan (CPP) or electricity generation plant closures and replacements. The implementation of and compliance strategies in response to the CPP, as well as other plant closures, will have an uncertain impact on the District and are likely to overlap with emissions reductions achieved through the RPS (as states and suppliers look for the most cost-effective approaches to complying with

[334] The RFC-East eGRID subregion includes the District of Columbia, Delaware, New Jersey, and portions of Maryland and Pennsylvania, https://www.epa.gov/energy/egrid.

[334] eGRID grid gross loss factor for Eastern Grid of 5.82%. Grid loss calculation done based on guidance from Appendix C of ICLEI's U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (Version 1.1). Grid gross loss factor sourced from How to use eGRID for Carbon Footprinting Electricity Purchases in Greenhouse Gas Emission Inventories, 2012, https://www.epa.gov/sites/production/files/2015-01/documents/adiem.pdf

both regulations). As such, to avoid optimistic assumptions about declining electricity emissions, these external forces were assumed not decrease the electricity emissions factor. This may mean deeper emissions reductions from changes in electricity supply occur by 2032 than is modeled for the Plan's BAU scenario. If the GHG intensity of the electricity grid declines due to such external forces, it will reduce the GHG reductions attributed to actions in the Plan.

Table A.7: GHG emissions factors for energy types in BAU simulations

Energy Type	BAU GHG Emissions Factor	Notes for Policy Scenarios
Electricity	0.000134 tCO2e/kBtu [336]	Declines due to the RPS in BAU simulations and both the RPS and other policies in policy simulations.
Natural Gas	0.000053 tCO2e/kBtu [337]	Stays constant in all scenarios
Fuel Oil	0.000074 tCO2e/kBtu [338]	
Gasoline	0.000074 tCO2e/kBtu [339]	
Diesel	0.000074 tCO2e/kBtu [340]	

A1.2.2.2 POLICIES TARGETING GHG EMISSIONS FROM ELECTRICITY

Two modeled electricity policies target the GHG emissions intensity of electricity. The first is the District's increasing RPS. As described in the Plan, suppliers can comply with the RPS either by acquiring renewable energy credits (RECs) or paying alternative compliance payments (ACPs) where RECs are unavailable to more costly than ACPs. As explained in section 2.2.1.2, the requirements of the GHG accounting protocol used by the District in combination with the compliance options offered by the RPS mean it is very unlikely that the full potential of GHG reductions possible under the RPS will be captured by the District.[341] Therefore, the actual decline in the District's electricity GHG emission factor is uncertain and depends on RPS compliance. As such, representatives from DOEE and the consultant team decided to assume 57% of the potential GHG emissions reductions that may be achieved under the RPS are captured by the District, while the remainder of the RPS is complied with using ACPs or RECs that do not affect the GHG emissions intensity of electricity in the District. In reality, the GHG reductions that may be triggered by and attributable to the RPS could be higher or lower than this, as discussed in the Plan.

The second policy is supplying the District's standard offer service (SOS) through a renewable energy power purchase agreement (PPA). Approximately 24% of the electricity supplied to the District is sold through the SOS. The policy scenario assumes that the full PPA can be supplied by a set of renewable energy PPAs with an average of 70% of the electricity supplied by renewable energy and the remainder from the spot market, which uses the average electricity GHG emissions intensity for that year. To be conservative, the model assumes 10% of customers opt-out after the switch to the renewable energy PPA, reducing the portion of electricity consumption served by the SOS to 21.6%. Actual customer retention or loss is uncertain at this time and could go either way. In fact, if a lower electricity rate can be secured, more customers may shift to the SOS, thereby increasing the GHG reductions achieved by this action. SOS adoption may also increase due to a desire by electricity customers to be supplied by renewable and/or zero emission energy.

[336] The U.S Environmental Protection Agency's eGRID factor for RFC-East subregion for 2014 (accessed January 20, 2016). http://www.epa.gov/sites/production/files/2015-07/documents/emission-factors_2014.pdf

[337] Table B.1, Appendix C, ICLEI U.S. Community Protocol V1.1, http://icleiusa.org/publications/us-community-protoco

[338] Ibid.

[339] Calculated from 2012 and 2013 transportation demand, energy consumption and GHG emissions data provided to DOEE by the Metropolitan Washington Council of Governments, which is also used for the District's GHG inventory.

[340] Ibid.

[341] The District uses ICLEI's U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (Community Protocol).

Table A.8 summarizes the assumed GHG intensity of electricity until 2032 when the above policies are implemented, assuming only 57% of the potential GHG reductions that may be achieved under the RPS are captured by the District. The numbers indicate that the GHG intensity of electricity consumed in the District must decline by approximately 38% for the District to achieve its 2050 GHG reduction target. The actual GHG intensity of the grid between now and 2032 will depend on multiple factors, including compliance with the RPS, what can be achieved by the PPA for SOS, and external factors that affect the regional electricity grid (e.g., market forces, federal regulatory impacts).

Table A.8: Estimated GHG intensity of electricity (tCO2e/kBtu) under the policy scenario

Year	2017	2018	2019	2020	2021	2022	2023	2024
Electricity GHG Intensity	0.000124	0.000123	0.00011	0.000108	0.000101	0.000101	0.000101	0.000100
Year	2025	2026	2027	2028	2029	2030	2031	2032
Electricity GHG Intensity	0.000098	0.000096	0.000094	0.000092	0.000090	0.000088	0.000085	0.000083

A1.2.2.3 NEW DISTRICT ENERGY SYSTEMS

Finally, the energy supply is affected by installations of new district energy systems, referred to as neighborhood-scale energy systems in the Plan. The model includes two assumed sets of new district energy systems. First, the District is able to capture 20% of the wastewater thermal supply identified by DC Water by 2032, totaling 37 MW of supply at a capacity factor of 47.4%. The sources are assumed to be zero emissions and displace existing natural gas and electricity. Second, two natural gas-fired combined heat and power systems are installed at the Walter Reed and St. Elizabeth's sites currently under development. The annual GHG reduction potential from these sites is initially 7,000 and 14,000 tCO2e, respectively, then declines as the GHG intensity of electricity declines.

A1.2.3 TRANSPORTATION

A1.2.3.1 TRANSPORTATION DEMAND AND MODE SHARE

In addition to growth in the building stock, the model assumes growth in transportation demand and the associated energy and GHG emissions increases associated with growth in transportation demand. BAU transportation demand and mode share are based on recent transportation data and the District's Multimodal Long-Range Transportation Plan moveDC. moveDC projects total transportation demand and mode share out to 2040 in a BAU scenario, which is translated into VMT demand by mode share (passenger vehicle, transit, cycling and walking) out to 2032. BAU mode share in 2032 is 55% passenger vehicle, 24% transit, and 19% cycling. For the policy scenario, the consultant team assumed the same total VMT demand but shifted demand from passenger vehicles to transit, cycling and walking based on the District's mode share target in the Sustainable DC Plan.

The model captures energy consumption and GHG emissions from transit and other medium and heavy duty vehicles based on the aforementioned MWCOG transportation data provided to DOEE. Energy and emissions from on-road transit vehicles (buses) and metro transit grow with increasing transit demand, which is driven by the changes in mode share discussed above. For metro transit, the model assumes that metro energy consumption grows at 30% the rate of metro demand growth. The GHG emissions associated with metro transit are then affected by the changes in the GHG intensity of electricity. Energy consumption by medium and heavy

duty vehicles is assumed to grow at the same rate as passenger vehicle demand in the BAU scenario. No policies target these vehicles because the forthcoming Greening the Fleet Study is analyzing policies for this sector.

A1.2.3.2 VEHICLE ASSUMPTIONS AND POLICIES

As the passenger vehicle stock grows, existing vehicles in the stock are retired and new vehicles are purchased each year. As a result, the average fuel efficiency of the vehicle stock and the vehicles that comprise it change. Each year, 4.1% of the existing passenger vehicle stock is replaced by new vehicles. New vehicles entering the stock have a higher fuel efficiency rating due to the federal Corporate Average Fuel Economy (CAFE) Standard, which results in the average fuel efficiency of the entire stock declining. The GHG and energy use reduction impacts of the CAFE Standard were included in the policy scenario wedge diagrams to make its impact explicit to readers. Because it is a federal regulation already in place, the CAFE Standard will achieve GHG reductions regardless of action taken by the District, but the level of its impact changes based on the mode share changes achieved by the District.

Electric vehicle (EV) adoption is also assumed to increase over the model time period. The model includes battery electric vehicles, which are powered entirely by electricity from the grid, and plug-in hybrid electric vehicles, which are initially powered by a battery, then a petroleum fuel-based engine when the battery is depleted. The consultant team assumed EV market share for new vehicles (the share of new vehicles sold that are electric vehicles) reaches 30% by 2032. This requires effective policies and programs focused on EV readiness and adoption, and is in line with the levels of adoption found necessary for California to achieve its 2050 GHG reduction target of 80% below 1990 levels. The model assumes that 75% of all EVs adopted during this time at battery electric vehicles, reflecting an increasing shift to purely electric vehicles as EV technology improves and consumers become more comfortable with EVs.

A1.2.4 OTHER EMISSIONS SOURCES

Although GHG emissions from waste are included in the model, waste was not within the scope of the Plan, so these emissions are not affected by policies. Rather, they are held static to reflect uncertainty in the interaction between growth in waste and the impact of District action to achieve its zero waste vision.

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