Natural Gas and its Contribution to a Low Carbon Future

Climate Business Plan for Washington, D.C.

Washington Gas
A WGL Company

AltaGas

MARCH 2020

Forward Looking Statement

This Climate Business Plan, prepared solely for the Company's operations in the District of Columbia, contains forward-looking statements, which are subject to the inherent uncertainties in predicting future results and conditions. Such statements are based on our current expectations as of the date we filed this business plan, and we do not undertake to update or revise such forward-looking statements, except as may be required by law. Statements contained in this business plan concerning expectations, beliefs, plans, objectives, goals, strategies, expenditures, recovery of expenditures, future environmental matters, regulatory and legislative proposals, future events or performance and underlying assumptions and other statements that are other than statements of historical fact are "forward-looking statements." Forward-looking statements are based on management's beliefs and assumptions based on information available at the time the statement is made and can often be identified by terms and phrases that include "anticipate," "believe," "intend," "estimate," "expect," "continue," "should," "could," "may," "plan," "project," "predict," "will," "potential," "forecast," "target," "guidance," "outlook" or other similar terminology. The Company believes that it has chosen these assumptions or bases in good faith and that they are reasonable. However, actual results almost always vary from assumed facts or bases, and the differences between actual results and assumed facts or bases can be material, depending on the circumstances. Important factors that could cause actual results to differ materially from those projected in the business plan include (but are not limited to), changes in United States and District of Columbia laws and regulation, the inability to timely recover costs through utility rate proceedings, the impact of future legal proceedings, competitive pressures, compliance costs, changes in the structure of capital and/or energy markets, technological advancements and advances in new technologies, changes in consumer preferences, the availability of alternative or lower-priced energy options, access to capital, and existing and future environmental requirements, including those related to potential, anticipated or known impacts of climate change. You should not place undue reliance on forward-looking statements.

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A Message from our President and Chief Executive Officer

Delivering on Our Commitment to Help DC and the World Meet Future Climate Goals

When AltaGas acquired Washington Gas, we committed to continue our history of proven energy innovation by providing the District of Columbia with a long-term business plan that can contribute to the District achieving its climate goals. As a trusted energy partner to the District for over 170 years, we set out to develop a blueprint detailing how we, as a newly combined company, can help the District reach its goal to cut greenhouse gas emissions (GHG) in half by 2032 and become carbon neutral by 2050. We are proud to submit the following plan in furtherance of that commitment.

BUILDING ON A LEGACY OF CLIMATE REDUCTION: IN OUR OWN OPERATIONS AND FOR CUSTOMERS

The Climate Business Plan builds on our record of achievement and our companies' collective determination to address climate change. AltaGas, and its subsidiary, Washington Gas, share a legacy of leadership and innovation. Both companies have excelled in bringing new clean energy sources to customers. AltaGas built and operated the first wind generation facility in British Columbia, the 102 MW Bear Mountain Wind Park, and the impressive Northeast Hydro run-of-the-river hydroelectric generation facilities in British Columbia. We are also helping to reduce emissions globally by shipping propane to Asia that displaces emissions from burning coal, oil and wood. It is estimated that our Ridley Island Propane Export Terminal will help avoid emissions on an annual basis that exceed the total annual emissions attributed to natural gas use in Washington, D.C. Closer to home, WGL Energy was among the first companies to provide wind power to retail electric customers. WGL is also a leading first-mover company in the installation of solar in the mid-Atlantic region. In DC alone we developed 68 distributed generation solar projects which generate 15,150 MW-hours annually, reducing local GHG emissions for years to come.

DELIVERING BOLD INNOVATION TO EMPOWER THE DISTRICT'S CARBON-NEUTRAL FUTURE

We are confident that our Climate Business Plan provides a sensible path forward. Collaborating with the District to implement the steps toward decarbonization gives us the opportunity to continue to leverage our resilient, vast and established energy delivery and storage system to reduce emissions while providing affordable and reliable energy. Our Plan promotes customer energy efficiency and savings, builds and maintains a modern infrastructure for today and tomorrow, and introduces carbon-free fuels, such as renewable natural gas (RNG) and hydrogen.

Looking 30 years into the future means that we have to do our best to anticipate what's ahead. While many factors are unknowable over that long timeframe, there are emerging, disruptive and breakthrough technologies that are showing tremendous promise and are expected to impact everything from sourcing (including renewable natural gas and hydrogen) to distribution, to how effectively we use energy in the future. The Plan includes investing in, and piloting, some of these emerging technologies that will maintain and enhance the District's position as responsible climate leaders.

We look forward to productive discussions and closely collaborating with the District to create policies and regulations to meet the District's climate targets, while continuing to provide essential energy in a cost-effective manner to the people, businesses and institutions that call the District of Columbia home.

Sincerely,

Randy Crawford
President and Chief Executive Officer

Plan Overview: Empowering the District to Meet Carbon Neutral Status by 2050

BRINGING IN A NEW ERA OF CLEANER ENERGY TO THE NATION'S CAPITAL

AltaGas Ltd., with its subsidiary Washington Gas Light Company (Washington Gas), is proud to submit a comprehensive Climate Business Plan (the Plan) designed to serve as a bold blueprint to achieve carbon neutrality in support of the District of Columbia's long-term climate goals. The Plan achieves **a 50 percent greenhouse gas (GHG) emissions reduction associated with the use of natural gas by 2032 and 100 percent carbon neutrality associated with the use of natural gas by 2050.**

The core tenets of the Plan's three-pronged approach will maximize energy efficiency programs as well as leverage our existing, vast and reliable energy infrastructure system to deliver not only natural gas but also forward-looking fuel sources like biogas and 'green' hydrogen as part of a broader portfolio mix of energy supply. Importantly, the cost to implement the **plan saves an estimated $2.7 billion** as compared to approaches that rely solely on electrification, while enhancing the reliability of energy to the District's energy consumers.

The Plan is not only a part of AltaGas' commitment made with the Public Service Commission of the District of Columbia (DC PSC) during its proceedings to approve AltaGas' acquisition of Washington Gas in July 2018, but continues to demonstrate our long-standing efforts to address the issue of climate change.

A FUEL NEUTRAL DECARBONIZATION APPROACH MEETS GOALS, IS COST EFFECTIVE AND FLEXIBLE FOR THE FUTURE

Over the last year, AltaGas has engaged in extensive and thorough research, leveraged its own decades of energy expertise and enlisted the respected consulting firm ICF Resources, LLC (ICF), to assess an optimal path forward for the District and its residents. AltaGas has determined that **Fuel Neutral Decarbonization** is the right choice for the District to meet its Climate Goals.

Among its many benefits, a Fuel Neutral Decarbonization strategy provides the desired GHG emission reductions at a fraction (59 percent) of the cost of full electrification, while maintaining energy reliability for District residents, businesses, government agencies, and visitors. In addition, it preserves customer choice, empowering all energy consumers in the District to select an energy source most suited to their needs.

> **FUEL NEUTRAL DECARBONIZATION – THE RIGHT APPROACH TO ACHIEVE OUR CLIMATE GOALS**
>
> - Achieves the District's 2050 carbon neutrality goals and saves residents and businesses $2.7 billion relative to meeting the goals primarily through electrification
> - Preserves customer choice, secures energy reliability, and enhances resiliency in the face of increasing climate-related weather variability

THREE BUILDING BLOCKS OF 2050 NATURAL GAS DECARBONIZATION

Action in three key areas – **End Use, Transmission and Distribution, and Sourcing and Supply** – will lead to the success of Fuel Neutral Decarbonization by embracing new emerging technologies, as well as energy innovations – such as the promise of green hydrogen and renewable natural gas – that use the reliable energy delivery infrastructure system already in place across the District. Other important benefits include stabilized costs, resiliency and reliability, and energy storage, as compared to alternative scenarios that were studied but come with higher cost, more risk and uncertainty.

End Use – Providing practical energy efficiency solutions to our customers. The cleanest and lowest cost energy is that which is not used. Increasing energy efficiency is the first step to reduce energy use and the associated GHG emissions. The Plan highlights the many methods to reduce use and improve efficiency.

Transmission and Distribution – Continue to reinforce and strengthen our infrastructure and advanced leak detection to reduce leaks and fugitive methane emissions. Fugitive methane emissions, attributable to pipeline transmission and distribution, account for the smallest source of emissions relating to natural gas. However, their community impacts – including odor, noise and disruptions during repairs, planned construction, and proactive pipeline replacement programs – make them the most visible to people living in our communities.

Sourcing and Supply - Decarbonize the energy supply delivered. There are two ways to reduce emissions associated with natural gas supply. The first is through introducing low/no carbon non-fossil-based gases into the natural gas delivery system and the second is avoiding methane emissions from the upstream extraction of natural gas.

Building Blocks of Decarbonization

End Use	Transmission and Distribution	Sourcing and Supply
Energy Efficiency ▪ Expand DCSEU programs ▪ Develop Washington Gas programs that support – Behavioral demand reductions – High-efficiency appliances – Building envelope upgrades – Gas heat pumps – Demand response internet of things automation – CHP deployments ▪ Electric/Gas Hybrid Heating – Explore approaches, such as Energy-As-A-Service, to ease financial burden – Reduce economic disincentives through decoupling/revenue normalization adjustment adoption – Accelerate advanced technology development/adoption via partnerships and pilots with National Labs/original equipment manufacturers	▪ Prioritize Accelerated Pipeline Replacement Programs projects based on GHG emissions using data analytics ▪ Promote advanced leak detection and enhanced response solutions ▪ Recover gas during maintenance, repair and replacement projects using drawdown compressors ▪ Evaluate the efficacy of several promising airborne and vehicle-based methane detection systems	▪ Certified Gas – Low cost emissions reduction – Ready now strategy ~ 1–2% reduction – Pending study with Rocky Mountain Institute to validate emissions reductions ▪ RNG – Facilitate development of and access to non-fossil supply (13% by 2032; 58% by 2050) – Purchase/distribute RNG and other zero carbon fuels including biogas, power-to-gas, and green hydrogen ▪ Seek regulatory cost recovery – Socialize cost across customer base – Encourage marketers to provide additional opt-in RNG offering

THE CRITICAL ROLE OF INNOVATIVE LOW/NO CARBON FUELS - RENEWABLE NATURAL GAS AND GREEN HYDROGEN

Two non-fossil-based gases – RNG and green hydrogen – are included in the Climate Business Plan due to their strong emissions reduction potential and compatibility with existing pipeline infrastructure and customer end-use equipment and appliances. They also require no action on the part of customers to implement and bring to scale.

RNG – can be introduced and provide emissions reductions without requiring upgraded or new equipment by the end-user. RNG is developed from biomass, waste, or other renewable resources and is a pipeline-quality gas that is fully interchangeable with conventional natural gas. It is carbon neutral, extremely versatile and fully compatible with the U.S. pipeline infrastructure.

Green Hydrogen – a carbon-free fuel that emits no GHG emissions, is made with renewable energy and stored in a tank until needed. The technology to produce clean hydrogen from water and electricity has been commercially available for more than 50 years and there are many initiatives underway to advance this technology. As renewables increasingly come on line as a source for electricity, the viability of using this energy as a source for generating the hydrogen becomes increasingly attractive. Green hydrogen can be produced from “curtailed” electricity – that which is not needed on the grid and would otherwise be wasted – or through dedicated renewable installations.

BENEFITS OF A FUEL NEUTRAL DECARBONIZATION APPROACH

Stabilizing Cost – A diversified energy portfolio helps stabilize costs. Diversification provides a ‘hedge’ against price increases and volatility from competition for projected escalation in demand for renewable electricity supply and renewable energy credits (REC), as well as protection against unknown costs of electric utility system distribution and transmission upgrades.

Resiliency and Reliability – Energy resiliency and reliability are enhanced by leveraging the 99.9 percent reliability of the natural gas delivery system. Additionally, multiple energy sources and distribution networks incorporated within the Fuel Neutral Decarbonization approach provide an inherent redundancy of energy supply, reducing the District's risk exposure to disruptions in energy delivery from weather or other events.

Providing Energy Storage – Long-term energy storage is enabled for the District to support its peak energy needs which occur during the winter months. Washington Gas's existing system stores energy for months (up to years) at a time and demonstrates how natural gas provides high capacity, long duration and long discharge seasonal energy storage that can provide backup power when intermittent renewables such as solar and wind energy are not generating.

NATURAL GAS IS A FOUNDATIONAL FUEL THAT CAN HELP US ACHIEVE OUR CLIMATE GOALS

> Because natural gas is warm and quickly responsive, it is the preferred method of heating and cooking for 165,000 District residences and businesses. It is over **99 percent reliable** and **affordable,** costing **$879** less per year than a comparable home using electricity for heating, hot water, cooking and clothes drying.[1] According to the 2017 emissions inventory, natural gas use, primarily in the residential and non-residential buildings sectors, provided more energy but accounted for less emissions than other sources — accounting for about 17.7 percent of the District's 2017 GHG emissions while delivering 27.1 percent of the energy used. Comparatively, electricity provided 46.7 percent of the energy but accounted for 55.1 percent of the GHG emissions.

ACHIEVING OUR TARGETS BY 2050

The figure below illustrates the projected GHG emissions reductions associated with measures proposed in the Plan. The figure includes the forecast reductions by category relative to the 2006 baseline. It also recognizes natural gas emissions reductions already realized since 2006, as reflected by the District's most recent GHG emissions inventory[2].

CLIMATE BUSINESS PLAN (2020-2050)		2032	2050
TOTAL End-Use REDUCTIONS	• Energy Efficiency (including Behavioral Programs and Gas Heat Pumps) • CHP and Distributed Energy Systems • Dual Fuel Systems (Hybrid Heating) • Emerging Technology and Offsets	12%	36%
TOTAL Distribution REDUCTIONS	• Second phase of PROJECT*pipes* • Advanced leak detection and response • Third-party damage prevention	2%	4%
TOTAL Sourcing and Supply REDUCTIONS	• Certified Gas Production (of geologic gas) and Transmission • Renewable Natural Gas (RNG) • Power-to-Gas and Hydrogen	13%	31%
	SUB-TOTAL of Climate Business Plan REDUCTIONS	27%	71%
	Net EMISSIONS REDUCTION from natural gas achieved between 2006 - 2017	27%	27%
	Net CHANGES in business as usual emissions after 2017	-3%	2%
TOTAL REDUCTION in GHG Emissions against Business as Usual		**50%**	**100%**

Note: numbers do not sum due to rounding

1 http://playbook.aga.org/#p=8

2 https://doee.dc.gov/service/greenhouse-gas-inventories

AltaGas and Washington Gas share a long legacy of leadership and innovation, and of excelling when it comes to bringing new clean energy sources to customers. For example, AltaGas built the first fully-operational wind park in British Columbia (B.C.), the 102-megawatt (MW) Bear Mountain Wind Park, that is located near Dawson Creek, and the Northeast Hydro run-of-the-river hydroelectric generation facilities in British Columbia. Today it delivers enough electricity to power most of B.C.'s South Peace region. WGL is a leading, first-mover company in the installation of solar in the mid-Atlantic region. In DC alone, WGL Energy developed 68 distributed generation solar projects which produce 15,150 megawatt-hours annually, reducing local GHG emissions for years to come. In addition, AltaGas is working to reduce emissions globally by shipping propane that displaces emissions from higher emitting fuels, resulting in annual emissions avoided that are greater than the total emissions attributed to natural gas use in the District's entire 2017 GHG inventory.

Washington Gas has a demonstrated commitment to reducing GHG emissions and addressing climate change in its own operations. In 2011, four years prior to the Paris Agreement, the company set 2020 targets for GHG emissions reductions for its fleet and facilities as well as to reduce the carbon intensity of the gas it delivers. The Company exceeded those goals in 2016. Washington Gas then announced new, updated targets for 2025—carbon neutrality for Washington Gas fleet and facilities by 2025 and a 38 percent reduction in fugitive carbon intensity per delivered therm of natural gas. These targets put the Company on track to meet the "2 degrees Celsius" scenario that reflected the guidance from the Intergovernmental Panel on Climate Change (IPCC) in support of the 2015 Paris Agreement as being necessary to avoid the most damaging impacts of climate change.

A FLEXIBLE FRAMEWORK ACHIEVES GOALS OVER THE NEXT 30 YEARS

On the road to 2050, AltaGas and Washington Gas have pledged to work closely with the District's leadership, its community and influencers to drive sustained and positive change by significantly reducing GHG emissions, protecting the environment and improving how District residents, businesses, and visitors enjoy their everyday life experiences. The Plan will further distinguish the District as a leader in climate change among major cities across the nation.

With proper regulatory and legislative support, the companies are poised to partner with the District, so it is positioned to achieve its climate goals by:

- Implementing the "ready now" actions with specific targeted reductions — like those offered by the application of efficiency measures aimed at reducing energy use, as well as the decarbonization of Washington Gas' gas supply through the use of renewable energy sources.
- Engaging in forward looking, emerging technologies and pilots to support the development of highly promising new areas like green hydrogen (zero/negative carbon) and direct air carbon capture, as well as re-use technologies that enable the District to cost-effectively leverage the highly reliable, existing energy delivery infrastructure system that currently serves residents and businesses across the District.

> As we plan for the future we must take into consideration the important role that energy plays in our lives. Energy is a necessity. Energy provides the pathway to a more sustainable economy, helps eradicate poverty, combats climate change, generates advancements in health, education, food and water quality and is a critical building block for economic development, competitiveness and quality of life.[3]
>
> In creating the Plan, AltaGas recognizes that envisioning 30 years into the future represents the challenges of projecting the evolution of science and technology and the likelihood that there may well be revolutionary advances that could render today's thinking obsolete. It is in this spirit that the Plan is offered to provide a responsible and effective path forward. It will evolve over the coming decades to ensure a brighter, cleaner energy future that draws on an energy innovation vision, abundant resources and extensive carbon emissions reduction expertise.

3 Researchers including Amulya Reddy, Valclav Smil, and PM Dekker et al. have studied the relationship between per capita energy use and a variety of basic quality of life measures. They have found a correlation between energy use and life expectancy, literacy, education, GDP, and access to clean water. As well as declines in infant and maternal mortality rates.

Climate Business Plan

Introduction

AltaGas' principal subsidiary in the District, Washington Gas, has developed the Plan in fulfillment of AltaGas Merger Commitment DC 79 (the Commitment) and as a continuing demonstration of its long-standing efforts to address the serious issue of climate change. AltaGas committed to submit a "long-term business plan on how it can evolve its business model to support and serve the District's 2050 climate goals (e.g. providing innovative and new services and products instead of relying only on selling natural gas)."

The Commitment consists of two elements. This Plan represents fulfillment of the first element. The second element will involve regular updates and dialogue with stakeholders through bi-annual public meetings.

The Plan recognizes the scientific consensus that human activity — primarily GHG emissions from industrialization and the conversion of land for agriculture and development — is contributing to changes in the global climate including changing weather patterns, rising sea levels and more extreme weather events. The companies understand that climate change necessitates the evolution of how we provide essential energy solutions to our customers and presents us with the opportunity to develop new ways to serve the community while reducing the impact on the environment.

The Plan that AltaGas has developed provides a conceptual framework that, with proper regulatory and legislative support, evolves our business model in and for the District to meet the District's Climate Goals, achieving both a 50 percent GHG emissions reduction associated with natural gas use by 2032 and carbon neutrality by 2050 compared with baseline GHG emissions in 2006. In drafting the Plan, AltaGas recognizes that extrapolating 30 years into the future represents a significant challenge due to the number of unknown and unknowable variables, such as the exact timing for the development and adoption of new technologies.

As the future unfolds it is more than likely that revisions will need to be made, so that the District (and AltaGas) can adapt our efforts. Despite these caveats, based on what we know today, the Plan as outlined achieves the GHG emissions reduction targets and is the lowest cost pathway to the 2050 GHG emission reduction target. The Plan offers significant additional benefits including greater resilience, safeguards against service interruptions and preservation of customer choice.

To inform the Plan, AltaGas engaged ICF to develop and model a variety of scenarios to evaluate the effectiveness and implications of different approaches to meet the District's 2032 and 2050 GHG emission reduction targets. ICF has extensive experience evaluating natural gas and power markets, helping natural gas and electric utilities assess business opportunities and risks, and supporting corporate entities and governmental agencies with the development of energy and environmental policy initiatives.

The scenarios evaluated in the development of the Plan also incorporated findings from a separate study that assessed the potential for renewable natural gas (RNG)[4] to contribute to the achievement of the District's climate goals. The study evaluated environmental benefits, economic viability, and operating and regulatory challenges and solutions relating to the introduction of RNG in the DC metro region.

The outputs of the scenario models demonstrated that a **Fuel Neutral Decarbonization**[5] approach provides the most affordable and flexible framework for meeting the District's climate goals through expeditious measures that also meet the District's needs for safe and reliable energy.

A Fuel Neutral Decarbonization approach is also most compatible with the seven key factors identified in the DC PSC's Vision for modernizing the District's energy delivery system; namely that it be: (1) sustainable[6], (2) well-planned, (3) safe and reliable, (4) secure, (5) affordable, (6) interactive, and (7) non-discriminatory.[7] To ensure further alignment with the needs and desires of District stakeholders, the company is conducting ongoing stakeholder outreach, including meetings and surveys, to solicit their input and inclusion in the ongoing process.

The Plan, developed based on the Fuel Neutral Decarbonization scenario, contains recommendations to reduce GHG emissions from **(a) end-use; (b) transmission and distribution; and (c) sourcing and supply.**

4 RNG is a pipeline compatible gaseous fuel derived from biogenic or other renewable sources that has lower or negative lifecycle carbon dioxide equivalent emissions than geological natural gas.

5 Fuel Neutral Decarbonization is a non-prescriptive, multi-fuel approach that sets priorities based on GHG emissions reductions potential in the short, medium and long term.

6 The Notice of Inquiry (November 25, 2019) GD2019-04-M, In the Matter of the Implementation of the 2019 Clean Energy Omnibus Act Compliance requirements states; "Under the factor of "sustainable," the Commission made it clear that it will focus on: (1) Environmental Protection, including protecting the District's natural resources and assisting the District Government in reaching its Clean Energy DC goals by fostering the use of more efficient energy and renewable energy sources, distributed energy resource ("DER") technologies, and controllable demand alternatives to reduce GHG emissions and overall energy consumption; (2) Economic Growth; and (3) Social Equity, including positively impacting the daily lives of District residents and strengthening community involvement in reaching environmental protection and economic growth goals related to modernizing the District's energy delivery system."

7 https://dcpsc.org/CMSPages/GetFile.aspx?guid=068d9b90-cb2d-4844-ab23-b94842588d13

The figure below illustrates the projected GHG emissions reductions associated with measures proposed in the Plan. The figure includes the forecast reductions by category. It also recognizes natural gas emissions reductions already realized since 2006, as reflected by the District's most recent emissions inventory.[8]

Summary Estimated Climate Business Plan Emissions Reductions	2032	2050
1) End-Use	12%	36%
2) Distribution and Transmission	2%	4%
3) Sourcing and Supply	13%	31%
Total Climate Business Plan Emissions Reductions	**27%**	**71%**
+ Net emissions reduction from natural gas achieved 2006 - 2017	27%	27%
+ Net change in Business As Usual emissions after 2017	-3%	2%
= Total Reduction in GHG Emissions against Business as Usual	**50%**	**100%**

Numbers do not sum due to rounding

> The gas-related proposals set forth in this Plan – which depend upon supportive policy and regulations – will enable the District to exceed its 50 percent 2032 GHG emissions reduction target ahead of schedule – a critical achievement due to the urgency of climate action.[9]

Climate Business Plan: A Sensible, Cost Effective GHG Emissions Reduction Pathway

The successful track record established by Washington Gas to reduce GHG emissions in the District demonstrates that Washington Gas is a preferred energy partner that will continue to help the District lower its GHG emissions and meet its 2050 climate goals by bringing innovation to what we deliver, how we deliver and the business model that pays for our service.

> While the mandated 100 percent renewable portfolio standard (RPS) will help the District meet the 2032 50 percent emissions reduction target, implementing the Plan will lead to even greater reductions, sooner, which the recent Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming tells us is necessary to avoid the worst impacts of climate change. Furthermore, early approval and implementation of the Plan will enhance the opportunity to meet the 2050 carbon neutral target at the lowest cost.

The Plan identifies specific measures that, if and when fully implemented with supportive government policy and regulatory certainty, offer GHG emissions reductions to meet the District's climate goals.

Based on a **Fuel Neutral Decarbonization approach**, AltaGas and Washington Gas, with the assistance of ICF, evaluated the emissions reduction potential for a number of measures organized by:

1. **End Use** - *Providing practical energy efficiency solutions to our customers*
   The cleanest and lowest cost energy is that which is not used. Increasing energy efficiency is the first step to reduce energy use and the associated GHG emissions.

2. **Transmission and Distribution** – *Continue to reinforce and strengthen our infrastructure and advanced leak detection to reduce leaks and fugitive emissions*
   Fugitive methane emissions attributable to pipeline transmission and distribution account for the smallest source of emissions relating to natural gas.

8 https://doee.dc.gov/service/greenhouse-gas-inventories

9 The reductions associated with the implementation of the DC Omnibus Clean Energy Act mandates the use of 100% renewable electricity by 2032, achieving the District's interim goals. Washington Gas' proposals will accelerate the path to the achievement of carbon neutrality.

3. **Sourcing and Supply** - *Decarbonize the energy supply delivered*
   There are two ways to reduce emissions associated with natural gas supply. The first is through introducing low/no carbon non-fossil-based gases into the natural gas delivery system and the second is avoiding methane emissions from the upstream extraction of fossil natural gas.

The following table summarizes the Plan's proposed GHG emissions reduction measures and the expected GHG emissions reductions for 2032 and 2050.

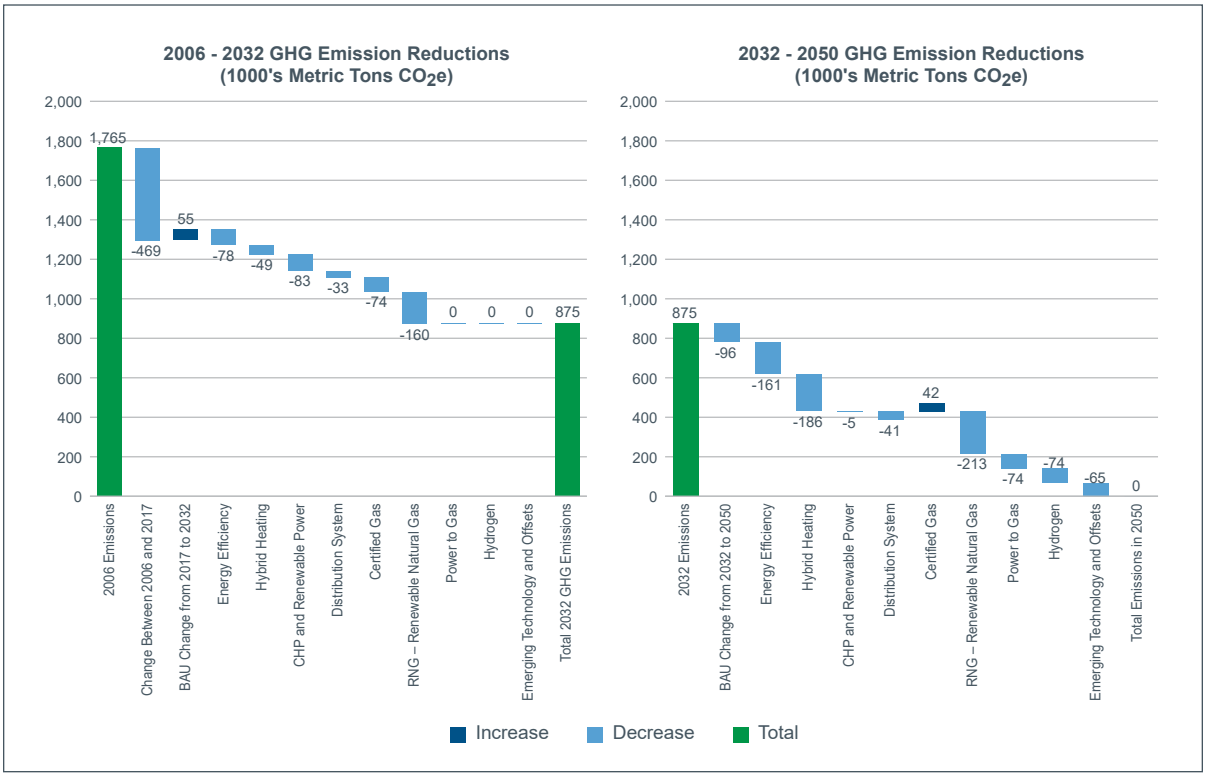
Detailed Estimated Climate Business Plan Emissions Reductions*	**2032**	**2050**
1) End-Use		
Energy Efficiency (including Behavioral Programs and Gas Heat Pumps)	4%	14%
CHP and Distributed Energy Systems	5%	5%
Dual Fuel Systems (Hybrid Heating)	3%	13%
Emerging Technology and Offsets	0%	4%
Total End-Use Reductions	**12%**	**36%**
2) Transmission and Distribution		
Distribution (Emissions reductions including second phase of PROJECT*pipes*)	2%	4%
Total Transmission and Distribution Reductions	**2%**	**4%**
3) Sourcing and Supply		
Certified Gas Production (of geological gas) and Transmission	4%	2%
Renewable Natural Gas (RNG)	9%	21%
Power-to-Gas and Green Hydrogen	0%	8%
Total Sourcing and Supply Reductions	**13%**	**31%**
Total Climate Business Plan Emissions Reductions	**27%**	**71%**
+ Net emissions reduction from natural gas achieved 2006 - 2017	27%	27%
+ Net change in Business as Usual emissions after 2017	-3%	2%
= Total Reduction in GHG Emissions against Business as Usual*	**50%**	**100%**

*Numbers do not sum due to rounding

Emissions Reduction Measures in 2032 and 2050

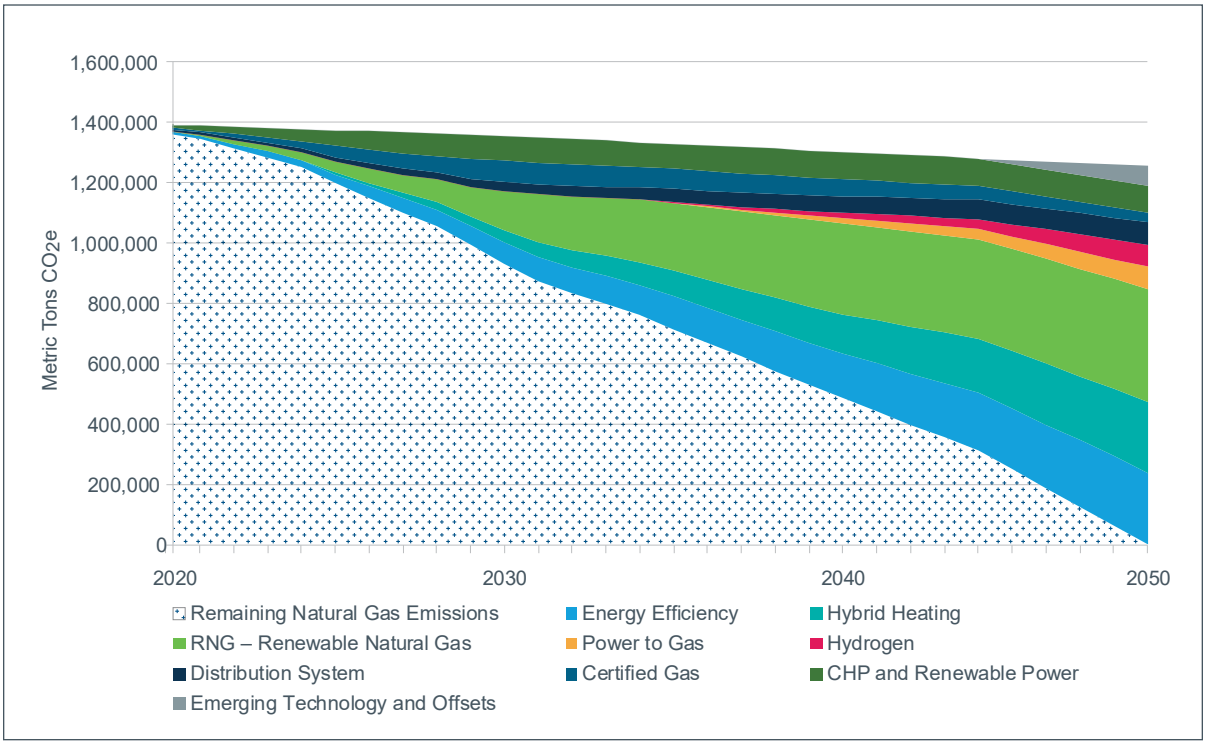
The figure below illustrates how the above proposed measures are expected to achieve emissions reductions at target dates 2032 and 2050, respectively. The GHG emissions reductions align with the District's overall targets, so that by 2032 GHG emissions associated with natural gas will be reduced 50 percent.

Natural Gas Emission Reduction Measures in the WGL Climate Business Plan at 2032 and 2050



Emissions Reductions Over Time

The figure below offers a visual representation of the relative emissions reduction contributions of the various measures over time.



Over the next 30 years, there are likely to be major new technology developments that will increase the ability and reduce the costs of eliminating GHG emissions. That is why investment in research and development and pilot programs are included in the Plan. As the District takes an aggressive approach to reducing GHG emissions, it is critical that the options for new technologies are not foreclosed but are rather supported, and that new technologies that help energy to remain affordable and reliable are encouraged as part of the low carbon future.

End Use: Energy Efficiency and Beyond

Enables us to achieve

12%

toward the 2032 50 percent GHG reduction target

Enables us to achieve

36%

toward the 2050 50 percent GHG reduction target

Promoting energy efficiency measures is one of the best (cleanest, least expensive) approaches to GHG emissions reductions. It avoids the need for new energy infrastructure, promotes conservation of our natural resources, lowers customer bills and creates jobs. Energy efficiency is 'by far' the largest source of jobs in the energy sector, including construction, production/manufacturing, installation, maintenance and repair.[10]

Today, programs that promote natural gas energy efficiency in the District are exclusively carried out by the DCSEU. DCSEU provides rebates to homeowners for the installation of energy-efficient equipment. Increasing the number and types of energy efficiency programs holds tremendous value.

To deliver this value to our customers, Washington Gas is participating in the Commission's Formal Case No. 1160 Working Group dedicated to establishing utility-led energy efficiency programs that are not duplicative of those now offered by the DCSEU.[11]

Washington Gas believes that more can be done through complementary programs that empower customers to make intelligent and informed decisions to reduce their energy use. The programs include ideas such as the introduction of additional initiatives to enhance the installation of energy efficiency equipment and building envelope measures, new behavioral programs, and new demand response programs that leverage smart thermostats and the Internet of Things (IOT) potential to automate and use data to maximize efficient uses of energy.

With supportive government policies and a constructive regulatory framework, the Plan anticipates the adoption of several promising and proven energy efficiency measures including, but not limited to, those detailed below.

ENERGY EFFICIENCY BEHAVIORAL PROGRAMS

Empowering People to Save Energy and Reduce GHG Emissions

The "home energy report program" is a behavioral program that assesses how the energy performance of a customer's home compares with peers residing in similar homes. This assessment has been proven to induce changes in customer behavior which could lead to energy savings of between 0.5 to 2 percent[12]. In preparing the Plan, we have conservatively estimated savings of 0.85 percent per customer participating in the program, which is consistent with the savings reported for the Washington Gas 2019 EmPOWER Maryland Report. Savings are achieved through the adoption of good conservation habits in setting point thermostat temperature, reducing hot water use, and promoting do-it-yourself low-cost conservation measures such as the installation of window wrapping or water aerators. Typical reports include energy conservation tips and recommendations, as well as cross promotions of other utility programs. The programs can be augmented over time by adding enhancements

10 https://www.ase.org/sites/ase.org/files/the_jobs_opportunity_of_energy_efficiency_-_alliance_to_save_energy_-_fact_sheet_final.pdf

11 In addition, as a condition of the merger between Washington Gas and AltaGas, AltaGas agreed to provide $4.2 million for energy efficiency and energy conservation initiatives with a primary focus on assisting low and limited-income residents who are living in affordable multifamily units. The cost cannot and will not be recovered in rates. On February 5, 2019, Washington Gas made compliance filing indicating the company has chosen VEIC https://www.veic.org/ as the administrator.

12 Mazur-Stommen, S., & Farley, K. (2013). Behavior Change Programs: Status and Impact. ACEEE Report Number B132. Retrieved from http://www.aceee.org/research-report/b132

like gamification features. The behavioral programs would be based on an opt-out approach in order to maximize participation. Reports can be delivered both on paper and by email. Program effectiveness would be measured based on a billing analysis. The best outcomes are achieved when programs provide customers with both gas and electric energy information. These programs educate customers about the value of energy efficiency and are an entry point for promoting more aggressive energy efficiency programs. The Plan uses a penetration rate for behavioral programs of 53 percent of residential meters by 2032 and 71 percent of meters by 2050.

ENERGY EFFICIENCY EQUIPMENT & BUILDING UPGRADES

High Efficiency Appliances and Equipment Guarantee GHG Emissions Reductions

The Plan includes Commission-approved utility programs that enable energy efficiency upgrades in 26 percent of buildings using natural gas by 2032, and 66 percent of the buildings using natural gas in the District by 2050.

These upgrades are expected to result in at least a 24 percent reduction in energy use for heating and hot water, primarily by replacing lower efficiency appliances/systems with higher efficiency appliances/systems and installing basic enhancements to building envelopes. The building envelope upgrades are limited to low cost measures that reduce energy consumption by 2 percent per building, and do not include deep building retrofits due to the cost of the more aggressive building envelope measures.

Several of the most promising new and emerging technologies in the Plan are described below.

ENERGY EFFICIENCY COMBINED HEAT AND POWER

CHP also called “cogeneration” is an energy efficient technology that generates electricity and captures the heat that would otherwise be wasted to provide useful thermal energy—such as steam or hot water—that can be used for space heating, cooling, domestic hot water and industrial processes. CHP can be located at an individual facility or building or be a district energy system or utility resource. CHP is typically located at facilities where there is a need for both electricity and thermal energy.

The CHP system’s thermal output displaces the fuel otherwise consumed in an on-site boiler, and the electric output displaces fuel generated by central station power plants. Moreover, the CHP system’s electric output also avoids the loss of electric energy that occurs during transmission and distribution. CHP installations offer enhanced reliability and resilience because both heat and power are generated on-site.

According to ICF’s analysis, CHP will continue to reduce the total GHG emissions associated with energy use in the District through at least 2050, providing important reductions needed to meet the District’s 2032 and 2050 GHG emissions targets. CHP is expected to reduce overall GHG emissions because it will continue to displace fossil fuel power generation in PJM, without changing the amount of renewable power generation attributed to the District. As long as fossil fuel generation in PJM provides the marginal source of electric generation, natural gas CHP systems will always result in fewer emissions than separate heat and grid power. While CHP installations in the District will lead to increased consumption of natural gas in the District, the reduction in GHG emissions from power generation in PJM will more than offset the emissions from the natural gas consumed in the CHP units.

Today there are natural gas-powered CHPs at the U.S. Capitol Power Plant, GSA’s Central Heating and Refrigeration Plant, the U.S. Department of the Interior, Boland Trane (multi-family building), Carrollsburg Condominiums, George Washington University, the British Embassy and the National Archives Buildings. Additional CHPs at the Walter E. Washington Convention Center and the Blue Plains Advanced Wastewater Treatment Plant are fueled by waste and biomass respectively.[13]

CHP installations can also be paired with rooftop solar photovoltaic and other technologies in a resilient microgrid configuration that offer deeper GHG emission reductions than a standalone CHP system. Use of RNG in CHP systems would lead to further reductions in GHG emissions and would achieve net negative emissions.

13 https://doe.icfwebservices.com/chpdb/state/DC

ICF projects a theoretical potential of more than 750 appropriate sites for CHP in the District, which could provide 912 MW of electrical generation. Based on their calculations, penetration of CHP units in the District could grow to 12 units per year by 2026 and remain stable through 2034. Starting in 2035, the rate of CHP installations is projected to start a gradual decline, due to the GHG emissions reduction potential and the declining availability of cost-effective site opportunities.

CASE STUDY | LESSONS FROM HURRICANE SANDY

When Hurricane Sandy hit in October 2012 eight million customers across 21 states lost power for days and even weeks. Ironically, many buildings outfitted with solar arrays stayed dark because they were permanently connected to the grid and had to be shut down.[14]

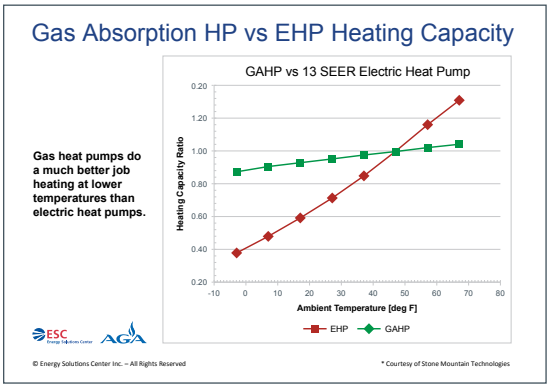
Co-op City with 60,000 residents, more than 14,000 apartment units, 35 high rise buildings, seven clusters of townhouses, eight parking garages, three shopping centers, a high school, two middle schools and three grade schools never lost power thanks to a 40-megawatt combined heat and power (CHP) plant that uses natural gas to provide both heat and power. Similarly, the 22 buildings connected to New York University's cogen plant continued to have power, heat and hot water leading the Environmental Defense Fund (EDF) to conclude:

"Sandy taught us lessons not only about what couldn't withstand the storm, but what did work and why."[15]

ENERGY EFFICIENCY

GAS HEAT PUMPS

Gas heat pumps are an emerging technology solution that, like electric heat pumps, collect heat from external sources – air, water, and geothermal sources – and transfer it for use inside the building. The efficiency measures for this technology (coefficient of performance or COP)[16] range from 1.4 to 1.5, whereas today's conventional high-efficiency natural gas furnaces have an effective COP of 0.90 to 0.98. This results in a 30-50 percent reduction in energy use when compared to today's already highly efficient natural gas furnaces. Like an electric heat pump, these devices will also provide hot weather cooling. Gas heat pumps offer certain benefits not provided by electric heat pumps. For example, gas heat pumps are more effective at delivering heat at lower temperatures and do not require an additional fuel source or technology during cold weather snaps. In addition, many of these devices are being developed to be self-powered and will not be dependent on an electrical source of energy, offering far greater resilience and reliability in the face of severe weather events and energy interruptions.



Gas Heat Pumps are making inroads in commercial and multi-family settings and are being readied for piloting and deployment in the residential sector. There are several key players already in the marketplace, including Stone Mountain Technologies, BoostHeat, Thermolift and Robur. Many of these companies are developing their technology in collaboration with commercial manufacturers and Department of Energy (DOE) national labs.

With supportive government policy and regulatory framework, ICF assumed the inclusion of gas heat pumps for both residential and commercial buildings within the equipment and building upgrade program. The Plan assumes a penetration rate of 2.3 percent of residential and commercial meters per year after the program ramp up in 2023.

Due to their high efficiency and promising commercialization pathway, the Plan projects gas heat pumps will first start to have an impact in 2026, and then grow steadily through 2050.

ICF assumed that between 2026 and 2040, 50 percent of the projected efficiency upgrades include conversion to a gas-fired heat pump with a COP of 1.4 for space heating. After 2040, all of the upgrades include gas-fired heat pumps with a COP of 1.4. The Plan anticipates that 38 percent of residential and commercial buildings will adopt gas heat pumps by 2050.

14 What New York's Sandy successes can teach us about resiliency https://www.greenbiz.com/blog/2013/01/14/New-York-Sandy-resiliency

15 https://www.edf.org/blog/2013/10/29/two-technologies-literally-shone-during-sandys-darkest-hours

16 COP - the ratio of Energy Output to the Energy Input

ENERGY EFFICIENCY

HYBRID HEATING

The Plan also includes greater use of hybrid heating systems designed to combine an electric heat pump with a natural gas furnace. The heat pump operates during most of the year and displaces about 60 percent of the annual natural gas demand for the consumer. However, the natural gas furnace operates during the coldest days reducing the need for additional and costly investments in the electric grid which would be required under the policy-driven electrification scenario. The Plan anticipates that 40 percent of residential and 20 percent of commercial buildings now exclusively heated with natural gas will become dual fuel hybrid heating systems by 2050.

Hybrid heating systems have a slower rate of adoption in the Plan due to their higher upfront costs. However, with the appropriate policy and regulatory support, we believe that they have a role in reducing GHG emissions associated with end use. On that basis, the Plan uses a conservative rate for high-efficiency equipment turnover and replacement in the analysis. Washington Gas recognizes that open and collaborative dialogue with multiple stakeholders is necessary to facilitate this element of the Plan.

Facilitating Transition to High-Efficiency Equipment

There are multiple pathways to encourage customers to adopt high-efficiency equipment ranging from traditional utility appliance incentives to more innovative financing arrangements such as Energy as a Service that can serve as accelerators, facilitating faster adoption of ultra-high-efficiency appliances and equipment by reducing customers' upfront costs. As an example, under the Energy as a Service model, energy service providers will own and maintain the equipment; and customers will pay fees to the energy service provider based on their energy savings pursuant to energy service agreements signed between the parties. Washington Gas will explore the feasibility of creating new partnerships to facilitate this.

A November 2019 survey of Housing Association of Nonprofit Developers (HAND) members revealed that cost of implementation was the highest concern and that 83 percent would like equipment rebates to cover upfront costs."[17]

Transmission and Distribution

Enables us to achieve

2%

toward the 2032 50 percent GHG reduction target

Enables us to achieve

4%

toward the 2050 50 percent GHG reduction target

Based on the 2017 District GHG emissions inventory, fugitive methane emissions from the distribution and delivery of natural gas represent less than a quarter of one percent of emissions in the District. Reducing transmission and distribution emissions offers multiple benefits: (a) enhanced safety and reliability; (b) reduced methane emissions associated with climate change, and (c) conservation of our natural resources.

DISTRIBUTION

MODERNIZING OUR INFRASTRUCTURE

In the United States, natural gas infrastructure includes 2.5 million miles of underground pipelines made of different materials, with GHG emissions factors assigned by the U.S. Environmental Protection Agency (EPA), based on material type (see below). Replacing pipes with those that have a lower GHG emission factor (e.g. removing cast iron or unprotected steel and replacing with plastic) reduces the release of these fugitive methane emissions while significantly enhancing safety and reliability.

17 Results from Washington Gas survey of HAND members, November 2019

Methane is emitted from a variety of sources, both natural and man-made. The EPA reports that 75 percent of US methane emissions came from agriculture, landfills, mining and other sources – with only 25 percent attributable to natural gas use. In 2017, 165.6 MMT CO_2e of methane associated with natural gas use were emitted into the atmosphere. Those emissions have decreased by 27.5 MMT CO_2e (14.2 percent) since 1990.[18] Since 1990, GHG emissions from cast iron pipelines have declined 58 percent and unprotected steel have declined by 50 percent as they have been replaced with modern plastic pipelines with lower emissions factors.

Emission Factor by Type of Pipeline Material

Pipeline Type/Material	Equipment Leak Emission Factor
Mains – Unprotected Steel	110 Mcf/mile/year
Mains – Protected Steel	3.07 Mcf/mile/year
Mains – Plastic	9.91 Mcf/mile/year
Mains – Cast Iron	239 Mcf/mile/year
Services – Unprotected Steel	1.70 Mcf/service/year
Services – Protected Steel	0.18 Mcf/service/year
Services – Plastic	0.01 Mcf/service/year
Services – Copper	0.25 Mcf/service/year

Washington Gas reports annual data to the EPA that identifies changes in the types of pipeline material used on our system. The report applies EPA emissions factors for each type of pipe material to calculate the GHG emissions associated with system changes and replacements. Washington Gas also publicly reports progress in emissions reductions on its website https://sustainability.wglholdings.com/results-reports/ and through industry sites.[19]

Accelerated pipeline replacement programs are designed and intended to ensure system integrity by replacing older pipelines with new and modern materials, promoting safety and system reliability. As an ancillary benefit, they also reduce GHG emissions associated with natural gas throughout our operating territory. Between 2008 and 2017, Washington Gas' pipeline replacement work in the District resulted in an eight percent GHG emissions reduction (see case study below). In the District reductions have come from two programs: FC 1027 and PROJECT*pipes*. The continuation of these efforts, as detailed in our PROJECT*pipes* 2 filing now pending before the DC PSC, is expected to further reduce the District's GHG emissions and enhance the safety and reliability of the gas distribution system. Modernizing our energy infrastructure today also prepares us for the future – enabling the system integrity needed to deliver tomorrow's low/no carbon fuels like RNG and green hydrogen.

CASE STUDY | INFRASTRUCTURE MODERNIZATION REDUCES EMISSIONS

Based on our annual GHG inventory and reporting, between 2008 and 2017 Washington Gas replacement programs have reduced absolute emissions from our distribution system in the District by 8 percent and a significant portion of that reduction came from reducing fugitive methane emissions from pipelines.

Washington Gas' accelerated pipeline replacement work in the District includes the remediation of 41 miles of main and 4,644 service lines.

- Through FC 1027 we replaced 27 miles of main and 1,605 services.
- Our progress on PROJECT*pipes* since June 2014 includes successfully replacing approximately 14.2 miles of pipe and 3,039 service lines.
- Through our proposed continuation of PROJECT*pipes*, currently before the DC PSC for consideration, we estimate an additional total cumulative reduction of 973,968 tons of CO_2e by 2050 by replacing/remediating 458 miles of main and 59,741 service lines.

18 EPA, 2019, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2017 https://www.epa.gov/sites/production/files/2019-04/documents/us-ghg-inventory-2019-main-text.pdf (ES-15)

19 See https://www.aga.org/policy/natural-gas-esgsustainability/

DISTRIBUTION

LEAK DETECTION AND ENHANCED RESPONSE

Other efforts that modernize the Washington Gas system include the use of new technologies to monitor and check for leaks. Whether deployed on trucks, drones, and airplanes, new and promising technologies for finding natural gas leaks swiftly and cheaply offer the possibility of quicker detection and faster response to methane leaks. While still in development, many of the technologies have demonstrated strong potential.

Inexpensive detectors combined with focused use of optical gas imaging systems could pay for themselves by reducing losses of natural gas.

Washington Gas' leak survey technicians and our contractors primarily use Heath Remote Methane Leak Detectors to find leak indications. These units use Tunable Diode Laser Absorption Spectroscopy (TDLAS) for the detection method and can sense indications as small as 5 PPM-M. Once a leak indication is found, a Bascom-Turner Rover is used to further assess the indication and grade the leak. Following this assessment, the leak repair is prioritized per company protocols.[20] Washington Gas' Leak Survey team is planning to begin refreshing its population of Remote Mobile Leak Detectors. Several units which use TDLAS, from multiple manufacturers, are being tested.

Washington Gas will work to include leak volume quantification analyses, utilizing where it can, and survey processes, including alternative advanced leak detection (ALD) technologies (on a pilot basis), as part of its approved list of pipe replacement project prioritization criteria. In addition, the Company will continue to refine, or contract for the use of advanced data analytics in analyzing and projecting leaks on its piping assets, with a focus on developing better predictability of future leak occurrences. The goal of this program is to utilize better analytics and machine learning to reduce/avoid leaks at a faster rate through pipe replacement.

With respect to its PROJECT*pipes* 2 and 3 program, the company intends to pursue the following measures subject to DC PSC approval and cost recovery:

1. For PROJECT*pipes* 2 service only projects, Washington Gas will determine a list of services scheduled for replacement in the upcoming PROJECT*pipes* 2 construction year, currently based on a service leaks per quad ranking. Once the list is developed and approved, Washington Gas will leak survey the services scheduled for that year to determine if any are currently leaking. All leaking services will be replaced as a priority over non-leaking services where feasible.
2. Main and service replacement projects will be prioritized utilizing Washington Gas's Distribution Integrity Management Program (DIMP) and risk modeling tool or through an Advanced Data Analytics program. Through the term of PROJECT*pipes* 2, when prioritizing Program 2 and 3 main replacement projects, Washington Gas will integrate ALD based methane quantity information, as appropriate and based on the limits and availability of the ALD technology, in addition to the consideration of additional factors such as construction efficiencies, logistics, coordination with other construction activities (AOP, DC PLUG, DC GRID, and other utility and road-based construction projects), and other risk factors
within Washington Gas's discretion, including the prioritization ranking methodology used by the Company in support of its DIMP.
3. The Company will endeavor to implement leak flow rate data from the ALD survey as a factor in prioritizing those pipeline replacement projects previously selected for the upcoming PIPES construction year, as determined in accordance with the PROJECT*pipes* 2 Program. Washington Gas' consideration of leak flow rate will be secondary to safety considerations.
4. For the PROJECT*pipes* 2 construction year, leak flow rate per mile will be used to sub-prioritize among project areas selected with comparable risk ranks. Project areas with higher leak flow rates per mile will be prioritized sooner than other project areas that have a comparable risk ranking but a lower leak flow rate subject to permit and crew constraints.
5. In advance of the agreed upon termination of the PROJECT*pipes* 2 Program, Washington Gas will provide to DC PSC staff and intervenors a written evaluation of the use of ALD survey technologies as a factor in selecting and prioritizing accelerated pipeline replacement. The written evaluation will include Washington Gas' assessment of the impact of ALD technologies on the nature and extent of GHG emissions reductions achieved within PROJECT*pipes* 2, including whether Washington Gas recommends the continued use of such technologies in proposed subsequent accelerated pipe replacement renewal programs.

20 Washington Gas' standing requirement is to repair Grade 1 leaks immediately. Our average time of repair of Grade 2 leaks is under three months, well faster than the industry safety standard (12-15 months with monitoring) for that level of leak. These practices continually seek to reduce the number and the duration of emitting leaks in the District.

In addition, Washington Gas will continue evaluating the efficacy of several promising systems that are available today including:

- Airborne - LiDAR system capable of rapid, simultaneous, and precise 3D topography and methane concentration measurements.
- Mobile - The Picarro system[21] combines multiple individual surveys, increasing leak location accuracy and false positive rejection. Inertial GPS ensures accurate location information in dense urban environments and provides record of walking path and survey results to ground survey crews. It prioritizes leak indications by potential risk and is able to reduce false positives by distinguishing between natural gas and biogas and vehicle exhaust.

CASE STUDY | DRAWDOWN COMPRESSORS

Washington Gas is piloting the use of Drawdown Compressor technology to recover gas in infrastructure during maintenance and replacement projects in order to avoid atmospheric venting. The first drawdown operation was performed in October 2017 and to date, Washington Gas has redirected approximately **754,000** SCF back into its system. We are evaluating the use of drawdown compressors on a variety of pressures and project types to fully understand the operation and capacity of the equipment.

Thus far, the use of drawdown compressors has been best suited for medium scale projects. We are in the process of developing our own compressor technology that would be suitable to address small-scale recovery projects. Washington Gas is currently developing the appropriate training modules, emission reduction tracking mechanisms, and equipment selection strategies to support deployment. Implementation of a full drawdown compressor program is planned for 2020.

DISTRIBUTION

THIRD PARTY DAMAGE PREVENTION

Washington Gas encourages and supports third-party damage prevention programs, including MISS UTILITY as well as contractor training programs for all contractors working in our area of operations, not just our own contractors, to prevent accidental damages and the concomitant release of methane when they are digging in proximity to pipelines.

MISS UTILITY is the free service that people can call prior to digging that notifies member utilities, including Washington Gas, to mark the approximate locations of underground utility lines with high-visibility safety paint and/or flags. Washington Gas promotes this on its website, phone hold messages, signage, service vehicles, and through advertising.

The company also hosts Damage Prevention Workshops that focus on how to improve safety and lower the number and duration of third-party damages as well as reducing the amount of natural gas released.

Sourcing and Supply

Enables us to achieve

13%

toward the 2032 50 percent GHG reduction target

Enables us to achieve

31%

toward the 2050 50 percent GHG reduction target

21 https://naturalgas.picarro.com/support/library/documents/picarro_solution_brief_whitepaper

There are two ways to reduce GHG emissions associated with natural gas supply:

1. Through the injection of non-fossil, renewable gases into the natural gas delivery system
2. By avoiding methane emissions from the upstream extraction of fossil natural gas.

For each of these options the factors to consider are:

- Location – with preference given to sources within or near Washington Gas' service territory
- Availability of supply to meet demand
- Proximity to existing natural gas delivery infrastructure
- Cost

Assuming supportive government policies and regulatory framework are in place to promote low-carbon gas supply, the Plan calls for the phased introduction of non-fossil-based gases that are expected to achieve the emissions reductions summarized below.

Low Carbon Fuel Source Volumes

YEAR	Total BCF	RNG BCF	% System RNG	P2G+ Green Hydrogen BCF	Total Low-Carbon Gas BCF	Percent of Low-Carbon Gas
2018	24.41	-	0%	-	-	0%
2025	24.22	0.48	2%	-	0.48	2%
2032	23.20	3.00	13%	-	3.00	13%
2050	**17.02**	**7.00**	**41%**	**2.80**	**9.80**	**58%**

HIGHLIGHTS:

Blending renewable fuels with fossil fuels or substituting them altogether is a proven path for creating low-carbon fuels.

The principal benefits to the District are:

- Limited additional investment in the electrical or natural gas distribution systems
- Does not require customers/end users to purchase new or different equipment
- The lowest-priced clean fuels for industry, transportation and the individual consumers
- New industries with permanent jobs

SOURCING AND SUPPLY

RENEWABLE NATURAL GAS

As defined by The American Gas Association; "Renewable natural gas (RNG) is derived from biomass or other renewable resources and is a pipeline-quality gas that is fully interchangeable with conventional natural gas." RNG is carbon neutral, extremely versatile and fully compatible with the U.S. pipeline infrastructure. It can be directly used in homes and businesses, in manufacturing and heavy industries and also for electricity production and as an alternative fuel for transportation. One of the most attractive features of RNG is that it can be introduced and provide emissions reductions without necessitating upgraded or new equipment by the end-user. Because of these benefits, RNG is a key element in the Plan.

AltaGas commissioned ICF to engage in a separate study of the potential for RNG to decarbonize Washington Gas' fuel supply in the District, including an assessment of supply availability and accessibility in fulfillment of Merger Commitment #6. The study found that ample supplies could be available for delivery by Washington Gas. Outputs of this study were integrated into the Plan's scenario modeling.

Assuming the enactment of supportive policy and regulatory framework, Washington Gas (and our third-party suppliers) can purchase RNG and other low carbon fuel specifically for delivery to District customers. The Plan calls for increasing volumes of RNG to be delivered through a combination of local, regional and national supply sourcing in staggered, stair-stepped amounts with varying contract durations.

For more information see Appendix D: Renewable Gas Study

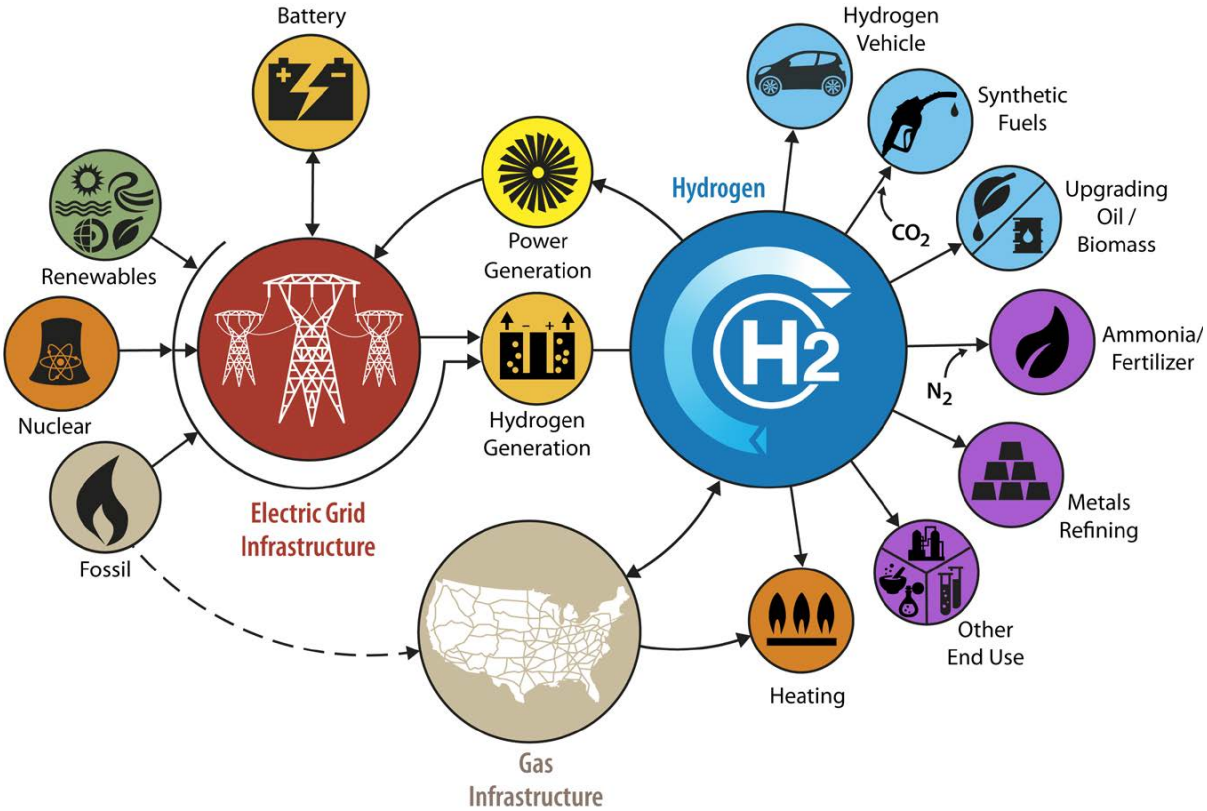
SOURCING AND SUPPLY

POWER-TO-GAS AND GREEN HYDROGEN

Power-to-Gas (P2G) is another renewable gas supply source. P2G is a promising and growing energy technology that converts electricity to a gaseous fuel effectively storing excess electricity in gas form rather than in conventional batteries. P2G has two distinct advantages over batteries for storing energy, including storing energy from excess renewable sources: i) unlike today's limited capacity batteries, nearly unlimited amounts of electricity can be easily stored for very long periods of time, and ii) fuel from P2G can be stored and used with existing infrastructure.[22] When the electricity is generated by renewable resources, such as wind and solar, then the resulting gas is considered carbon neutral.

The key process in P2G is the production of green hydrogen from renewably generated electricity by means of electrolysis which uses electricity to split water into hydrogen and oxygen.[23] This green hydrogen conversion method is not new, and there are three electrolysis technologies with different efficiencies and in different stages of development and implementation. This can be a particularly attractive option when the electricity is generated from wind, solar or hydro-electric plants when they are producing more power than is needed and must otherwise be curtailed. Alternatively, dedicated renewable electricity installations may be used to produce a firm supply of green hydrogen. This green hydrogen can be blended into the natural gas system directly, reducing the carbon intensity of the gas as well as providing a higher temperature at combustion which reduces the amount of gas needed to provide the same amount of heat.

Combining this green hydrogen with carbon dioxide (ideally carbon from captured emissions, for example from a brewery or other processing facility) produces methane that can be directly fed into the natural gas system. Fuel produced in this manner will be carbon neutral and may even be considered carbon negative.



Source: https://www.energy.gov/eere/fuelcells/h2scale

22 Lawrence Livermore Natural Labs https://www.llnl.gov/news/using-microbes-convert-co2-natural-gas

23 Hydrogen can be produced by the electrolysis of water (using an electric current to break water into its component elements of hydrogen and oxygen). When this electric current is produced by a renewable source (e.g. solar, wind or other renewable sources), the hydrogen is known as green hydrogen. https://www.geopura.com/blog/why-we-should-start-using-green-hydrogen-in-2019/

THE BENEFITS OF HYDROGEN

Hydrogen allows energy from renewables to be stored in a tank for use at a later date, time and place. That is very different from the usual output of a wind turbine or a solar array, which must be transmitted and used immediately. Its flexibility as either a fuel or a storage medium is similar to petroleum, with none of the fossil fuel deficiencies. Long duration, even seasonal storage, has been the holy grail sought by the renewables industry. Since hydrogen can be made from renewables and stored in a tank, it serves as:

- A carbon-free fuel that emits no GHG emissions
- An enabling technology to deal with the intermittency of renewables
- A long-duration storage solution[24]

The technology to produce clean hydrogen from water and electricity has been commercially available for more than 50 years. As renewables increasingly come on line as a source for electricity, the idea of using them as a source for generating the hydrogen becomes increasingly attractive. P2G technologies are showing tremendous promise as demonstrated by several facilities operating in Europe (e.g. Audi's 6-MW P2G facility in Germany), Japan and a SoCalGas® partnership with the National Fuel Cell Research Center (NFCRC) at the University of California at Irvine (UCI) that launched the first U.S. P2G project. A second project with UCI, a simulation of the campus microgrid, showed that P2G could increase their use of renewable power from 3.5 percent to 35 percent.

Currently electolyzers are expensive but are expected to come down in price, especially as states like New Jersey are investing heavily in integrating green hydrogen into their power mix. A key inflection point for P2G is anticipated beginning around 2020 "as costs reach parity in more areas" according to Navigant Consulting.[25] Reflecting this reality, the Plan assumes that with supportive government policies, Power-to-Gas pilot programs will begin in 2035, and then grow steadily through 2050.

It remains to be determined whether these technologies can produce low carbon/no carbon gas at a lower price than RNG. If they do not, it is expected there is sufficient RNG available to take the place of P2G and green hydrogen blending in the scenarios used to develop the Plan.

SOURCING AND SUPPLY

CERTIFIED NATURAL GAS

Efforts to reduce methane emissions during the sourcing of traditional natural gas are also underway. The most practical near-term option is to arrange physical procurement of certified natural gas via third parties. Several third-party companies apply certification criteria to specific wells and/or producing regions. The criteria are tiered depending upon how sustainable the practices are, with higher levels being modestly more expensive. Longer-term efforts are underway to identify and separate the environmental attributes associated with certain gas producers on a nation-wide basis. This effort would use "Big Data" and ultimately separate the attribute from the physical gas so that they could be acquired and/or traded on exchanges, like RECs or Renewable Identification Numbers (RINs).

Certified gas is very inexpensive. Based on our discussions with providers/deal makers, we estimate a per annum cost of $27,000 to $270,000 based on the procurement of 20 percent of sales gas volume for today's residential District customers. Since the procurement of natural gas represents the largest expenditure by the Washington Gas, exercising our buying power to drive emissions reduction in the natural gas value chain is an effective, sustainable strategy to help reduce GHG emissions. Washington Gas is currently in talks to collaborate with the Rocky Mountain Institute and others to more clearly quantify GHG emissions reductions from gas supply produced by best practice companies. With the necessary government policy and regulatory support, certified natural gas can be blended into existing gas supply and is expected to result in a 1 – 2 percent GHG emissions reduction.

24 https://www.forbes.com/sites/patsapinsley/2020/02/11/its-time-to-talk-hydrogen/#4552c8d0470b

25 The Future of Power-to-Gas Couldn't Be Brighter https://www.renewableenergyworld.com/2018/02/20/the-future-of-power-to-gas-couldn-t-be-brighter/#gref

How the Plan Was Developed

The Plan is designed to reduce GHG emissions throughout the natural gas value chain – from end use to distribution and sourcing. The Plan mirrors the District's climate goals by achieving a 50 percent reduction in GHG emissions associated with natural gas by 2032 and carbon neutrality by 2050 when compared with GHG emissions in base year 2006. In addition, some of the actions outlined in the Plan will help reduce emissions in other sectors (such as reducing emissions produced by transportation and electricity generation).

AltaGas selected ICF, a consulting firm recognized for its leadership in energy and climate change policy, research, and technical analysis, to assist with the development of the Plan.

The Plan was informed by, and based on, the desire to develop a framework that will accommodate changes to market and policy realities, such as in the District's climate goals, energy needs, and economic growth, as well as technologies and innovations that are anticipated to be refined and/or developed over the next 30 years. The Plan was developed to recognize and optimize the following considerations:

- Ensuring public safety, resilience and reliability by protecting against interruptions in energy delivery and use from weather-related and other disruptions;
- Evaluating the GHG emissions reduction potential of various approaches as well as associated cost per ton of carbon abated ($/$CO_2$e ton);
- Moderating the impact on customer cost, including up-front capital costs (i.e. for new equipment) and monthly energy costs, particularly for lower-income households;
- Preserving energy availability during both normal and peak demand conditions;
- Leveraging existing assets to their fullest potential;
- Sequencing actions based on technology and regulatory maturity;
- Pursuing a non-prescriptive approach that maximizes opportunities presented by innovations, technological advances and scientific understanding; and
- Implementing a regulatory framework and policy that facilitates and incents emission reduction measures.

Four different energy scenarios were modeled and evaluated to compare and contrast their ability to achieve the District's climate goals. All the scenarios considered reflect the District's requirement to have 100 percent of the District's electricity usage come from renewable generation by 2032.[26]

Scenario 1, **Business as Usual (BAU)**, is used as a reference case against which to compare all other scenarios. Based on the 100 percent renewable portfolio standard (RPS), GHG emission reductions in 2032 and 2050 are approximately 73 percent to 75 percent relative to 2006.

Scenario 2, **Partial Decarbonization**, uses BAU case as its foundation, with additional penetration of EVs, increased energy efficiency and modest decarbonization of gas supply including introduction of RNG and certified gas. It achieves additional GHG emissions reductions (82 percent) associated with those actions by 2050.

Scenario 3, **Policy-Driven Electrification**, uses the BAU case as its foundation, reaches net zero carbon emissions in the District in 2050 by requiring existing homes and businesses using natural gas to convert to electricity and banning natural gas for all new construction. It also reflects aggressive market penetration of electric vehicles and relies on a small volume of carbon offsets.

Scenario 4, **Fuel Neutral Decarbonization**, uses the BAU case as its foundation, reaches net zero carbon emissions in the District in 2050 by including significant actions to decarbonize the natural gas supply through the introduction of RNG, certified gas, and green hydrogen. As described in the preceding sections, it leverages expected improvements in technologies, aggressive energy efficiency programming for residential and commercial buildings, as well as hybridized dual fuel approaches. It also includes aggressive market penetration of electric vehicles and relies on a small volume of carbon offsets.

26 A more complete list of detailed assumptions (including discount rates) can be found in the ICF Technical Analysis Executive Summary which is appended to this Plan (Appendix E).

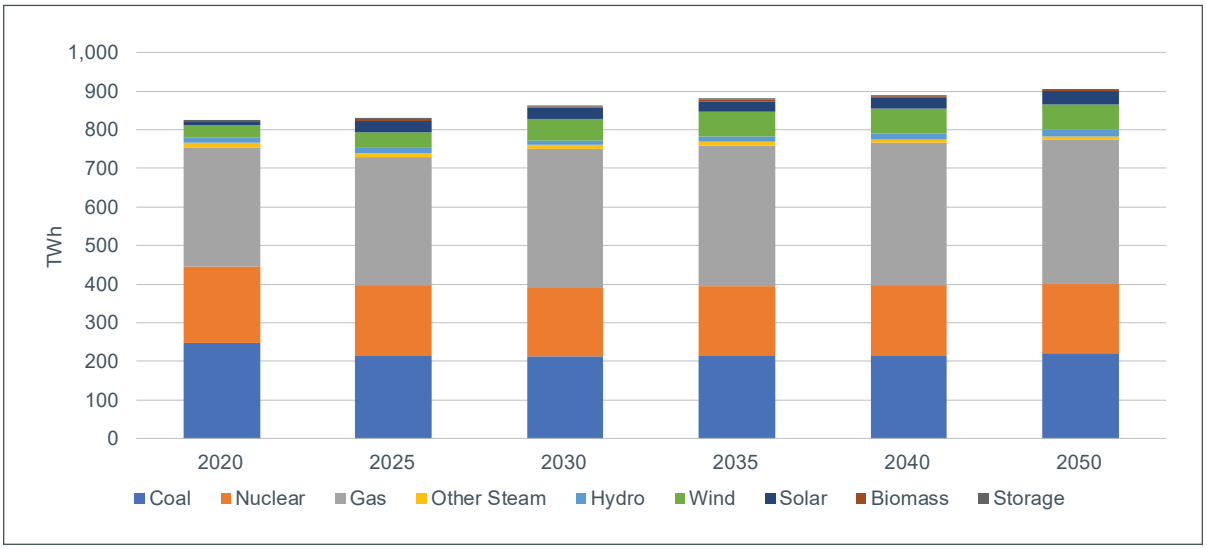
Overview of Energy in the District

The District of Columbia occupies ~68 square miles, is home to over 700,000 people, and more than 20,000 business and 300,000 housing units.[27] The District consumes 11.3 TWh of electric power and 101 BCf of natural gas and 2,400 MBarrels of petroleum products annually[28]. The District imports nearly all of its energy except for 1.3 percent of the electric generation from rooftop solar[29] and biomethane[30]. WGL Holdings, Inc. (WGL) helped seed some of this generation through initiatives that included the installation of 68 solar projects.

About 60 percent of the energy used in the District is consumed by the commercial sector, which includes the many federal buildings, museums, and universities that are a large part of the city's economic activity. The District of Columbia receives nearly all its electricity from power plants in other states through the distribution system of the local electric utility, which receives power via PJM interconnection that manages electricity transmission on the regional power grid for the District and all or part of 13 states.[31]

PJM is the federally regulated regional transmission system operator that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District.[32] While the District is but a small fraction of the total demand served by the greater PJM interconnection network (approximately 1.5%) the overall demand from other jurisdictions within PJM will have a significant impact on the cost of electricity for the District. As the figure below illustrates, though PJM is forecasting substantial growth in wind and solar generating mix (5 percent of 2020 generation and 11 percent of 2050 generation assuming business as usual), it remains a small portion of the overall electric generating capacity.

PJM Generation Mix 2020 - 2050



Source: PJM Projection

The District of Columbia receives its natural gas via Washington Gas' local distribution system, which, in turn, obtains the natural gas via interstate pipelines. The natural gas interstate transmission pipeline systems allow for the seamless movement of natural gas across the country, connecting sources of supply and storage to large industrial users and local distribution companies (LDCs) who, in turn, deliver energy to residential and commercial customers. The US DOT PHMSA Office of Pipeline Safety regulates the safety of construction, operation and maintenance of interstate transmission pipeline systems, while the Federal Energy Regulatory Commission (FERC) regulates the transmission and sale of natural gas for resale in interstate commerce. The District of Columbia Public Service Commission oversees Washington Gas rates and other local operational matters.

27 https://www.census.gov/quickfacts/DC

28 https://www.energy.gov/sites/prod/files/2016/09/f33/DC_Energy%20Sector%20Risk%20Profile.pdf

29 The District generates 0.071 TWh of electric power from small scale solar, 0.057 TWh from biomass and 0.023 TWh from natural gas, representing 1.3% of total electric consumed 11.358 TWh https://www.energy.gov/sites/prod/files/2016/09/f33/DC_Energy%20Sector%20Risk%20Profile.pdf

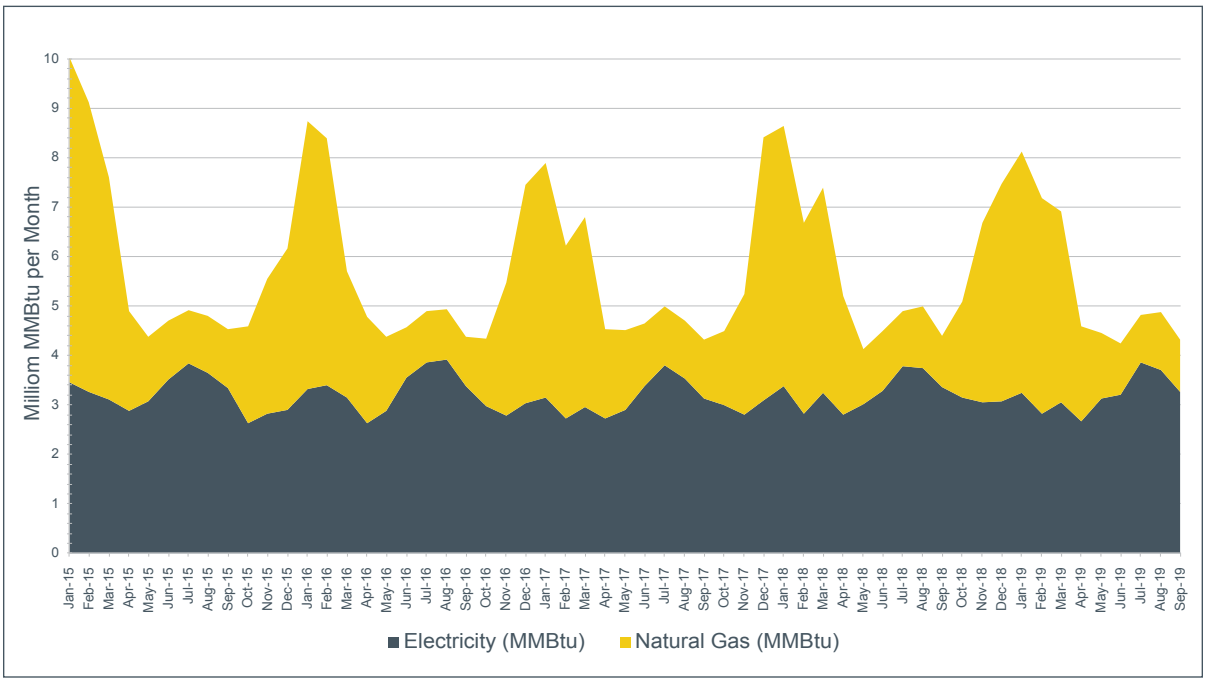
30 https://www.dcwater.com/sites/default/files/Blue_Plains_Plant_brochure.pdf

31 https://www.eia.gov/state/analysis.php?sid=DC

32 https://www.pjm.com/about-pjm/who-we-are.aspx

The District of Columbia's energy consumption is highly seasonal, with peak energy consumed occurring in the winter months.

Monthly Natural Gas and Electricity Energy Consumption in the District of Columbia



Source: US Energy Information Administration

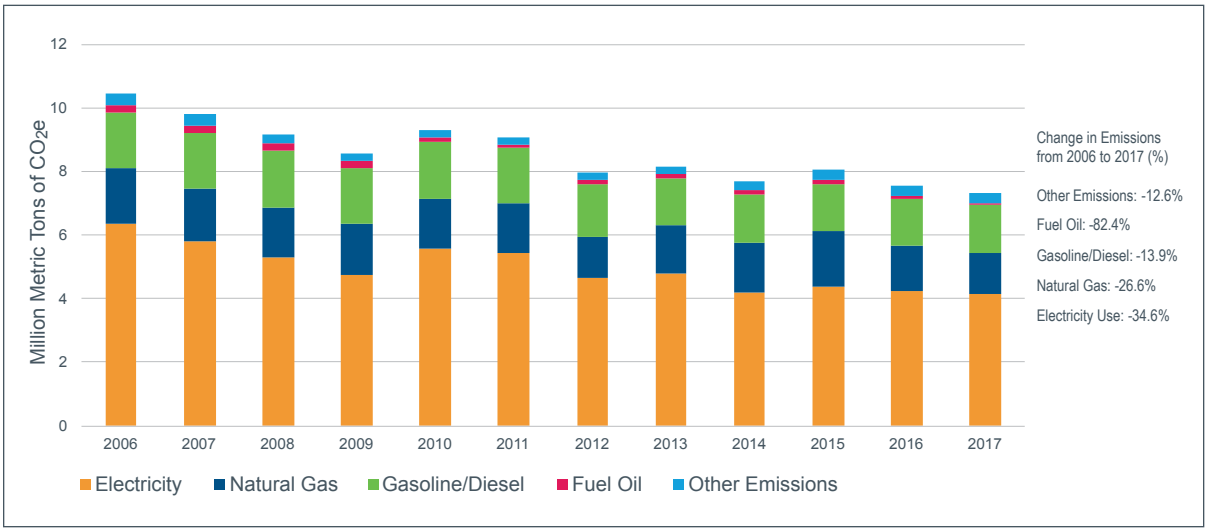
In 2017 the District was named the first Leadership in Energy and Environmental Design (LEED) Platinum City in the world; and boasts the most LEED Certified buildings and the most LEED space per resident, according to the US Green Building Council. With 30 percent of all points allocated to building energy efficiency[33], LEED has a strong emphasis on energy and the associated impacts, giving extra points for advanced energy metering and demand response. Many of these buildings depend on high-efficiency natural gas equipment for LEED eligibility. Natural gas systems that earn LEED certification Rating System Points include: high efficiency boilers, furnaces, and water heaters; high efficiency energy recovery systems; high efficiency food service equipment; and desiccant regeneration systems.

STRONG EMISSIONS REDUCTIONS SINCE 2006; MORE REMAINS TO BE DONE

The use of clean efficient natural gas has well positioned the District to meet its GHG emissions reduction targets. GHG emissions from the direct use of natural gas have declined 26.6 percent. In addition, the increased use of natural gas, replacing coal, for electricity generation has been a key driver of the 34.6 percent GHG emissions reduction since 2006. Similarly, AltaGas is leveraging its Canadian midstream and export capabilities to support the transition from high carbon fuels like coal and oil to lower carbon natural gas and natural gas liquids (NGLs) throughout Asia, which accounts for a third of global GHG emissions.

33 https://www.usgbc.org/articles/how-leed-saves-energy

Historical District of Columbia GHG Emissions by Fuel Type



From 2006 to 2017, the District reduced citywide emissions by 30 percent, achieving almost 60 percent of its 2032 goal.

The District's most recent – 2017 – GHG emissions inventory reported the following sectoral GHG emissions:

- The power sector accounted for the majority of emissions (55 percent of total emissions) attributed to the District of Columbia, including 42.5 percent in non-residential buildings, 8.9 percent in residential buildings, and 3.8 percent in other applications.
- According to the District's Clean Energy Plan[34] the rising use of natural gas for electric generation has been the key factor in the District's reduction in electricity carbon intensity, along with the growth of renewable electric generation. GHG emissions associated with electricity – primarily due to natural gas replacing coal generation - have declined by 34.6 percent since 2006.

As the figure below illustrates, today no other energy source matches the high energy/low GHG ratio (1.53) that natural gas provides.

Comparison of Fuel Source Energy Content and GHG Emissions

Energy Sources and Associated GHG Emissions	Energy Consumption (Billion kBtu's)	GHG Emissions ($MTCO_2e$)	Energy Consumption (Percent)	GHG Emissions (Percent)	Energy to Emissions Ratio
Natural Gas					
Residential	13.44	714,776	16.0%	9.8%	----
Non-Residential / Other	9.25	491,790	11.0%	6.7%	----
Natural Gas Distribution	----	**89,447**	**0.0%**	**1.2%**	----
Total Natural Gas	**22.69**	**1,296,013**	**27.1%**	**17.7%**	**1.53**
Electricity					
Residential	6.40	648,697	7.6%	8.9%	----
Non-Residential / Other	32.73	3,388,270	39.1%	46.2%	----
Total Electricity[35]	**39.13**	**4,036,967**	**46.7%**	**55.1%**	**0.85**
Fuel Oil and Kerosene	**0.57**	**470,159**	**0.7%**	**6.4%**	**0.11**
Gasoline and Diesel Transportation	**21.35**	**1,525,832**	**25.5%**	**20.8%**	**1.22**
Total	**83.75**	**7,328,971**	**100.0%**	**100.0%**	

34 Clean Energy DC – August 2018, p. 24

35 Electricity grid losses and emissions are based on eGRID data

Natural Gas: More Energy/Fewer Emissions

Natural gas provides critical energy to key sectors that drive the District economy including the federal government, technology, construction, international business, and hospitality. For more than 170 years, energy provided by Washington Gas has been an integral part of the District's energy portfolio. Today natural gas provides low carbon energy to fuel highly efficient thermal applications including heating and hot water for residential and commercial buildings, as well as cooking for families and restaurants, etc. Washington Gas also fuels 461 District buses[36] with compressed natural gas, producing virtually no particulates and approximately 25 percent fewer GHG emissions than conventional diesel buses.

In 2017
Natural Gas provided

27%

of the energy used

While emitting

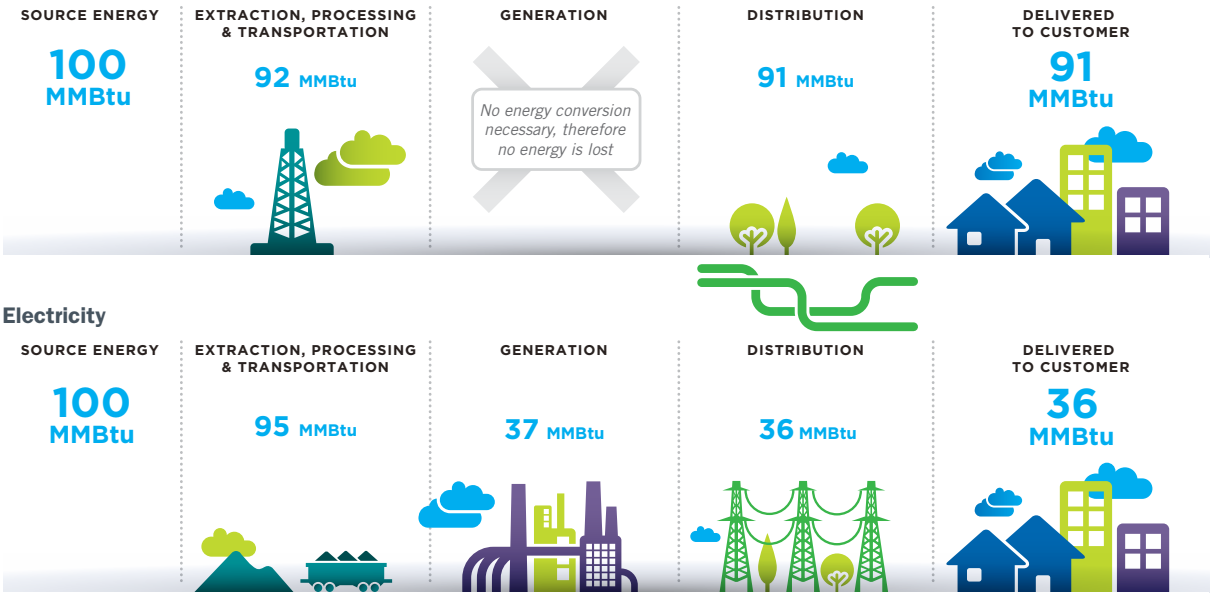
18%

of the District's emissions

According to the 2017 emissions inventory natural gas use, primarily in the residential and non-residential buildings sectors, accounted for about 17.7 percent of the District's 2017 GHG emissions, with 9.8 percent attributable to the residential sector, 4.9 percent to non-residential buildings, 1.8 percent from WMATA and other applications, and 1.2 percent from natural gas distribution system emissions.[37]

Because natural gas is warm and quickly responsive, it is the preferred method of heating and cooking for 165,000 district residences and businesses. It is over **99 percent reliable** and **affordable,** costing $879 less than a comparable home using electricity for heating, hot water, cooking and clothes drying.[38] It is also **highly efficient**, with 91 percent of the energy value delivered, compared to only 36 percent for electricity, as the following diagram illustrates.[39]

Natural Gas – Delivering 2.5 Times More Energy Than Electricity



Natural gas delivers more than 90 percent of the energy from the source to the customer's doorstep. Conversely, 64 percent of the energy used to generate electricity is 'lost' and therefore wasted.

36 https://www.washingtongas.com/media-center/green-commute
37 https://doee.dc.gov/service/greenhouse-gas-inventories
38 http://playbook.aga.org/#p=8
39 http://playbook.aga.org/#p=50

NATURAL GAS: THE DISTRICT'S MOST CRITICAL PEAK DAY ENERGY RESOURCE

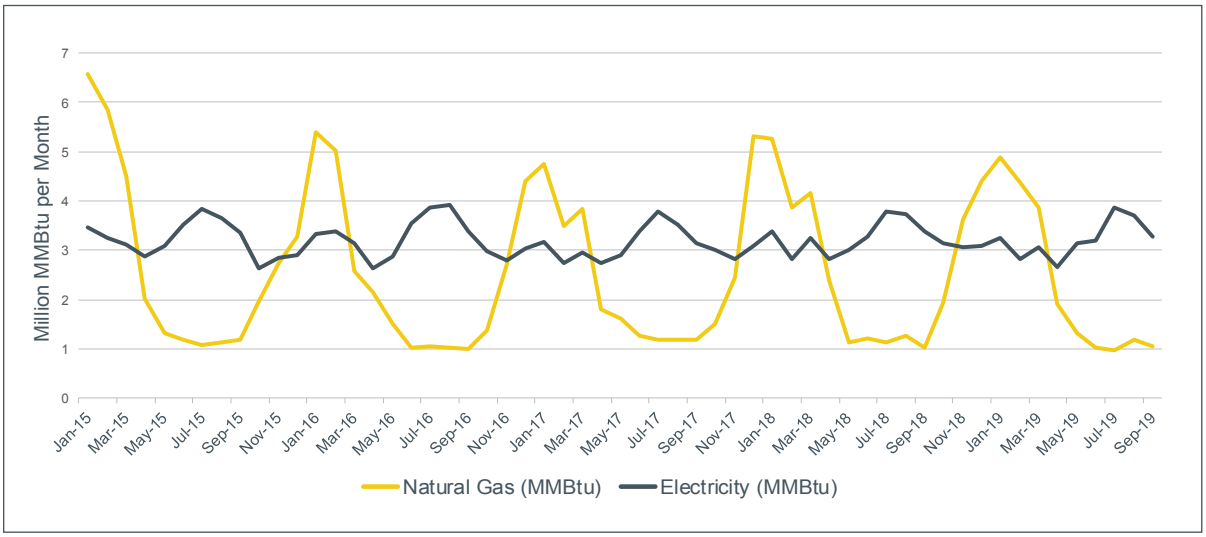
By design, the natural gas distribution system in the District is capable of delivering 61 percent more energy on a peak winter day than the electric grid is designed to deliver during a peak summer day. The natural gas distribution system is designed to deliver twice as much energy during a peak winter hour than the electric grid is capable of delivering during a peak summer hour.

Actual physical deliveries of natural gas mirror design day plans.

> Over the last five years, during high demand winter peak periods, the natural gas system delivered **60 percent more energy** to District customers than the electric grid delivered during its highest demand (summer) periods.[40]

The natural gas system also possesses unique and dynamic load following capabilities. During a typical January, the natural gas system delivers more than five times the energy as it does during the summer months, as illustrated in the following figure:

Comparative Monthly Natural Gas and Electricity Energy Consumption in the District of Columbia



AltaGas: Proven Partner in GHG Reduction

AltaGas' subsidiary, Washington Gas, has a long-demonstrated commitment to reducing GHG emissions and addressing climate change in its operations.

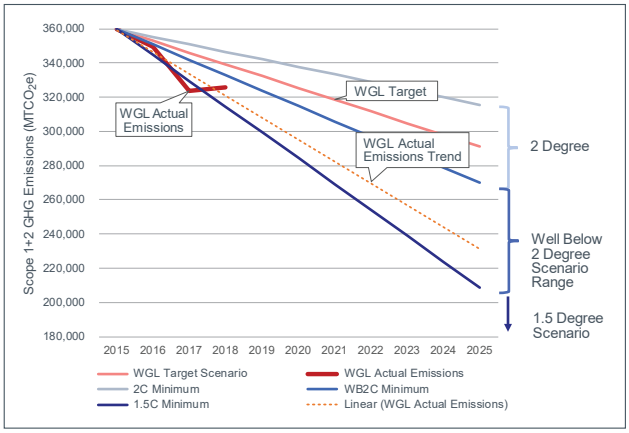
1. In 2011, four years prior to the Paris Agreement, the company set aggressive 2020 targets for GHG emissions reductions for its fleet and facilities as well as to reduce the carbon intensity associated with gas delivery. In 2016 Washington Gas announced it had exceeded those goals four years ahead of schedule.[41]
2. Less than a year later, it announced new, updated targets for 2025. The new targets; carbon neutrality for Washington Gas' fleet and facilities by 2025 and a 38 percent reduction in fugitive carbon intensity per delivered therm of natural gas, put the Company on track to meet the "2 degrees Celsius" scenario that reflected the guidance from the Intergovernmental Panel on Climate Change (IPCC) for the 2015 Paris Conference as being necessary to avoid the most damaging impacts of climate change.

40 January 2015 for natural gas; August 2016 for summer cooling

41 https://www.washingtongas.com/newsroom/2016/washington-gas-exceeds-carbon-reduction-goals-four

3. An analysis conducted by consulting firm WSP shows the actual Scope 1 and Scope 2 GHG emissions reductions from 2015 through 2018 on a trend line comfortably in the "well below 2 degrees" GHG emissions reductions range of 2.5 percent to 4.2 percent per year – as defined by the Science Based Target Initiative.[42]

WGL Scope 1+2 GHG Emission Reduction Analysis



4. Washington Gas has implemented energy efficiency measures that, as of 2018, have reduced its emissions more than 78 percent from its own fleet and facilities. Washington Gas has also achieved a 24 percent reduction in emissions intensity per therm of gas delivered and is on track to meet both of our targets.
5. An even more impactful contribution in the District has been the direct use of natural gas for thermal purposes. A home using natural gas for heating, cooking, hot water and clothes drying produces about half of GHG emissions than a comparable home using electricity for those same applications. It also saves the household $879 per year.[43]

> **CASE STUDY | 78 PERCENT EMISSIONS REDUCTION**
>
> Washington Gas has reduced emissions from its facilities and fleet by more than 78 percent since 2008. This demonstrates not only our commitment, it also serves as a local pilot and proof of concept.

With constructive stakeholder collaboration, supportive policy and regulatory certainty, Washington Gas can implement the measures proposed in the Plan and can continue to be an effective partner in achieving the District's climate goals.

The Plan once again puts AltaGas at the forefront; having taken a deep dive into the possibilities, emerging and nascent technologies and outlining the company's desire to support those innovations and to pilot/proof of concept as well as working to bring promising low-carbon opportunities to the District over the course of the next 30 years.

Policy Considerations

The Plan sets forth GHG emissions reduction measures based on their ability to meet the desired GHG emissions reductions while preserving the energy affordability and reliability Washington Gas' customers need. To implement the Plan measures in support of the DC Climate Goals, collaborative and good faith dialogue among Washington Gas, the DC PSC, policymakers and various other stakeholders will be required.

Constructive stakeholder collaboration, supportive policy and regulatory certainty facilitate investments in GHG reduction and support implementation of the measures proposed in the Plan such that Washington Gas can continue to be an effective partner in achieving the District's climate goals while maintaining its financial integrity and its ability to continue to attract capital to safely and reliably serve its customers in the District.

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42 The analysis completed by WSP used the methodology prescribed by the SBTi for setting science-based targets. The Sectoral Decarbonization Approach is currently unavailable for our business sector, so WSP utilized the Absolute Contraction method using SBTi's reduction percentages required to meet the different scenarios under this methodology. WSP confirmed the reduction range required for the "Well-below 2 degree" scenario was an average reduction of 2.5 percent to 4.2 percent per year. The annual average of the total reductions in Washington Gas' emissions over the 3-year period from the end of 2015 through the end of 2018 falls in this range.

43 American Gas Association Playbook 2019 p. 8 http://playbook.aga.org/?utm_source=google&utm_medium=banner&utm_campaign=2019_AGAPlaybook&utm_term=playbook#p=8

The following section outlines policy considerations and regulatory mechanisms that are necessary to enable the implementation of GHG emissions reduction measures identified in the Plan. Washington Gas will seek consideration for the following over-arching regulatory mechanisms.

1. Decoupling rates from volumetric throughput. This will enable Washington Gas to support energy efficiency while recovering operating costs to preserve safety and reliability. Due to the aggressive efficiency measures proposed and resulting decrease in energy deliveries, such decoupling is a necessity.
2. Developing a cost recovery mechanism that would socialize the costs and benefits of gas use to all energy users. It would recoup the avoided cost of overbuilding peak electricity and associated storage from electric utilities, which is made possible by gas service. Recovery would help equitably distribute fixed costs of the natural gas system and maintain reasonable rates for gas (and electric) customers.

POLICY – END-USE

Policies to facilitate measures specifically related to energy efficiency promotion and programs as well as accelerating the deployment of high-efficiency equipment and appliances include:

1. Expanding energy efficiency programs to include best-in-class programs. These programs are described in the end use discussion. A detailed description of programs in the District, Maryland and Virginia is included as Appendix A;
2. Ensuring cost recovery and enabling utilities to earn a return on investment (ROI) for investments in next-generation end-use technology;
3. Allowing for cost recovery associated with the promotion of ready-now lower GHG emissions appliances, contractors' education, demonstration pilots, and similar items;
4. Providing deeper energy efficiency incentives for emerging technologies with very high GHG emissions reduction potential; this could include multi-fuel source, integrated whole house performance programs;
5. Initiatives to encourage the District's energy providers, including local distribution companies and others, to form working groups and create the opportunity for parties to seek a better and unbiased understanding of emerging hybrid heating technologies and an equitable pathway for implementation;
6. Utilizing accelerated recovery mechanisms to support infrastructure investment in service areas of high CHP/demand potential;
7. Promoting innovative programs such as Energy as a Service, and enabling on-bill financing mechanisms, including third party financing, to encourage adoption of technologies and equipment for energy conservation; and
8. Applying tiered performance incentives (e.g. ROI adders) to support the implementation of behavioral energy efficiency programs.

POLICY – TRANSMISSION AND DISTRIBUTION

In addition to programs currently in place, there are other policies that policymakers and the DC PSC can pursue to facilitate GHG emissions reduction during the transmission and delivery of natural gas, including:

1. Approval for PROJECT*pipes* 2 (currently under consideration);
2. Cost recovery for investments in new detection equipment and personnel and/or pilot project participation;
3. Approvals necessary to deploy advanced leak detection technologies; and
4. Built-in incentives for performance that reward timely deployment and results.

POLICY – SOURCING AND SUPPLY

The development of RNG production sources for national, regional and local supply scenarios in the greater Washington, D.C. metropolitan region are all contingent upon Washington Gas being able to gain approval of some kind of legislative and/or regulatory structure that will include a timely cost recovery mechanism for Washington Gas.

This policy structure should address the following key areas of cost recovery:

1. Allow for long-term supply contracts for acquisition of low-GHG emissions gases including certified natural gas, RNG, P2G, Green Hydrogen, with an agreed upon volumes, durations and pricing;
2. Allocate incremental cost of low carbon gas supply to all customers in the District;
3. Rate base and approve return for investments in interconnection facilities and equipment to facilitate access to low carbon gas supplies needed to meet gas quality specifications and standards (odorization, metering, gas chronometers, emergency shut off valves, etc.);
4. Rate base of investment in larger facilities such as pipelines and low carbon gas production, supply facilities and recovery of pipeline capacity costs that would support and facilitate the development and access to RNG and other low carbon supply;
5. Enable investments associated with the development and deployment of next-generation technologies, including pilot programs and funding research [e.g. via Gas Technology Institute (GTI) or other associations] and other initiatives;
6. Developing regulatory framework and policy to enable third party retailers to provide additional quantities of low/no carbon gas supply to customers, including;
    a. Allowing incremental volumes of low carbon gas supply as a percentage of third-party marketer supply in set tranches over time from now until the year 2050; and
    b. Require third-party retailers to report to Washington Gas annual sales volume and environmental attributes of all low carbon gas sold and delivered to Washington Gas customers.

The significant reductions in GHG emissions available through the utilization of low carbon fuel supply are predicated upon the timely approval of supportive policy. Because the regulatory process in the District lacks a suspension statute, achieving regulatory certainty is a significant consideration. In some instances, it may be desirable for authorization related to cost recovery to be legislatively enacted. Because of the investment levels and project timelines required to support RNG and green hydrogen sourcing development, clarity regarding regulatory policy is critical.

CONCLUSIONS:

1. The Climate Business Plan, guided by a Fuel Neutral scenario, provides a pathway to meet the District's Climate Goals for $2.7 billion less than alternatives being proposed.
2. The Plan demonstrates that natural gas CAN be decarbonized; and natural gas infrastructure is tremendously valuable resource that can be leveraged to deliver and store – low/no/negative carbon fuel.
3. Washington Gas has earned an established reputation as a trusted partner, responsibly managing a set of valuable community assets; with history of proactive leadership in achieving GHG emissions reductions.
4. With the necessary policy changes and supportive regulatory framework to facilitate GHG emissions reductions, Washington Gas can enable cost-effective and deep GHG emissions reductions that support the achievement of the District's climate goals while preserving access to affordable, resilient and reliable energy.

Glossary of Terms

Biogas – is a type of biofuel that is naturally produced from the decomposition of organic waste. When organic matter, such as food scraps and animal waste, break down in an anaerobic environment (an environment without any oxygen) they release a blend of gases, primarily methane and carbon dioxide. Biogas from wetlands, for example, is a source of GHG emissions. Capturing these emissions at their source and using them to displace/replace fossil natural gas is often considered 'carbon neutral' or even 'carbon negative' because the emissions associated with its combustion are far lower than what naturally occurs.

British Thermal Units (Btus) - a measurement of the amount of heat required to raise the temperature of one pound of water by one-degree Fahrenheit.

Carbon dioxide equivalent (CO_2e) – standard unit for measuring carbon footprints. The idea is to express the impact of each different greenhouse gas in terms of the amount of CO_2 that would create the same amount of warming, allowing for direct comparison between the warming potential of different emissions.

Carbon Neutral – also called carbon neutrality – is a term used to describe the action of organizations, businesses and individuals taking action to remove as much carbon dioxide from the atmosphere as each put in to it. The overall goal of carbon neutrality is to achieve a zero-carbon footprint.

Carbon Intensity (CI) - the amount of carbon by weight emitted per unit of energy consumed. A common measure of carbon intensity is weight of carbon per British thermal unit (Btu) of energy.

Combined Heat & Power (CHP) – also called "cogeneration" CHP describes the concurrent production of electricity or mechanical power and useful thermal energy (heating and/or cooling) from a single source of energy.

Distributed Generation – when power is generated at or near the point of consumption/use.

Electrolyzer – device that use an electric current to provide the energy that splits a water molecule (H_2O) into hydrogen (H_2) and oxygen (O_2).

Fossil Gas – natural gas formed from buried combustible geologic deposits of organic materials from decayed plants and animals that have been exposed to heat and pressure in the earth's crust over hundreds of millions of years.

Greenhouse Gas (GHG) – A greenhouse gas is a gas that absorbs and emits radiant energy within the thermal infrared range. Greenhouse gases cause the greenhouse effect. The primary greenhouse gases in Earth's atmosphere are water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3).

Paris Agreement – the 2015 multi-national agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. Its central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.

Power to Gas (P2G) – Technology that utilizes electrical power to split water into hydrogen and oxygen by means of electrolysis. Can be injected into the natural gas system as hydrogen or combined with carbon dioxide and be converted into methane for injection or use as transportation fuel. Particularly attractive option when green hydrogen is generated by electricity generated from wind, solar or hydro power.

Renewable Natural Gas (RNG) – Renewable Natural Gas – Pipeline compatible gaseous fuel derived from biogenic or other renewable sources that has lower lifecycle carbon dioxide equivalent (CO_2e) emissions than geological natural gas.

Scope 1 emissions – direct emissions released from on-site fossil fuel combustion and fleet fuel consumption.

Scope 2 emissions - indirect emissions from sources that are owned or controlled by the organization. Includes emissions that result from the generation of electricity, heat or steam purchased by the company from a utility provider.

Scope 3 emissions – indirect emissions from sources not owned or directly controlled by but related to the company activities such as employee travel and commuting. Scope 3 also includes emissions associated with customers. Some Scope 3 emissions can also result from transportation and distribution (T&D) losses associated with purchased electricity.

Therms – a measurement of the amount of heat energy in natural gas, equal to 100,000 BTUs.

List of Acronyms

Acronym	Description
EIA	Energy Information Administration
BAU	Business as Usual
CHP	Combined Heat and Power
CO_2	Carbon Dioxide (CO2e) – Carbon dioxide equivalent
COP	Coefficient of Performance
DCSEU	DC Sustainable Energy Utility
DOE	Department of Energy
DOEE	District of Columbia Department of Energy & Environment
EaaS	Energy-as-a-Service
EPA	Environmental Protection Agency
EV	Electric Vehicles
GHG	Greenhouse Gas
ICF	ICF Resources, LLC
NHTSA	National Highway Traffic Safety Administration
P2G	Power-to-Gas
RECs	Renewable Energy Credits
RNG	Renewable Natural Gas
RPS	Renewable Portfolio Standard
WGL	WGL Holdings, Inc.
WMATA	Washington Metropolitan Area Transit Authority

Appendices

Appendix A: Energy Efficiency Programs Gap Analysis

WGL offers several programs that cross the jurisdictional boundaries. These include:

1. **Master Meter Conversion program:**[44] This program offers the ability to convert large residential buildings from a single meter to individual customer meters. This is a measure that can facilitate greater "ownership" of energy efficiency measures.
2. **8A Housing Program:**[45] WGL provides technical expertise to work with low-income buildings to provide energy efficiency natural gas options, including design in pre-construction as well as retrofits of existing businesses.

DISTRICT OF COLUMBIA PROGRAMS

The DCSEU, which is funded by Washington Gas and Pepco ratepayers, runs energy efficiency programs in Washington, DC. The DCSEU provides energy conservation tips and conducts home energy audits. For its residential customers, DCSEU offers rebates for a wide variety of appliances, including smart thermostats, water heaters, heating appliances, and air conditioners. In 2018, the DCSEU participated in a residential heat pump study and worked with participating customers to optimize energy efficiency via smart thermostats with its Seasonal Savings program. For its commercial and industrial customers, the DCSEU offers rebates for efficient lighting, heating equipment, water coolers, and other appliances.

Table 1. DC WGL Rebates[46] [47]

Appliance Type	Eligible Equipment	Efficiency Requirement	Rebate
Space Heating	Furnace	ENERGY STAR certified and minimum 94% AFUE	$500
Space Heating	Boiler Tier 1	ENERGY STAR certified and minimum 90% AFUE	$500
Space Heating	Boiler Tier 2	ENERGY STAR certified and minimum 95% AFUE	$750
Space Heating	Boiler Reset Controls	N/A	$250
Water Heating	Storage Water Heater	ENERGY STAR certified and minimum UEF 0.64	$100
Water Heating	Light Duty Storage Water Heater	ENERGY STAR certified and minimum UEF 0.80	$500
Water Heating	Tankless Water Heater	ENERGY STAR certified and minimum UEF 0.92	$300
Appliance	Gas Clothes Dryer	ENERGY STAR Certified	$50
HVAC	Condensing Boiler	75-225 kBtu/hr. and minimum 90% AFUE	$2.50 kBtu/hr.
HVAC	Condensing Furnace	<225 kBtu/hr. and minimum 95% AFUE	$2.75 kBtu/hr.

44 https://www.washingtongas.com/media-center/programs-and-solutions-master-meter-conversion
45 https://www.washingtongas.com/media-center/programs-and-solutions-8a-housing
46 https://www.washingtongas.com/home-owners/savings/rebates#washington,-d.c.
47 https://www.dcseu.com/

VIRGINIA PROGRAMS

There are limited direct customer incentives from WGL in Virginia. Those are detailed in Table 2 below.

Table 2. Virginia WGL Rebates[48]

Appliance Type	Eligible Equipment	Efficiency Requirement	Rebate
Space Heating	Furnace	ENERGY STAR certified and minimum 90% AFUE	$300
Thermostat	Wi-Fi-enabled thermostats	Wi-Fi-enabled	$50
Commercial rebates to offset first-cost equipment costs of up to $12,500 for small and medium sized businesses			

Other Virginia programs include:

Virginia DEQ:[49] There are several programs directly offered by the Virginia Department of Environmental Quality. These include incentives for energy efficiency, renewable energy, alternative fuels, and weatherization programs.

The Virginia Commercial Rebate program was designed to specifically target small businesses in the Washington Gas service areas of Virginia. Virginia business owners are eligible to receive rebates on high-efficiency natural gas furnaces and WIFI-Enabled smart thermostats.[50]

MARYLAND PROGRAMS

WGL offers high-efficiency natural gas equipment rebates for Home Heating, Home Appliances and Water Heating. Table 3 shows rebates that WGL offers to natural gas consumers in Maryland.

Table 3. Maryland WGL Rebates[51]

Appliance Type	Eligible Equipment	Efficiency Requirement	Rebate
Space Heating	Furnace Tier 1	ENERGY STAR certified and minimum 92% AFUE	$300
Space Heating	Furnace Tier 2	ENERGY STAR certified and minimum 95.1% AFUE	$400
Space Heating	Boiler Tier 1	ENERGY STAR certified	$400
Space Heating	Boiler Tier 2	ENERGY STAR certified and minimum 95% AFUE	$700
Space Heating	Boiler Reset Controls	N/A	$300
Appliance	Gas Clothes Dryer	ENERGY STAR Certified	$50
Water Heating	Storage Water Heater Tier 1	ENERGY STAR certified	$100
Water Heating	Storage Water Heater Tier 2	ENERGY STAR certified and minimum UEF 0.69	$150
Water Heating	Tankless Water Heater Tier 1	ENERGY STAR certified	$350
Water Heating	Tankless Water Heater Tier 2	ENERGY STAR certified and minimum UEF 0.89	$400
Commercial rebates to offset first-cost equipment costs of up to $12,500 for small and medium sized businesses.			

Within Maryland, there are also multiple programs available directly through **EMPOWER Maryland**, including energy efficiency and renewable energy programs.[52] There are also separate incentives offered for residential customers, businesses, and for the transportation sector.

48 https://www.washingtongas.com/home-owners/savings/rebates#virginia

49 https://www.deq.virginia.gov/Programs/PollutionPrevention/VirginiaInformationSourceforEnergy/FinancialIncentives.aspx

50 https://www.washingtongas.com/home-owners/savings/rebates#virginia

51 https://www.washingtongas.com/home-owners/savings/rebates#maryland

52 https://energy.maryland.gov/Pages/Facts/empower.aspx

Appendix B: Megatrends and Implications for the District

Affordability

While public support is strong and growing for actions that address climate change and reduce GHG emissions[53] a large number of customers are either unwilling or unable to pay premiums for 'greener' goods and services. Upwards of 70 percent of consumers indicate that they would pay an additional 5 percent for a green product if it met the same performance standards as a non-green alternative. But as the premium increases, the willingness to pay falls rapidly. Less than 10 percent of consumers said they would choose green products if the premium rose to 25 percent."[54]

More importantly, a significant number of people are unable to pay significantly more for their energy. According to a report prepared for the Department of Energy & Environment in September 2018:

> "About one quarter (27 percent) of the population in the District of Columbia is income-eligible for the Low-Income Housing Energy Assistance Program (LIHEAP). More than half of these low-income households (51 percent) use natural gas as their main heating fuel, while 44 percent rely on electric."

Increasing Frequency and Severity of Weather Events - Underscores Importance of a Diverse and Reliable Energy Portfolio

Scientists link rising global temperatures to an increased number and severity of storms around the world. Most models agree that climate change through the 21st century is likely to increase the average intensity and rainfall rates of hurricanes in the Atlantic and other basins.

In the District, Kate Johnson, climate chief with the District Department of Energy and Environment, says this research shows the District is going to be "warmer, it's going to be wetter, and it's going to be wilder in terms of our weather."

The average duration of electric power outages almost doubled between 2016 and 2017, according to an analysis from the U.S. Energy Information Administration (EIA), with major storms blamed for the longer interruptions. EIA data shows electric customers in the United States experienced power outages of an average of 7.8 hours in 2017, compared with just over 4 hours in 2016. (The overall analysis does not include the massive, extended power outage that struck Puerto Rico following Hurricane Maria.)

Though an underground initiative is underway in the District, the electrical grid is largely still above ground and therefore more susceptible to damage due to weather and weather-related incidents (such as high winds, downed trees, the formation of ice on power lines, etc.).

A prolonged loss of power is no longer just an inconvenience, it brings normal life to a standstill. But there are solutions.

Pacific Gas & Electric (PG&E)'s 'public safety shutdowns' in 2019 that have left millions of customers in the dark for days on multiple occasions demonstrate both the vulnerability of relying on non-redundant energy systems and also that financial integrity of the utility is essential in order to maintain safety and reliability.

Washington-area residents remember the June 2012 derecho that brought intense winds and rain to our region, knocking out power for more than a million residents.

It is important to note that according to NOAA, the most common natural hazard in the District is Thunderstorm & Lightning and the second-most common is Winter Storm & Extreme Cold.[55] [56] The electric grid is far more vulnerable to both of these weather conditions than is the natural gas delivery system.

With the increasing number and severity of weather events, the ability of natural gas to address and mitigate the vulnerability of our energy infrastructure becomes an important consideration.

53 https://earth.stanford.edu/news/public-support-climate-policy-remains-strong#gs.7a2du2

54 https://www.mckinsey.com/business-functions/sustainability/our-insights/how-much-will-consumers-pay-to-go-green

55 https://www.ncdc.noaa.gov/data-access/severe-weather

56 https://www.nerc.com/pa/rrm/ea/Pages/EA-Program.aspx

CASE STUDY | CARROLLSBURG CONDOMINIUM

In Southwest Washington, DC the Carrollsburg Condominium is an example of resilient and efficient use of energy. With new windows, a highly-advanced building automation system, and the District's first natural gas powered microturbine Combined Heat and Power plant which creates electricity for the property's North and East High-Rise Towers and recovers waste heat to warm water, heat, and cool the 11-acre campus. In addition to resiliency benefits, the property has realized well over $1,000,000 dollars in energy and operational savings from the upgrades and serves as a model for other buildings and campuses throughout the Region.

Aside from natural disasters, our energy delivery systems **must** be designed and built to meet 'peak load' days when energy usage increases substantially, whether it is during heat waves or cold spells. During the peak heating (often the coldest) days of the year, Washington Gas reliably delivers 150 percent of the energy delivered during summertime's peak cooling days. If Policy-Driven Electrification were to be pursued, the grid's capability would need to increase by 50 percent, at substantial cost.

CONCLUSION:

Maintaining our current integrated (multiple sources) energy system is essential to allow a smooth, affordable and reliable transition to a clean energy future.

Cold Weather Vulnerability

The issues of both affordability and reliability are paramount as demographic trends project a larger and increasingly vulnerable population.

The Urban Institute projects that Washington metropolitan area's population is expected to grow by at least 2 million by 2030 with 15.3 percent of the population being 65 years and older, about twice the current rate of 7.7 percent.[57]

US Census data for 2018 shows that approximately 17 percent of District residents over 65 live below the poverty line in the District.[58]

Older adults are particularly affected by energy poverty and cold weather, according to the National Institute of Health (NIH). For an older person, a body temperature of 95°F or lower can cause many health problems, such as a heart attack, kidney problems, liver damage, or worse. Even mildly cool homes with temperatures from 60 to 65 degrees can trigger hypothermia in older people.[59]

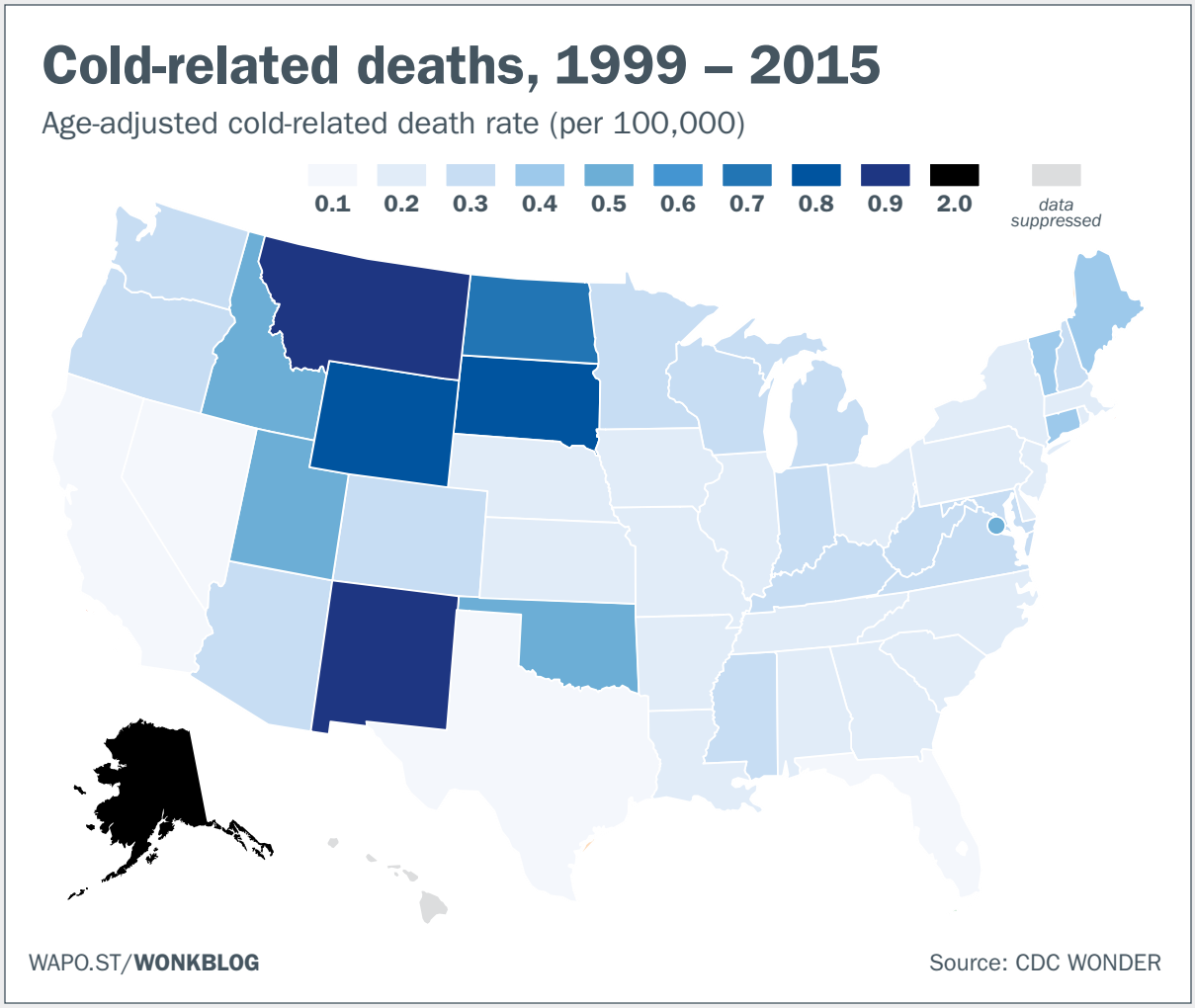
The Centers for Disease Control and Prevention (CDC) found: "cold-related deaths are more prevalent than heat related[60].

57 https://www.washingtonian.com/2015/01/22/washington-area-population-expected-to-increase-by-more-than-2-million-by-2030/

58 https://censusreporter.org/profiles/16000US1150000-washington-dc/

59 https://www.nih.gov/news-events/news-releases/hypothermia-cold-weather-risk-older-people

60 https://www.washingtonpost.com/news/wonk/wp/2016/12/17/cold-temperatures-kill-more-americans-than-hot-ones-cdc-data-show/



As this December 2016 Washington Post figure shows[61], this problem is more acute in Washington, DC than the mid-Atlantic region in general, with an adjusted per-capita death rate more associated with Idaho, Utah and Oklahoma than neighboring states.

CONCLUSION:

Washington, D.C. will need to accommodate and meet the energy needs of an additional 70,000 people and a growing number (and proportion) of elderly residents who are more susceptible to cold-weather-related maladies. Ensuring access to affordable, reliable, clean energy is an imperative.

NATURAL GAS AND RENEWABLE ELECTRICITY ROLES EXPANDING THROUGH 2050

Intermittent Power Sources Require Backup and Storage

As natural gas, wind and solar continue to replace coal for electrical power generation, the 'grid' will continue to get cleaner. This trend is anticipated to continue so that by 2050 renewably generated electricity serves almost a third of demand. However, because renewables are an intermittent source of power, other electrical prime movers like natural gas fired plants – or energy storage – will be required to meet 24 x 7 on demand power needs. While multiple energy storage technologies exist, battery storage is the technology most widely contemplated for our region.

PJM, a regional transmission organization located in 13 eastern states (including the states adjacent to DC that supply the city's electricity - Pennsylvania, West Virginia, Ohio and Illinois), has the most large-scale battery installations, with a storage capacity of **278 MW at the end of 2017**. The second biggest owner of large-scale battery capacity is California's ISO (CAISO) with a total storage capacity of 130MW.

The need for high-capacity, long-duration and long-discharge storage will be a limiting factor to the reliance upon wind and solar generated electricity, due to inherent intermittency of those sources. Limits for storage include technological limitations, resources and space required for installation.

Technological Limits

Batteries offer limited duration discharge, meaning that longer periods without generation require multiple numbers of batteries to provide power during intermittent periods when power is not being generated. For example, without backup generation, to provide enough power during two or three cloudy or windless days will require an unrealistic level of battery storage (see below) to meet the demand for the entire period of time.[62]

	Max Power Rating (MW)	Discharge Time	Max cycles or lifetime	Energy density (watt-hour per liter)	Efficiency
Pumped hydro	3,000	4h – 16h	30 – 60 years	0.2 – 2	70 – 85%
Compressed air	1,000	2h – 30h	20 – 40 years	2 – 6	40 – 70%
Molten salt (thermal)	150	hours	30 years	70 – 210	80 – 90%
Li-ion battery	100	1 min – 8h	1,000 – 10,000	200 – 400	85 – 95%
Lead-acid battery	100	1 min – 8h	6 – 40 years	50 – 80	80 – 90%
Flow battery	100	hours	12,000 – 14,000	20 – 70	60 – 85%
Green Hydrogen	100	mins – week	5 – 30 years	600 (at 200bar)	25 – 45%
Flywheel	20	secs - mins	20,000 – 100,000	20 – 80	70 – 95%

By December 2017, there was approximately 708 MW of large-scale battery storage operational in the U.S. energy grid.

Most of the battery storage projects are for short-term energy storage and are not built to replace the traditional grid. Most of these facilities use lithium-ion batteries, which provide enough energy to shore up the electric grid for approximately four hours or less. These facilities are used for grid reliability, to integrate renewables into the grid, and to provide relief to the energy grid during peak hours.[63] They are not sufficient to protect against large scale interruptions or to maintain service during extended outages.

Resource Limits

Global demand for Lithium, a key component material of today's batteries, is expected to rise at least 300 percent in the next 10 to 15 years, in large part because sales of electric vehicles are expected to increase dramatically.[64] The increase in lithium production required to meet demand is staggering, compared to the current global market for lithium. Future pricing estimates are adding two new global markets—electric vehicles and large-scale battery storage.

62 Environmental and Energy Study Institute, Storage Fact Sheet 2019 https://www.eesi.org/papers/view/energy-storage-2019

63 Environmental and Energy Study Institute, 2019, Fact Sheet: Energy Storage (2019) https://www.eesi.org/papers/view/energy-storage-2019

64 Science News, 2019, The search for new geologic sources of lithium could power a clean future https://www.sciencenews.org/article/search-new-geologic-sources-lithium-could-power-clean-future

This has resulted in increasing competition, and prices, for Lithium; a trend that is expected to continue through 2024.[65] [66] In addition, sourcing is a concern as the US has very few Lithium resources itself and will have to rely on the primary sources of Lithium (Australia, Chile, China, Argentina, and Zimbabwe). One need only recall the Oil Embargo of the 1970s to appreciate how a lack of energy independence presents an economic and potential natural security vulnerability.

Space Limits

Just as solar panels require space, so too would battery storage facilities. A state-of-the-art Lithium battery the size of the US Capitol building would be necessary just to support the District's peak electricity demand for 2 and a half hours. For average (non-peak) electrical load, the battery would supply ~4.5 hours of the electricity that the District requires. And the cost of that battery would be approximately $3 billion.

Solution: Natural Gas Pipelines Provide Ready-Now Energy Storage

In contrast, while largely invisible to the public (because they are underground) the existing gas pipelines in place today store hundreds of terawatt hours[67] of energy for indefinite periods of time and it is available at a moment's notice. Furthermore, if that gas were to be produced using P2G to generate green hydrogen, combined with sequestered carbon from other emissions sources and/or RNG, that energy would be carbon neutral.

CONCLUSION:

- One third of electrical power generation is projected to be sourced from intermittent renewables by 2050.[68]
- Battery technology will help manage and balance short-duration intermittency, however huge backup power generation will be required, most of which is forecast to be gas-fired.[69]
- Increased demand on the grid (such as for vehicle electrification or the potential displacement of natural gas) will require a massive increase in electrical generation and storage, at a higher carbon intensity and GHG emissions than the direct use of natural gas for heating, cooking, hot water and clothes drying. In addition, advancements in renewable natural gas provide promise of even lower emissions for these applications.

Transportation Emissions Are Regulated by the Federal Government and are Therefore Difficult to address at the local level

Despite the fact that transportation is the second-largest contributor to the District's GHG emissions, Clean Energy DC acknowledges that this will be a difficult sector to impact;

"Data indicates that 70% of vehicles are on the road for at least 15 years[70], and "the District Government has few policy tools to encourage an electric car purchase."[71]

The city has chosen to shift focus onto other sources of emissions to affect reductions. Vehicle electrification can yield important and relatively lower cost emisions reductions than electrifying residential and commercial buildings.

65 Oil And Gas Investments, 2017, Lithium Prices To Stay High To 2024–UBS https://oilandgas-investments.com/2017/top-stories/lithium-prices-to-stay-high-to-2024-ubs/

66 https://1reddrop.com/2018/06/07/tesla-panasonic-lead-ev-battery-cost-race-cutting-cobalt/lithium-carbonate-battery-grade-cost/

67 https://www.energycentral.com/c/ec/power-gas-enables-massive-energy-storage

68 EIA, Annual Energy Outlook 2019 with Projections to 2050

69 PJM projection- ICF

70 National Highway Traffic Safety Administration, http://www-nrd.nhtsa.dot.gov/Pubs/809952.pdf

71 Clean Energy DC – August 2018, page xii

Appendix C: Scenarios Evaluated for Emissions Reductions

Pillars of the Plan

The Plan was informed by, and based on, the desire to develop a framework that will accommodate changes to market and policy realities, such as in the District's climate goals, energy needs, and growth, as well as emerging technologies and innovations that will be refined and/or developed over the course of the next 30 years. As noted, the Plan supports and aligns with the seven factors articulated in the DC PSC Vision for modernizing the district's energy delivery system and in support of the Omnibus Clean Energy Act, namely that the energy systems be: (1) sustainable – including three sub-factors environmental protection, economic growth and social equity (2) well-planned, (3) safe and reliable, (4) secure, (5) affordable, (6) interactive, and (7) non-discriminatory. The figure below shows how the key criteria of the Plan align with the seven factors:

Critical Alignment with DC PSC Factors for a Modernizing Energy Delivery System

	Public Service Commission Factors						
The Plan was developed to recognize and optimize the following considerations	Sustainable	Well-planned	Safe & Reliable	Secure	Affordable	Interactive	Non-discriminatory
Ensuring public safety, resilience and reliability by protecting against service interruptions from weather and other disruptions	■	■	■	■	■		■
Evaluating GHG emissions reduction potential of various approaches as well as associated cost per ton of carbon abated	■	■			■	■	■
Moderating impact on customer cost, including up-front and monthly energy costs, particularly for lower-income households	■	■			■	■	■
Preserving energy availability during both normal and peak demand conditions	■	■	■	■		■	■
Leveraging existing assets to their fullest potential	■	■	■	■	■		
Sequencing actions based program and regulatory maturity	■	■			■	■	
Pursuing non-prescriptive approach which allows opportunities presented by future innovations and technological advances	■	■		■	■	■	■
Implementing a regulatory framework and policy that facilitates and incents strategies and tactics to reduce emissions	■	■	■	■		■	■

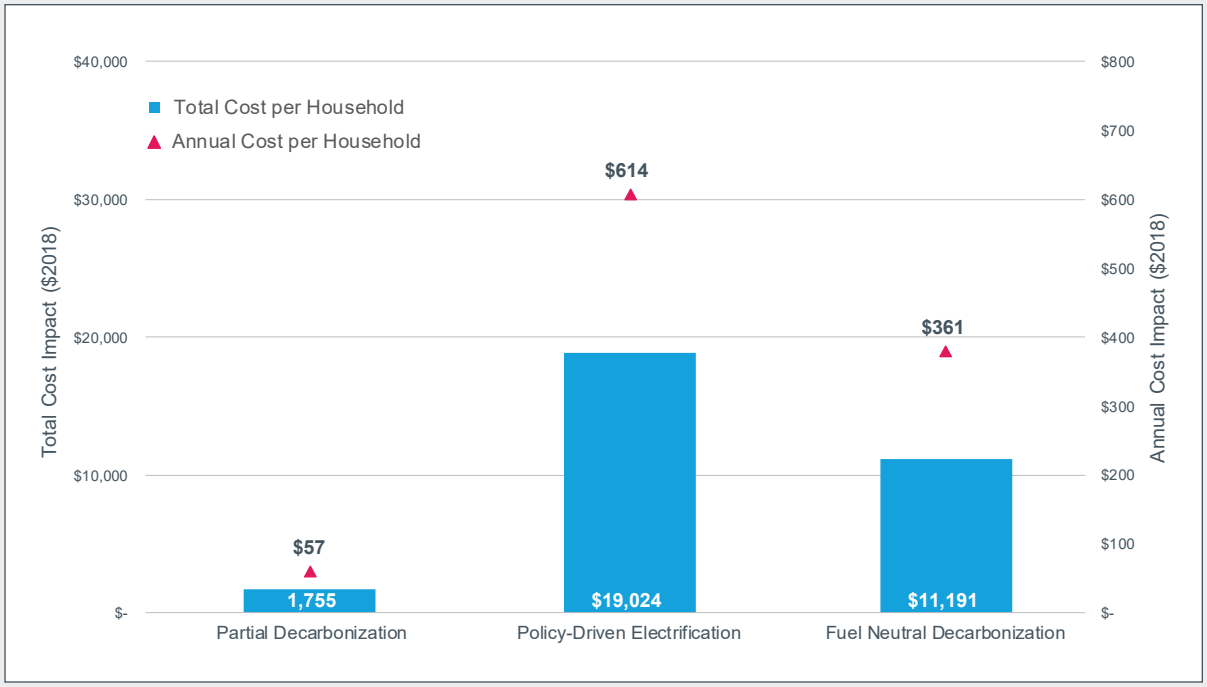
Washington Gas incorporated the above considerations as it examined and evaluated the effectiveness, comparative costs and timeframes associated with the four different energy scenarios to inform our Plan to support the achievement of the District's decarbonization and climate goals.

The following figure provides a comparative summary of the four scenarios, including their foundational assumptions, each scenario's respective potential to achieve the District's GHG emissions reduction targets, as well as the estimated cumulative costs (as related to the Business as Usual scenario) that would be incurred.

Summary of Scenarios, Benefits and Costs

	2050 GHG reduction since 2006	Additional cumulative cost (above BAU)
Business as Usual (Reference Case) Based on the 100 percent renewable portfolio standard (RPS)	**75%**	**–**
Partial Decarbonization BAU plus: ▪ moderate market penetration of EVs ▪ increased energy efficiency ▪ modest decarbonization of gas supply including introduction of RNG and certified gas	**82%**	**$603 Million**
Policy-Driven Electrification BAU plus: ▪ requires homes and businesses using natural gas to convert to electricity ▪ electrification of all new construction ▪ aggressive market penetration of electric vehicles ▪ small volume of offsets (not included in costs)	**100%**	**$6.5 Billion**
Fuel Neutral Decarbonization BAU plus: ▪ aggressive energy efficiency programming including gas heat pumps ▪ moderate introduction of dual fuel heating systems ▪ substantial decarbonization of gas supply introduction of renewable natural gas, certified gas, and green hydrogen ▪ leverages new and emerging technologies ▪ aggressive market penetration of electric vehicles ▪ small volume of offsets (not included in costs)	**100%**	**$3.8 Billion**

Cumulative and Annual Cost of Scenarios per District Household Compared to BAU



The scenarios make very conservative assumptions when estimating future electricity costs, in part because some of the required information was not available to ICF. ICF believes these costs could be very significant because of the electrification of space heating in the Policy-Driven Electrification Case is likely to cause a 50 percent increase in peak demand.[72] An ICF analysis, based on data from a DCSEU study, estimates the costs of meeting a 50 percent increase in peak demand is an additional $0.3 billion per year in costs.[73]

Likewise, this scenario did not consider the cost impacts of future demands for growing renewable electricity. For example, as more jurisdictions adopt or increase RPS targets the price of today's energy credits which are bought by the incumbent utility to meet the District's RPS requirements are likely to double.

> ICF analysis did not include an estimate of the increase in the District's electricity distribution, and transmission costs. The information required to make such an assessment is not public; it is only available to the electric utility.

The Lowest Cost Option to Meet Emission Targets

The fuel neutral decarbonization pathway achieves the desired emissions reductions for $2.7 Billion less than the overall total cost of Policy-Driven Electrification.

72 This is conservative because the Policy-Driven Electrification scenario assumed that practically no EV charging would occur during the system peak. One estimate indicates that full electrification would not only shift the peak power demand from summer to winter but could also double peak electricity demand. Rocky Mountain Institute, New Jersey Integrated Energy Plan, Public Webinar, November 1 2019, page 23. Full electrification of heating and transportation. ICF's estimate is 50 percent but contains conservative transportation assumptions.

73 TetraTech. (2017). *Evaluation of the District of Columbia Sustainable Energy Utility - FY2016 Annual Evaluation Report for the Performance Benchmarks (Final Draft)*. Madison, WI, USA. See page 31, and 33. The DCSEU uses this study in determining the amount of cost that every KW of demand avoided saves annually– i.e. the distribution and transmission capacity cost is $257/KW-year ($231/kw year for distribution and $27/kw year for transmission). The $0.3 billion per year assumes the reverse is true, namely that adding to peak electricity demand also increases costs.

ADDITIONAL IMPORTANT BENEFITS OF FUEL NEUTRAL APPROACH

Stabilizing Costs

Fuel neutral decarbonization helps to stabilize costs via a diversified energy portfolio. A diversified energy portfolio provides a 'hedge' against price increases and volatility from competition for projected escalation in demand for renewable electricity supply and RECs as well as protection against unknown costs of distribution and transmission upgrades. A diverse low-carbon fuel portfolio can reduce the demand for electricity, thereby lessening the potential of multiple jurisdictions to get into bidding wars for a scarce commodity.

> A November 2019 survey of HAND members revealed that more than three quarters (77 percent) currently rely on natural gas in their projects. More than half (54 percent) reported that they are familiar with DC's climate goals to reduce emissions in half by 2032, for the District's electricity supply to be 100 percent renewable by 2032 and for the District to be carbon neutral by 2050. When asked to rank concerns, **83 percent** of respondents cited the cost of Implementation as their greatest concern.

Resiliency and Reliability

The Fuel Neutral Decarbonization approach enhances energy resiliency and reliability for the District by leveraging the 99.9 percent reliability of the natural gas delivery system. Additionally, multiple energy sources and distribution networks incorporated within the Fuel Neutral Decarbonization approach provide an inherent redundancy of energy supply to the District, reducing the District's risk exposure to disruptions in energy delivery from weather or other events.

Resiliency is a matter that the District of Columbia seeks to quantify as a benefit in its proceedings to establish assessment metrics and factors relating to the implementation of the 2019 DC Clean Energy Omnibus Act[74].

The Washington DC Energy Risk Profile[75] lists winter storms, thunderstorms and extreme cold as the leading causes of interruptions in electrical power service with the DOEE finding that the District can anticipate an increasing frequency and intensity of these events.[76] Electric power interruptions range from modest events impacting several hundred for a few hours to severe events like the June 2012 derecho that left hundreds of thousands without power for extended periods. Electric only customers are more likely to lose heating than customers who also use natural gas, due to the underground nature of natural gas infrastructure.

During the winter months the need for heat can often become a matter of health and well-being and even life and death – particularly for the vulnerable elderly and lower-income populations.[77] [78] Energy security is becoming an issue of increasing concern for the District as the mean age of city residents continues to rise.[79]

74 Comments to this NOI submitted on November 12, 2019, by the District of Columbia Department of Energy and the Environment, recommend the establishment of benefit-cost test that accounts for the cost of resiliency. P3. See also Comments to this NOI submitted on November 12, 2019 by the Department of Energy and Environment, P 14-17, In the Matter of the Implementation of the 2019 Clean Energy DC Omnibus Act Compliance Requirements, Matter No. GD-2019-04-m. See also, "First Report from the Commission on Climate Change and Resiliency. First Report to the District of Columbia October 15, 2019".

75 https://www.energy.gov/sites/prod/files/2016/09/f33/DC_Energy%20Sector%20Risk%20Profile.pdf

76 The 2015 report: Climate Change Projections for the District of Columbia https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Attachment%201%20.ARC_.Report_07-10-2015.pdf

77 https://www.nih.gov/news-events/news-releases/hypothermia-cold-weather-risk-older-people

78 https://www.washingtonpost.com/news/wonk/wp/2016/12/17/cold-temperatures-kill-more-americans-than-hot-ones-cdc-data-show/

79 See Appendix B: Megatrends and Implications for the District

Providing Energy Storage

The Fuel Neutral Decarbonization approach enables long-term energy storage for the District to support peak winter energy needs. Washington Gas's existing system stores energy for months (up to years) at a time. In contrast, state-of-the-art batteries, such as Lithium Ion and flow batteries, can provide a few hours of backup power when intermittent renewables such as solar and wind energy are not generating. However, cost and space considerations limit the practicality of these batteries to be used to store large amounts of energy for extended periods. The existing natural gas pipeline network and associated underground storage facilities already provide a high-capacity, long duration and long-discharge seasonal energy storages, storing sufficient energy to meet the District's peak energy requirements in the winter months.

The results of the scenario analysis present a compelling case that Fuel Neutral Decarbonization is the best path to emission reduction. It provides the desired GHG emission reductions at a fraction (59 percent) of the cost of electrification, while maintaining energy reliability for District residents, businesses, government agencies, and others. In addition to achieving energy affordability and reliability, it also preserves customer choice.

Appendix D: Renewable Natural Gas Study

<< provided as a separate attachment >>

Appendix E:
ICF Technical Study Summary

<< provided as a separate attachment >>

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