REWIRING AMERICA

Electrification Study for the District of Columbia

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Executive Summary

Electrification has the potential to eliminate 100 percent of direct emissions from the building and transportation sectors in service of the District of Columbia's climate goals. It is the only viable path to a zero-carbon future.

Gas interests would have you believe otherwise. They will tout "renewable natural gas" (RNG) and other fossil fuel-based options as a way forward, when in fact their own industry reports demonstrate that these 'solutions' only lead to higher prices, more constrained supplies, and ongoing uncontrolled pollution and greenhouse gas emissions. For example, it is often stated that RNG may cost about twice as much as traditional fossil gas. Yet just 20 percent of potential future RNG supply will be accessible at that price, if it is available in sufficient quantities at all. By the time RNG supply reaches 50 percent of its hypothetical potential, the price will have jumped to four times the price of fossil gas, and this multiplier will grow to 15 times the cost of fossil gas at its peak. You just can't work your way out of a fossil fuel problem with more fossil fuels.

In contrast, electrification solutions are ready to be installed today for the vast majority of the District's building and transportation needs. By employing an aggressive strategy that front-loads easy wins and prioritizes equitable outcomes, the District can ably meet its climate targets. By further employing a 'managed decommissioning' approach to the existing gas grid, the District will also free up substantial funding to cover the costs of the electrification transition. Projected gas line replacements will cost up to $4.5 billion, a vast sum in exchange for more pipes in the ground. Most of this funding should instead be redirected to pay for

necessary electrification upgrades. In return for these smart and climate friendly investments, all District residents will be rewarded with lower and more stable energy bills, more comfortable and healthy homes, and improved air quality - all of which will deliver compounding social and economic benefits for decades to come.

The proposed electrification strategy includes four key elements: (1) All-electric New Buildings, (2) Rewiring for Readiness, (3) Proactive Full Electrification, and (4) the creation of a robust Enabling Environment. These elements will run in parallel for the duration of the fossil to electric transition, and are designed to make electrification accessible to all District residents, regardless of their neighborhood or social status, whether they rent or own, and whether they live in a single-family home, apartment, condo, or co-op. They aim to make electrification affordable to all District residents and building owners, regardless of their economic status. Lastly, they strive to decommission the existing gas distribution network in a manner that is equitable - by actively managing and distributing costs fairly across ratepayers and in fact the whole population.

Introduction

The District of Columbia has established a goal to reduce greenhouse gas (GHG) emissions at least 50 percent below 2006 levels by 2032 on a path to carbon neutrality by 2050. The only way to achieve those targets is through the wholesale electrification of the machines in buildings where DC residents live, work, learn, play and pray and the transportation they use to get between them.

Why is that? Because the major drivers of energy consumption and GHG emissions in the District are the building and transportation sectors.

- Buildings contributed 75 percent of site energy use and 75 percent of GHG emissions. Residential buildings accounted for 37 percent of this sector's energy use and 32 percent of this sector's GHG emissions, followed by commercial & industrial buildings (37 percent and 43 percent, respectively) and institutional and government buildings (25 percent and 25 percent, respectively).

- Transportation contributed 25 percent of site energy use and 21 percent of GHG emissions. Passenger vehicles accounted for 96 percent of this sector's energy use and 86 percent of this sector's GHG emissions, with the remainder coming from transit and other medium- and heavy-duty vehicles.[1]

From a fuels perspective, 42 percent of the District's site energy use was derived from electricity, 32 percent from methane gas, 23 percent from gasoline, and 2 percent each from fuel oil and diesel.[2]

The District's plans acknowledge that incremental changes (or worse, maintenance of the status quo) will fall well short of the necessary climate goals and will come at an extraordinary expense. Considering just the cost of gas system maintenance, the DC Department of Energy and Environment (DOEE) recently acknowledged that "what remains true regarding the GHG reduction estimates from PROJECTpipes is that they represent an unjustifiably small portion of the emissions reduction that is needed to achieve the District's climate and energy targets, especially given the huge costs of PROJECTpipes, which range from nearly $3 billion to $4.5 billion."[3]

In contrast, electrification has the potential to eliminate 100 percent of direct emissions from the building and transportation sectors in service of the District's climate goals. For reference, the same $4.5 billion price tag for gas distribution upgrades could provide $27,400 worth of electrification upgrades to each of the approximately 164,000 housing units currently using gas in the District. Such an investment would be transformational for the District, its residents, and the climate.

Electrification is a win-win strategy for the District. To date, even the modest short-term electrification proposal put forth by Pepco has been shown to provide

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[1] DC Department of Energy & Environment, *Clean Energy DC Plan* (Aug. 2018), https://doee.dc.gov/sites/default/files/dc/sites/ddoe/page_content/attachments/Clean %20Energy %20DC %20- %20Full %20Report_0.pdf.

[2] *Id.*

[3] *Formal Case No. 1154, In the Matter of Washington Gas Light Company's Application for Approval of PROJECTpipes 2 Plan* ("*Formal Case No. 1154*"), Direct Test. of Edward P. Yim on Behalf of the District of Columbia Government, filed June 15, 2020, https://edocket.dcpsc.org/apis/api/filing/download?attachId=105094&guidFileName=da84104f-469e-4aa6-b2b9-0d76a9fd9f66.pdf.

substantial economic returns. The Brattle Group found that just 5 years' worth of efforts on Pepco's building electrification plan would return a 20-year positive NPV of $41 million, and 5 years of work on transportation electrification would return a 20-year NPV of $113 million.[4] Notably these cost-benefit estimates do not include the many valuable societal benefits from electrification such as improved health and reduced air pollution, nor the massive cost savings that will accrue from scaling back gas distribution infrastructure. These estimates also do not account for the compounding benefits of any additional near-term and long-term electrification strategies that the District may pursue in response to the recommendations in this study.

Within the District, electrification will entail the replacement of all fossil-fuel end uses in buildings and transportation with electric alternatives. In buildings these end uses include space heating, water heating, cooking, and clothes drying. Electrifying transportation through the replacement of gasoline and diesel-powered vehicles with electric vehicles (EVs) is closely linked to buildings because of the need for charging, which is typically accomplished by the addition of a high-voltage, high-power EV charger to a home or parking area.

Electrification solutions exist today for a great many building and transportation needs, and new and improved solutions are introduced regularly as technology and market innovation continues to accelerate. By employing an aggressive strategy that front-loads easy wins, prioritizes equitable outcomes, and proactively identifies the technical challenges that will need to be tackled in the near future, the District can ably meet its climate targets.

This study outlines the plan for how to get there: the "schedule" for DC to electrify and achieve its goals. It will also demonstrate that any alternative proposed solution will necessarily involve the continued combustion of fossil fuels and emissions inconsistent with the District's climate mandates. Electrification is the

[4] The Brattle Group, *Pepco's Climate Solutions 5 Year Action Plan: Benefits and Costs* (Jan. 2022), https://edocket.dcpsc.org/apis/api/Filing/download?attachId=145484&guidFileName=8d93b10e-ace7-4401-bae1-205ecc837ef0.pdf.

zero-emission pathway for energy demand and, when coupled with continued progress in zero-emission energy supply, can deliver maximum GHG reductions.

The challenge is not the years remaining: we have more than 27 years to meet the District's decarbonization goals (and expect to do better still once momentum for electrification takes hold). This is far more time than it took to put a person on the moon following JFK's call to action in 1961. The challenge is also not technological: in contrast to the moon landing, the solutions we need are already here. The challenge is one of ambition and resolve: the District must launch a bold and ambitious effort to electrify its buildings and transportation today, and not stop until the last gas valve is closed.

This document lays out an electrification plan for the District in three parts. First, we provide evidence for electrification as a tried-and-true decarbonization strategy. Second, we provide the start of a "schedule" for electrification in the District that capitalizes on existing infrastructure, is consistent with citywide planning objectives, and ensures the most equitable and beneficial outcomes for all residents. Third, we highlight ways in which maintaining status quo commitments to gas infrastructure and delivery - especially to residential and commercial buildings in the District - are destined to fall well short of GHG emissions reduction goals.

Part 1: DC is Primed for Electrification

Electrification offers a technically feasible, cost effective, and climate friendly solution for many building types and applications that are commonly found around the District of Columbia. Even for those buildings that are presently challenging to electrify, technical solutions are not hypothetical and are coming soon. As noted in a 2021 report from NREL, "solutions can likely be transferred from one segment to another within the residential sector… [for example], packages developed for single-family detached, midcentury wood frame construction will likely be applicable to other segments, such as other wood frame single-family detached vintages, as well as low-rise, wood frame multi-family buildings."[5]

[5] National Renewable Energy Laboratory, *U.S. Building Stock Characterization Study, A National Typography for Decarbonizing U.S. Buildings* (Dec. 2021), https://www.nrel.gov/docs/fy22osti/81186.pdf.

Electrification policy is accelerating all over the United States,[6] from Federal climate legislation[7] currently under deliberation in the Senate, to changes in the EPA's Energy Star program[8], to expansive proposals in California,[9] New York,[10] and Maryland,[11] to local efforts in cities from Takoma Park[12] to Menlo Park.[13] Current and future policy and programs will only improve the economic case for electrification for all District residents.

Residential Buildings

According to the U.S. Census American Community Survey, as of 2019 there were 322,814 total residential housing units in the District, 90 percent of which (291,570) were occupied.[14] A summary of housing building types and uses[15] is shown in Figure 1. Residential housing units are split approximately evenly among single-family dwellings (attached or detached), small- to mid-sized multi-family buildings with 2 to 20 units, and large multi-family dwellings such as condominiums or apartments with more than 20 units. This distribution is such that "93,470 single-family units make up… 80 percent of the residential buildings. The rest of the

[6] Deepa Shivaram, *The largest city in the U.S. bans natural gas in new buildings*, WAMU (Dec. 15, 2021), https://wamu.org/story/21/12/15/the-largest-city-in-the-u-s-bans-natural-gas-in-new-buildings/.
[7] Rewiring America, *Zero-Emission Homes Act of 2021* (June 2021), https://www.rewiringamerica.org/policy/zero-emission-homes-act.
[8] Emily Pontecorvo, *Gas appliances are no longer eligible for Energy Star's top rating*, Grist (Oct. 1, 2021), https://grist.org/energy/natural-gas-appliances-not-eligible-for-energy-star-top-rating/.
[9] Cali. Public Utilities Commission, Building Decarbonization, https://www.cpuc.ca.gov/about-cpuc/divisions/energy-division/building-decarbonization (last visited Mar. 11, 2022).
[10] Tom DiChristopher, *NY governor unveils plan to electrify homes, achieve zero-emissions construction*, S&P Global (Jan. 6, 2022), https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/010622-ny-governor-unveils-plan-to-electrify-homes-achieve-zero-emissions-construction.
[11] Elizabeth Shwe, *In Marathon Hearing, Senators Consider Sweeping Climate Change Legislation That Aims to Slash Emissions from Buildings*, Maryland Matters (Feb. 16, 2022), https://www.marylandmatters.org/2022/02/16/in-marathon-hearing-senators-consider-sweeping-climate-change-legislation-that-aims-to-slash-emissions-from-buildings/.
[12] Jacob Fenston, *Takoma Park Could Be Among Nation's First Cities To Ban Fossil Fuels*, NPR (Mar. 4, 2020), https://www.npr.org/local/305/2020/03/04/812276379/takoma-park-could-be-among-nation-s-first-cities-to-ban-fossil-fuels.
[13] Aldo Toledo, *Menlo Park Wants to Electrify All Gas-Powered Buildings by 2030 in Bold Climate Plan*, Mercury News (Aug. 30, 2021), https://sd13.senate.ca.gov/news/in-the-news/august-30-2021/menlo-park-wants-to-electrify-all-gas-powered-buildings-2030-in.
[14] U.S. Census Bureau, American Community Survey, 2019 ACS 1-year Estimates, at Table DP-04, https://data.census.gov/cedsci/table?t=Heating%20and%20Air%20Conditioning%20%28HVAC%29&g=0400000US11&tid=ACSDP1Y2019.DP04 (last visited Mar. 11, 2022).
[15] Note that estimates of total building counts and types vary within this document due to the diversity of sources that are cited, and the counting methods, timeframes, and error margins assumed in each.

housing stock is made up of 120,600 rental apartment units, 64,300 condominium units, and 28,600 units in cooperatives, all squeezed into 23,900 buildings."[16]

Distribution of Housing in the District by Public and Private Ownership and Use

		Number of Buildings	Number of Units
Available for residents	Public (DC Government Owned) Housing Stock	764	6,419
	Private Taxable Housing Stock	116,021	297,531
Not available for residents	Private - Foreign Government	202	269
	Private -Educational	138	289
	Private - Religious	134	420
	Public - US Government Property	127	1,993
	Private - Charitable	214	2,895
	Private - Miscellaneous	316	9,992

Source: Housing data complied by the D.C. Policy Center.

D.C. POLICY CENTER

Figure 1: DC Housing Units by Building Type[17]

The building stock in the District is older than the national average, with a full 66 percent of housing units built prior to 1970 compared to a national average of 40 percent, as shown in Figure 2. Older, outdated buildings tend to present greater electrification challenges than newer buildings; they are often poorly insulated and drafty, have inadequate electrical panels and wiring, and have old-fashioned heating systems, among other complexities.

[16] Yesim Sayin Taylor, *Taking Stock of the District's Housing Stock*, DC Policy Center (Mar. 2018), https://www.dcpolicycenter.org/wp-content/uploads/2018/03/DC-Policy-Center-Housing-Report.final_.March25.pdf.
[17] *Id.*

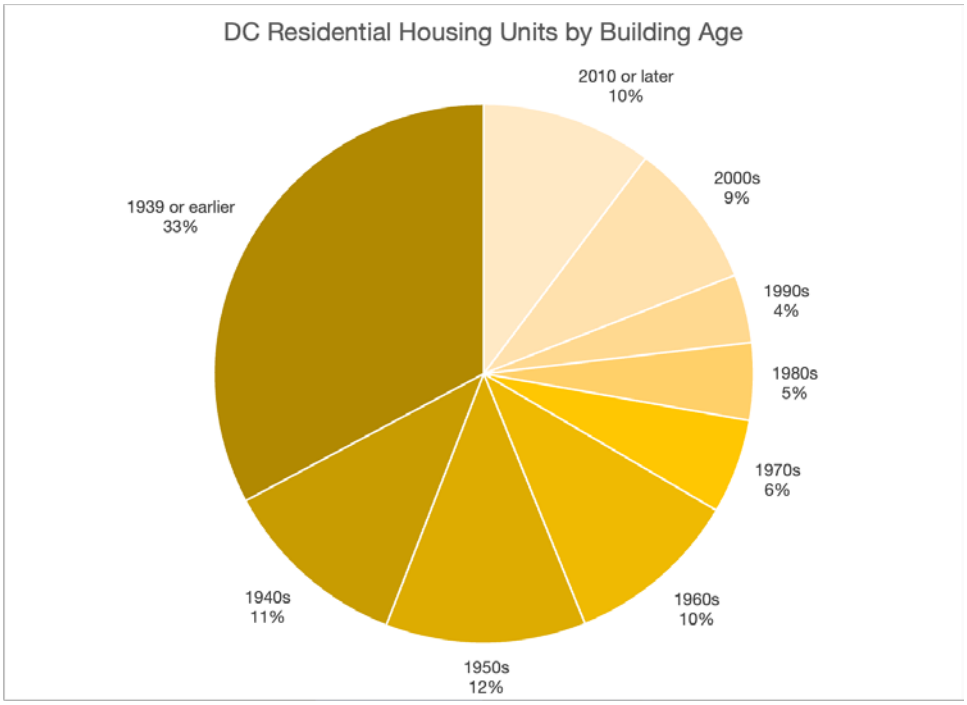

Figure 2: DC Residential Housing Units by Age

Across the District, the frequency of major building renovations is strongly correlated with household income levels, as shown in Figure 3. Each point represents a census tract in the district, and a strong correlation is evident between greater household income and more recent major renovations (Data from U.S. Census American Community Survey). Electrification of older buildings, particularly those that have not been recently renovated, will be accomplished most cost-effectively when combined with other low-cost energy efficiency measures including insulation and air sealing.

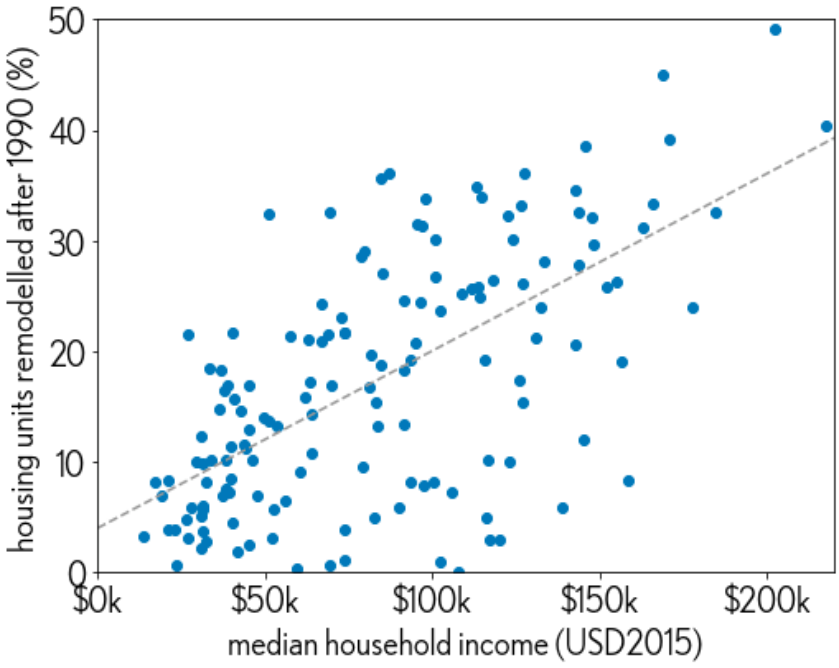

Figure 3: Correlation between housing unit remodeling date and median household income.

Gas and electricity provide the vast majority of heating for homes in the District, as shown in Figure 4. Overall, household heating in the District is relatively evenly split between electricity and gas. A small number of homes are heated with oil and other fuels.

Table 2. Household heating fuel by Ward

Household Heating Fuel	Ward 1	Ward 2	Ward 3	Ward 4	Ward 5	Ward 6	Ward 7	Ward 8	District Total
Electricity	53%	56%	34%	25%	39%	50%	39%	44%	43%
Gas	44%	40%	59%	72%	58%	47%	58%	54%	53%
Oil	1%	1%	3%	2%	1%	1%	1%	0%	1%
Other	2%	3%	4%	2%	1%	2%	2%	2%	2%

Data source: U.S. Census. 2019. ACS 5-Year Estimates Detailed Tables [Table ID: B25040].

Figure 4: Household heating fuel by Ward[18]

Computer Assisted Mass Appraisal (CAMA) data[19] for the District provides further information about heating appliances and correlation with building age as shown in Table 1. Though the data do not present a complete picture of the District, it is notable that heat pumps are found in many older buildings. This is evidence of their suitability for residential heating and cooling applications in the District. Heat pumps are more commonly found in the District's condominium properties than in single-family residential properties today.

	Residential		Condominium	
Heating Description	Count	Average Year Built	Count	Average Year Built
Electric Base Board	117	1923	255	1949
Electric Radiator	65	1939	71	1949
Heat Pump	1547	1929	22289	1963
Hot Water Base Board	180	1925	218	1955
Hot Water Radiator	41210	1917	3351	1934
Forced Air	35733	1937	25256	1962
Wall Furnace	215	1926	918	1945
Other/Unspecified	27866		54575	

Figure 5: Heating System Type vs. Building Type and Age

We used CAMA data to map the location of heat pump installations across the District, as shown in Figure 6. A large number of heat pumps have been installed successfully in every Ward in the district. The success of heat pump technology across neighborhoods and in homes and condos of all ages is evidence of their broad suitability for space heating in the District.

[18] *Formal Case No. 1167, In the Matter of the Implementation of Electric and Natural Gas Climate Change Proposals* ("*Formal Case No. 1167*"), Applied Econ. Clinic, *Equity Assessment of Electrification Incentives in the District of Columbia*, filed Dec. 3, 2021, https://edocket.dcpsc.org/apis/api/Filing/download?attachId=143682&guidFileName=500c5796-112e-4c35-88a8-ea3d3f821e99.pdf.

[19] District of Columbia, Open Data DC, Computer Assisted Mass Appraisal - Residential, https://arcg.is/DSW9S.

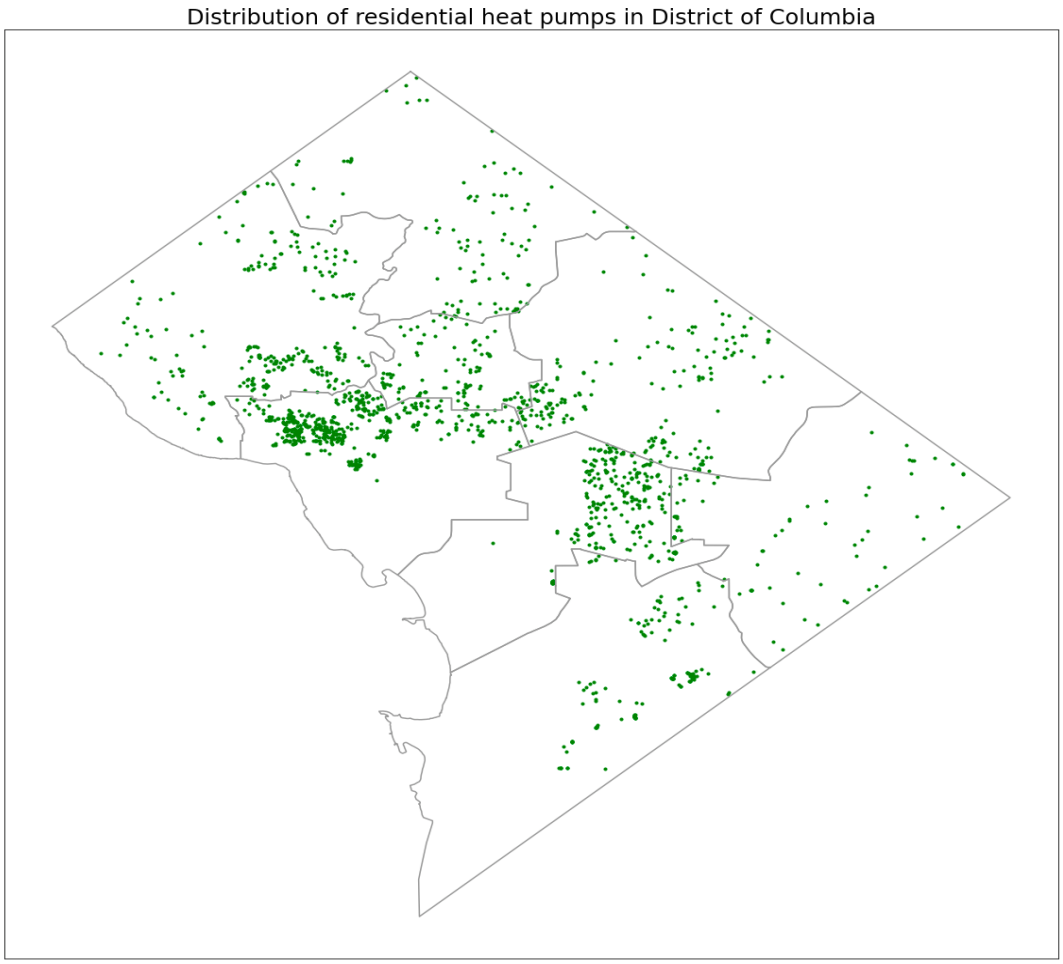

Figure 6: Map of Residential Heat Pump Installations Across the District

According to the EIA's Residential Energy Consumption Survey (RECS), of all residences that use gas for space heating across the South Atlantic census region, approximately 87 percent use gas for water heating and 62 percent use gas for cooking.[20] Using these data, we estimate that there are approximately 164,200 housing units that use gas for space heating and 142,800 housing units that use gas for water heating. We estimate that an additional 102,300 housing units use gas for cooking. Assuming one cooktop per residence, we estimate that there are approximately 102,300 gas cooktops in the District. As shown in Figure 7, this sums up to more than 409,000 gas appliances to be replaced.

[20] U.S. Energy Information Administration, Residential Energy Consumption Survey 2015, at Table HC1.8 Fuels used and end uses of homes in the South and West regions, 2015, https://www.eia.gov/consumption/residential/data/2015/hc/php/hc1.8.php (revised May 2018).

		Share	Est. Number of Appliances
Total Housing Units	(T)		*322,000*
% of Total Housing Units (T) w Gas Heat	(h)	51%	164,220
% of Homes w Gas Heat (h) that also have Gas Water Heating	(w)	87%	142,800
% of Homes w Gas Heat (h) that also have Gas Cooking	(c)	62%	102,340
Estimated Total Gas Appliances (h)+(w)+(c)			409,360

Figure 7: Estimated Number of Gas Appliances in DC Residential Buildings

Source: ACS 2019 1-year DP04 - Total Housing Units, ACS 2019 1-year DP04 - Fraction of Utility Gas vs. Total Occupied Units (assuming same mix for occupied/vacant), RECS 2015 HC1.8 - Fraction of homes with Natural Gas space heating that also have Natural Gas water heating & cooking (South Atlantic Region)

In the South Atlantic census region, approximately 41 percent of primary space heating equipment and 35 percent of water heating equipment is more than 10 years old, and 13 percent of primary space heating equipment and 5 percent of water heating equipment is more than 20 years old.[21,22] Old equipment is typically far less energy efficient and thus far more expensive to operate than even the most basic new equipment due to ongoing improvements in technology and energy performance standards, so homes with old appliances are likely to see fast payback from electrification and efficiency investments.

According to CAMA data, there are at least an additional 500 residences within the District that use electric resistance for space heating - either via electric baseboard or electric radiators. This number may in fact be greater - it is possible that some homes classified in CAMA as “forced air” have an electric central furnace. For these homes, electric heat pumps provide incredible value, as they operate on the same fuel but require just one quarter to one third of the energy to provide the same amount of heat.

[21] *Id.* at Table HC6.8, Space heating in homes in the South and West regions, 2015, https://www.eia.gov/consumption/residential/data/2015/hc/php/hc6.8.php (revised May 2018).
[22] *Id.* at Table HC8.8, Water heating in homes in the South and West regions, 2015, https://www.eia.gov/consumption/residential/data/2015/hc/php/hc8.8.php (revised May 2018).

Additionally, according to CAMA data 36,183 residential housing units and 3,991 condominium housing units currently do not have air conditioning. For properties without AC, the addition of an efficient heat pump that provides heating as well as cooling will improve occupant comfort and improve health, especially where residents are prone to heat-related health complications. Many additional housing units throughout the District are served by aging window or central ACs. In the South Atlantic census region, approximately 19 percent of residences use window ACs, 6.6 percent of which are more than 10 years old. Central AC equipment is even older; 42 percent of these devices are more than 10 years old, and 8.8 percent are more than 20 years old.[23] For homes with old or obsolete AC equipment, the introduction of modern energy efficient heat pumps can greatly reduce energy bills, improve comfort, and reduce summer peak loads on the electric grid.

In general, when assessing opportunities to electrify residential housing stock, single family residential buildings are among the easiest to tackle because they are typically served by individual heating, water heating, and cooking appliances, and are seldom space-constrained, so they can be retrofitted with a variety of heat pump products depending on the building construction and heating needs.

Multi-family residential buildings are often more difficult to electrify than single-family buildings. The Natural Resources Defense Council (NRDC) commissioned a study of space heating electrification technologies that will be applicable to much of the District's multi-family building stock. Technology options include the following:

- Packaged heat pumps that keep the refrigerant circuit in a single piece of equipment. These units output heat either to the indoor air directly, or to a water loop for distribution around the building.
- Split heat pumps that have one component that extracts heat from the heat source, then sends refrigerant to a different location where heating energy is needed.

[23] *Id.* at Table HC7.8, Air conditioning in homes in the South and West regions, 2015, https://www.eia.gov/consumption/residential/data/2015/hc/php/hc7.8.php (revised May 2018).

- Emerging hybrid distribution systems that have outdoor units like a split system, but only send refrigerant to each floor, where the heat is exchanged to a water loop that distributes the heat to each room.[24]

A recent paper[25] analyzing decarbonization of buildings in California identified a similar array of solutions which will be applicable to most if not all of the multi-family buildings in the District. These include:

- Ductless heat pumps, which can be installed to replace hydronic heating, as well as wall furnaces and window air conditioners (e.g., in apartments).
- Ducted heat pumps, which can replace ducted gas forced-air systems in smaller, low-rise multi-family buildings.
- A variety of mini-split heat pumps, package terminal heat pumps, air-source variable refrigerant flow (VRF) heat pumps, water-source VRFs, water-source heat pumps, or ground-source heat pumps which can work well in large multi-family buildings.
- Ductless mini-split and VRF systems, which can meet the needs of buildings with space limitations (e.g., historic buildings) or buildings with complex heat zoning control needs.

The diversity of the District's multi-family building stock (in terms of building age, size, installed HVAC and other gas appliances, owner vs. renter occupancy, and other factors) means that there is no one-size-fits-all electrification solution. However, the District has one distinct electrification advantage over many other major cities: there are no high-rise residential buildings. The mix of single-family and low- and mid-rise multi-family buildings simplifies the electrification challenge by reducing the total number of building typologies that must be addressed and avoiding some unique challenges associated with electrifying tall buildings.

[24] Steven Winter Associates, Inc., *Heat Pump Retrofit Strategies for Multifamily Buildings* (Apr. 2019), https://www.nrdc.org/sites/default/files/heat-pump-retrofit-strategies-report-05082019.pdf.
[25] Asa S. Hopkins et al., *Decarbonization of Heating Energy Use in California Buildings*, Synapse Energy Economics (Oct. 2018), https://www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf.

Commercial & Municipal Buildings

In the District, energy performance benchmarking for large private buildings (over 50,000 gross square feet) has been required since 2008. The District government also currently provides benchmarking information for municipal buildings over 10,000 gross square feet. Benchmarking requirements were extended to all privately owned buildings over 25,000 square feet beginning in 2021 (with reporting due April 1, 2022) and will be extended to over 10,000 square feet beginning in 2024.

More than 2,100 buildings (with a median size of 100,799 square feet) are in the District's Building Energy Performance Database as of 2020.[26] Overall, 40 percent of these buildings are used for residential purposes (including multi-family residential buildings, hotels, dormitories, residential care facilities, and similar), and the remaining 60 percent (1,260 buildings) are for commercial or public use, including 149 K-12 schools and 515 office buildings.

Figure 8 illustrates the location of various commercial building types in the District and the average emissions intensity and gas energy intensity by Ward.

[26] DC Department of Energy & Environment, DC Building Energy Performance (Feb. 2022), https://buildingperformancedc.org/#dc/2020.

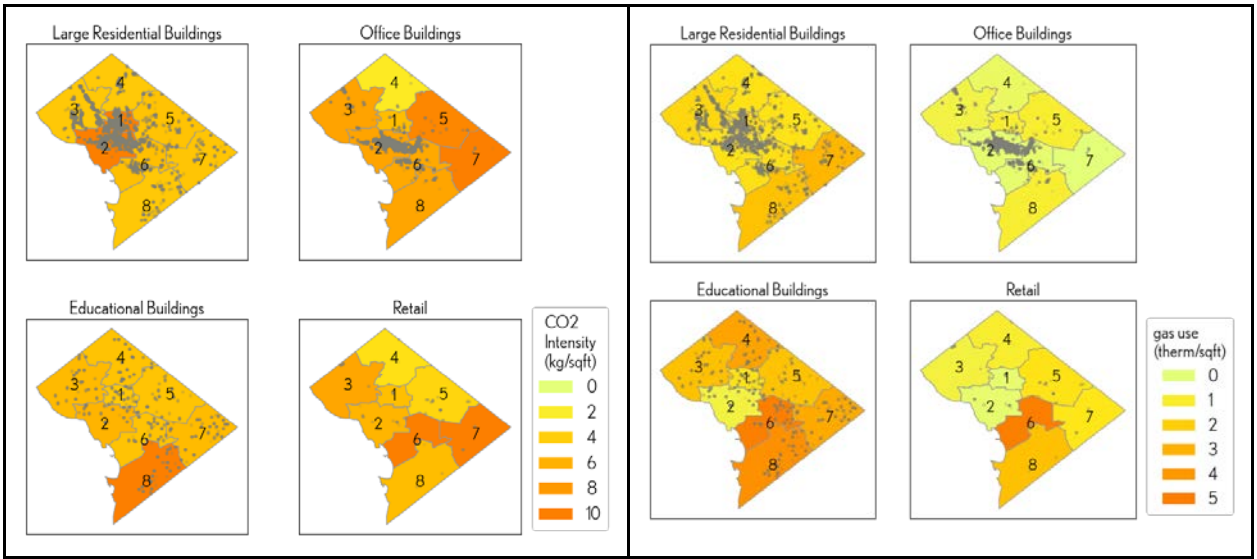

Figure 8: Emissions Intensity and Gas Use in Commercial & Municipal Buildings Across the District

Commercial and municipal buildings have a wider array of heating needs and utilize a wider array of heating systems than residential buildings, and thus present unique electrification challenges. Typical commercial building space heating systems include:

- Single zone packaged Rooftop Units (RTUs)
- Single zone split systems with gas furnaces and outdoor condensing units
- Central air handlers serving multi-zone devices with hot water or electric reheat
- Central boiler systems serving multi-zone heat exchangers

A detailed economic study[27] from Colorado found that for a typical 28,000 square foot commercial office building, the economics of installing a fully-electric heat pump RTU and heat pump water heaters instead of a gas-fired RTUs and water heaters was extremely close to cost-parity in an end-of-life replacement scenario (even in the absence of financial incentives -- a mere 2 percent difference) and substantially less expensive in a new-build scenario primarily due to the avoided cost of a new gas connection and piping, as illustrated in Figure 9.

[27] Group14 Engineering, PBC, *Electrification of Commercial and Residential Buildings* (Nov. 2020), https://www.communityenergyinc.com/wp-content/uploads/Building-Electrification-Study-Group14-2020-11.09.pdf.

Table 7: Office Building First Costs

	End-of-Life Replacement		New Construction	
Description	**Heat Pump**	**Natural Gas**	**Heat Pump**	**Natural Gas**
Central heating/cooling system (including install)	$234,000	$234,000	$216,000	$216,000
Tank type domestic hot water heater	$4,200	$2,600	$3,800	$2,400
Electrical modification	$3,000	----	$1,500	----
Natural gas connection and piping (new construction only)	----	----	----	$21,000
Total Cost	**$ 241,200**	**$ 236,600**	**$ 221,300**	**$ 239,400**
Delta in Cost for Heat Pump		***$ 4,600***		***$ (18,100)***

Figure 9: Office Building Electrification Cost Estimates for Denver Example[28]

The City and County of Denver has recognized this opportunity, and recently passed an ordinance[29] that establishes energy use intensity targets for commercial buildings over 25,000 sq. ft., prescriptive measures for commercial buildings 5,000 to 25,000 sq. ft., and electrification requirements for all commercial buildings, including those under 5,000 sq. ft.. The electrification requirements in Denver require all commercial buildings to partially electrify space and water heating systems upon system replacement when an electric heat pump is a near cost parity with a like-for-like gas system replacement. Requirements phase in over five years beginning in 2023 and include requirements for "electrification retrofit feasibility reports" any time a new gas-fired appliance is installed, as well as increasingly stringent requirements that ensure a growing portion of space and water heating is provided from efficient electric heat pumps.

The commercial building electrification opportunity is not unique to Colorado. A 2020 report from the American Council for an Energy Efficient Economy (ACEEE) found that "about 27 percent of commercial floor space heated with fossil fuel systems can be electrified today with a simple payback of less than 10 years and without any rebates or carbon pricing. Financial incentives, carbon pricing and/or additional efficiency improvements to reduce building loads could improve payback

[28] *Id.*

[29] City & County of Denver, Ordinance No. 20211310 (2021), https://denvergov.org/files/assets/public/climate-action/documents/energize-denver-hub/21-1310_recorded_bill_energize_denver.pdf.

for these buildings and would improve the economics of space-heating electrification for additional buildings."[30] ACEEE also found that "buildings with the best paybacks are more likely to be located… where space-heating needs are modest, and in building types across the United States that often have medium-to-high operating hours, such as health care, food, retail, and offices." These building types should be prioritized for electrification within the District.

Part 2: The Building Electrification Schedule for DC

The following building electrification schedule is intended to maximize beneficial climate, economic, and equity outcomes as residents and leadership in the District of Columbia pursue long-term decarbonization goals. The elements of the schedule are designed to meet the following major objectives:

- First, to make electrification accessible to all District residents, regardless of their neighborhood or social status, whether they rent or own, and whether they live in a single-family home, apartment, condo, or co-op.
- Second, to make electrification affordable to all District residents, regardless of their economic status.
- Third, to ensure that the existing gas distribution network can be decommissioned in a manner that is equitable - by distributing costs fairly across the population.

Wherever possible, we note opportunities to align electrification efforts with existing District government programs that provide energy-related funding and services to developers, homeowners, landlords, and tenants.

Strategy Overview

These efforts are focused on ramping up electrification momentum over the next 10 years, or roughly the first third of the District's overall timeline for decarbonization. This is arguably the most critical period in the timeline, for it is

[30] Steven Nadel, Electrifying Space Heating in Existing Commercial Buildings, ACEEE (Oct. 2020), https://www.aceee.org/sites/default/files/pdfs/b2004.pdf.

when sufficient electrification momentum must be established in the market to carry progress through 2050. This momentum will be driven by effective policy and a conducive enabling environment, robust incentive schemes and delivery mechanisms, and growing demand among residents as they realize the many economic and health benefits of all-electric homes. Most importantly, it will be driven by local commitment and leadership.

- 1: All-electric New Buildings
    - Affordable housing
    - Building codes
- 2: Rewiring for Readiness
    - Electrification audits
    - Rewiring upgrades
    - AC replacements
- 3: Proactive Full Electrification
    - Block-by-block for priority small residential
    - Public housing & priority multi-family residential
    - Commercial & municipal buildings
- 4: The Enabling Environment

1: All-electric New Buildings

This recommendation is intended to stop the proliferation of new gas connections in the District, which will impede the District's ability to achieve its climate mandates, by requiring electric-only new construction.

Rationale

Housing demand in the District is high and is expected to remain so throughout the implementation period of the DC Climate Business Plan. Prior to the COVID-19 pandemic, the DC Office of Planning projected that the number of households in the District would increase at a rate of 1.3 percent per year over the 30-year period

from 2015 to 2045. This would result in the net addition of 115,000 households, a 38.6 percent increase over baseline.[31]

All these homes should be built as efficient electric.

From 2019 to 2021, the District issued an average of just over 6,000 residential housing units per year,[32] substantially ahead of the pace projected by the Office of Planning. Of these new building permits, approximately 4 percent were for single-family homes (228 per year), and the remainder for multi-family units, primarily large developments with more than 100 units per building.

According to Census data, as of 2020 approximately 60 percent of newly constructed single-family homes and 80 percent of newly constructed multi-family buildings in the South region use air-source heat pumps as their primary heating system.[33] The proportion of buildings with heat pumps is well above the national average, but this still means that a lot of new gas connections are added every year.

Assuming the District's ratio of heat pump installation in new buildings is consistent with the South Census region average, we estimate that new gas connections are installed in approximately 1,266 housing units across 117 buildings in the District each year. Projected forward to 2050, this implies the addition of more than 31,000 new gas connections across some 3,000 buildings, each of which will come with new infrastructure that would have to be maintained and subsequently decommissioned at ratepayers' expense or stranded entirely over the course of the next century.

Every new gas connection and new gas appliance sets the District back another step on the path to decarbonization and is a missed opportunity for lasting climate progress.

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[31] DC Office of Planning, *Forecasting the District's Growth* (Nov. 2016), https://planning.dc.gov/sites/default/files/dc/sites/op/publication/attachments/Forecasting%20DC%20Growth%202015-2045%20-%20Results%20and%20Methodology%20-%20FINAL_011217.pdf.

[32] U.S. Census, Building Permits by State Annual, https://www.census.gov/construction/bps/stateannual.html (last visited Mar. 11, 2022).

[33] U.S. Census, Characteristics of New Housing, https://www.census.gov/construction/chars/ (last visited Mar. 11, 2022).

Targeting & Priority Actions

This effort is targeted at all new buildings and major renovation projects in the District.

Require all New Affordable Housing to be Electrified Housing

Electrified housing is affordable housing. The electrification strategy for new buildings should be aligned with District plans to increase the stock of affordable housing. Mayor Bowser's Housing Framework for Equity and Growth[34] envisions 12,000 new affordable housing units (and a total of 36,000 new housing units overall) by 2025. As of December 2021, a total of 4,003 affordable units had been produced, achieving 33 percent of the goal.[35]

In the absence of an electrification strategy, the addition of a gas line to an otherwise affordable home (or truly any home) will have the effect of increasing energy burdens in the long term and making that home far less affordable. Economic costs include both the energy bill itself and a growing range of fixed fees, from the fixed meter fee (which does not vary even for customers who stop using gas) to the prospect of additional disconnection fees in the future. Indeed, severe disconnection fees are already being proposed by gas utilities in some parts of the country today.[36] Beyond these, there are additional costs in terms of increased pollution and health impacts from burning fossil fuels in the home. For example, a study of two public housing apartment buildings found significant decreases in multiple indoor exposures and improved health outcomes among participants who moved from conventional apartments to "green" housing.[37] The researchers noted that NO2—which the EPA has long acknowledged as "an inherent consequence of fossil fuel combustion"[38] and as a precursor pollutant to harmful ground-level

[34] Sustainable DC, *Housing Equity Report* (Oct. 2019), https://sustainable.dc.gov/page/housing-equity-report-Oct19.
[35] DC Deputy Mayor for Planning & Economic Development, 36,000 Housing Count Dashboard, http://open.dc.gov/36000by2025/ (last visited Mar. 11, 2022).
[36] Dale Denwalt, *ONG's Proposed Utility Service 'exit Fee' Explained: Why It Triggers Debate, Criticism*, The Oklahoman (Feb. 17, 2022), https://www.oklahoman.com/story/business/2021/12/04/oklahoma-natural-gas-customer-service-exit-fee-ong-bill-pay-utility/8795571002/.
[37] Brady A. Seals & Andee Krasner, *Gas Stoves: Health and Air Quality Impacts and Solutions*, RMI (2020) (citing Meryl D. Colton et al., *Indoor Air Quality in Green Vs Conventional Multifamily Low-Income Housing*, 48 Env't Sci. & Tech. 7833, 7837 (2014)), https://rmi.org/insight/gas-stoves-pollution-health/.
[38] U.S. Environmental Protection Agency, *Nitrogen Oxides*, at 1-1 (1977), https://nepis.epa.gov/Exe/ZyPDF.cgi/2000XWPA.PDF?Dockey=2000XWPA.PDF; *see also* Jim Dennison et al., *How Air Agencies Can Help End Fossil Fuel Pollution from Buildings*, RMI, at 5 (2021), https://rmi.org/insight/outdoor-air-quality-brief/.

ozone and fine particulate matter—concentrations decreased by 65 percent and particulate matter concentrations decreased by 57 percent, and noted the change from gas to electric stoves as a contributor to the evidenced reductions. Health impacts are further discussed in Part 3 of this report.

Accelerate Adoption of All-Electric New Building & Renovation Codes

The DOEE's 2018 Clean Energy DC Plan recommended that for the next building code cycle that District Government should push a much stronger update that drives all buildings toward net-zero energy performance by 2026, at the very latest.[39] As part of future electrification plans, the District should continue to pursue building code improvements to ensure that all new construction and major renovation projects in the District are fossil fuel free.

Alignment

The Department of Housing & Community Development operates a wide range of programs that finance the development of affordable housing across the District. All these programs should be reviewed and wherever possible revised to ensure that only all-electric construction and major renovation projects are eligible for grant funding. Relevant programs and partners include:

- Developers who receive grants, bridge loans, or preferential financing through the District's Housing Production Trust Fund (HPTF)[40], which distributes more than $100 million annually to support the development and preservation of affordable housing.
- Community Housing Development Organizations (CHDOs) that participate in the *Home Investment Partnerships (HOME) Program*[41] which distributes Federal block grant funds for building, buying, and/or rehabilitating affordable

[39] DC Department of Energy and Environment, 2018 Clean Energy DC Plan, at 65–71 (Aug. 2018), https://doee.dc.gov/sites/default/files/dc/sites/ddoe/page_content/attachments/Clean%20Energy%20DC%20-%20Full%20Report_0.pdf.
[40] DC Department of Housing and Community Development, Housing Production Trust Fund, https://dhcd.dc.gov/page/housing-production-trust-fund (last visited Mar. 11, 2022).
[41] DC Department of Housing and Community Development, Home Investment Partnerships (HOME) Program, https://dhcd.dc.gov/page/home-investment-partnerships-home-program (last visited Mar. 11, 2022).

housing for rent, homeownership, or provides direct rental assistance to low-income residents.
- Property owners who purchase and rehabilitate vacant or blighted homes through the Property Acquisition and Disposition Division (PADD)[42].

2: Rewiring for Readiness

This recommendation is intended to overcome one of the principal barriers to electrification: the lack of sufficient electric service capacity within existing buildings. Proactive planning and proper pre-formatting of buildings will ease the process of replacing gas appliances with electric alternatives throughout the District.

Rationale

Perhaps the biggest structural barrier to building electrification is the complexity and up-front cost of conversion. Most people do not think about their furnace or water heater until it breaks down and they find themselves in an emergency without heat or hot water. At this point most people, even those with every intention of electrifying their home, will default to the most readily available and cost-effective solution, which often means skipping a heat pump and installing a replacement fossil fuel appliance. Researchers at the Pecan Street Project state, "simply put, if switching to an electric appliance requires an electric panel upgrade, the additional cost and effort may favor the purchase of another combustion fuel appliance."[43]

The additional cost and complexity of electrification arises for two primary reasons:

- An efficient electric heat pump, water heater, induction cooktop, etc. is likely to be more expensive than a run-of-the-mill inefficient fossil fuel device. This price differential can be addressed with targeted incentives such as those already offered by DCSEU.

[42] DC Department of Housing and Community Development, Transforming Vacant and Blighted Properties, https://dhcd.dc.gov/PADD (last visited Mar. 11, 2022).
[43] Pecan Street, *Addressing an Electrification Roadblock: Residential Electric Panel Capacity* (Aug. 2021), https://www.pecanstreet.org/wp-content/uploads/2021/08/Pecan-Street-Panel-Sizing-Whitepaper-Update.pdf.

- The installation of an electric device may require upgrades to the home; these may include upgraded electrical service panels, new electrical wiring and connection points, and improvements to air sealing, insulation, and duct work. These elements can be mitigated with a proactive 'rewiring' approach as described below.

These obstacles are confirmed by recent electrification program experience elsewhere in the US. For example, the Sacramento Municipal Utilities District (SMUD) notes that "It is much more cost effective and efficient for homes to be made electric-ready prior to the need for equipment or appliances to be replaced. Most of the upfront cost differential in switching from gas to electric is due to the infrastructure needed to make the switch at the building level. To date, the majority of SMUD's electrification has occurred in buildings that already have appropriate panel capacity. However, the issue is not simply a capacity constraint. All buildings with gas appliances will need to have electric circuits installed from the panel to the point of use by the new electric equipment, EV, or appliance."[44]

Targeting & Priority Actions

This effort is targeted at all homes with existing fossil fuel appliances in the district, as well as homes that are currently heated with inefficient electric resistance devices such as electric baseboards, radiators, and furnaces.

Electrification Audits

The District Department of Energy & Environment conducts energy audits and implements air sealing, insulation, and energy efficiency improvements for low-income residents under its existing *Weatherization Assistance Program (WAP)* with funding from the US Department of Energy. This program serves approximately 100 households per year in its current manifestation and is not in high demand given that there is no waiting list for services.[45] Existing energy audit procedures for

[44] Comments of Sacramento Municipal Utility District Sacramento Municipal Utility District on Building Decarbonization and Energy Efficiency, Docket No. 21-IEPR-06 (Cal. Pub. Utils. Comm'n Sept. 2, 2021), https://efiling.energy.ca.gov/GetDocument.aspx?tn=239579&DocumentContentId=73012.

[45] U.S. Department of Energy, Weatherization Assistance Program (WAP) Annual File Worksheet (2021) (Grant Number: EE0007911, State: DC), https://doee.dc.gov/sites/default/files/dc/sites/ddoe/service_content/attachments/Approved%20WAP%20State%20Plan%20for%20Fiscal%20Year%202022.pdf.

single-family homes[46] include an assessment of electrical wiring, while those for multi-family buildings[47] do not.

As part of the District's overall electrification strategy, this program should be paired with a new 'Electrification Audit' scheme. The Electrification Audit should be made accessible at little to no cost to all District residents whose homes contain fossil fuel appliances or electric resistance heating systems. The Electrification Audit program will lead to several important outcomes that will greatly ease the path to decarbonization. First, and most importantly, it will provide all residents with a specific action plan for their home, with a detailed accounting of panel, wiring, air sealing, insulation, ductwork, electric vehicle charging, and other upgrades required to make their homes electrification ready.

Electrification Audit recommendations to building owners should include cost-benefit and estimated payback analysis, links to financing and incentive programs and other resources offered by the District, and connections to qualified contractors. Second, the audit program will enable a more detailed electrification-readiness analysis of the existing building stock, which will inform additional prioritization for block-by-block electrification retrofits and better estimates of costs across the District. Third, it will help to identify residents who are interested in electrification and enable outreach and various rewiring and equipment incentive programs to be more precisely targeted at residents who are likely to engage.

Rewiring Upgrades

Residents who have received an Electrification Audit should be promptly directed to resources that will facilitate the next several steps in the electrification process. Since rewiring on its own will not deliver value to a homeowner until the electric appliance is installed, a strong incentive package will likely be required in order to encourage uptake. These incentives should be menu-based, depending on the extent of upgrades that are required (e.g., a new service panel, length of wire runs, air sealing and insulation, etc.). Additional incentives should also be earmarked for low-income residents to ensure that program benefits are equitably distributed.

[46] *Id.*
[47] *Id.*

According to SMUD, in the Sacramento area, "costs run between $300 and $1,200 per circuit, including for the wiring, conduit, breaker, and drywall repairs… Panel replacements along with the addition of new circuits for our low-income program costs $4,725 on average. Some panel and circuit upgrades may cost well over $9,000 in situations where the panel placement must change, the distribution line is underground, and/or there is substantial vegetation management that must be completed prior to the new panel installation."[48] In the District, similar upgrade costs could be substantially offset by the $27,400 per household that would be available from a repurposed $4.5 billion PROJECTpipes 2 budget.

When combined with the information in the Electrification Audit, rewiring investments will pay dividends as soon as the next fossil fuel appliance is up for replacement, because both the building and the homeowner will be prepared with everything they need for a smooth transition to an electric device.

AC Replacements

There are many homes in the District that currently use central air conditioning (AC) equipment for cooling. Common unitary AC systems are only capable of providing cooling service but can be easily and cost-effectively replaced with two-way heat pumps that deliver equivalent service to the AC in summer and additionally provide highly efficient electric heat in the winter. Recent analysis from CLASP projects that the replacement of an AC with a heat pump at the time of AC failure could offset an average home's fossil fuel use for heating by up to 40 percent.[49] DCSEU currently offers rebates of $250 to $375 for cooling-only central AC products.[50] In order to push the market towards greater adoption and awareness of heat pump technology, DCSEU should discontinue its central AC rebates in favor of only heat pump rebates.

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[48] Comments of Sacramento Municipal Utility District Sacramento Municipal Utility District on Building Decarbonization and Energy Efficiency, Docket No. 21-IEPR-06 (Cal. Pub. Utils. Comm'n Sept. 2, 2021), https://efiling.energy.ca.gov/GetDocument.aspx?tn=239579&DocumentContentId=73012.

[49] Stephen Pantano et.al., *3H Hybrid Heat Homes: An Incentive Program to Electrify Space Heating and Reduce Energy Bills in American Homes*, CLASP (May 2021), https://www.clasp.ngo/research/all/3h-hybrid-heat-homes-an-incentive-program-to-electrify-space-heating-and-reduce-energy-bills-in-american-homes/.

[50] DC Sustainable Energy Utility, Home Heating & Cooling, https://www.dcseu.com/homes/home-heating-cooling#get-started (last visited Mar. 11, 2022).

Alignment

Implementation plans should leverage existing DCSEU programs to the extent possible. In Fiscal Year 2020, DCSEU's *Residential Heating & Cooling* program served 265 participants in 2020.[51] Installed measures included: smart thermostats, Energy Star central AC systems (21 participants), ductless mini-split heat pumps (16 participants), water heater replacement (11 participants), furnace replacement, and boiler replacement.[52] Four of the five ductless mini-split heat pump purchasers said they were "very likely" to recommend the technology to someone else.

DCSEU's Performance Benchmarks must also be updated to align with the District's electrification goals. DCSEU performance is currently measured in terms of the reductions that are achieved in electricity and natural gas consumption,[53] but progress on electrification will have the effect of increasing electricity consumption. It will still be important for DCSEU to deliver improved energy efficiency, but new metrics must also give credit for electrification progress even if it results in increased net electricity consumption.

3: Proactive Full Electrification

This recommendation is intended to serve District residents who stand to benefit the most from electrification in the short term, who cannot afford to be last in line to electrify, and who have the greatest need for financial support. It is focused on electrifying large numbers of housing units at once - either via a city-block approach or through large multi-family buildings - to enable sections of the existing gas distribution network to be cost-effectively decommissioned.

[51] DC Department of Energy & Environment, *Evaluation of DC Sustainable Energy Utility FY2020 Programs* (July 21, 2021), https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/DCSEU%20FY2020%20Portfolio%20Evaluation%20Report%20-%20FINAL_compressed.pdf.

[52] DCSEU furnace and boiler rebates have been discontinued as of August 2021, while rebates for heat pump water heaters and air source heat pumps (both central and mini-split) have been increased.

[53] DC Department of Energy & Environment, *DCSEU FY2020 Performance Benchmarks Report* (July 23, 2021), https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/DCSEU%20FY2020%20Performance%20Benchmarks%20Report%20FINAL.pdf.

Rationale

By proactively electrifying entire city blocks and simultaneously decommissioning sections of the gas distribution network, the District will drive down overall energy infrastructure costs for its residents. By beginning this effort in neighborhoods with the greatest energy burdens and the least ability to pay, the District will prioritize communities that stand to gain the most.

As noted by the Greenlining Institute, environmental and social justice (ESJ) communities "cannot be expected to prioritize the cost of electrifying their homes if they are barely staying afloat. Residents from these communities experience multiple and often compounding economic barriers that make electrification nearly impossible if they are expected to go it alone. However, they will also be the hardest hit if they wind up being the last customers served by the gas distribution system, because they can least afford the risk of significantly increased bills that will be needed to support aging and stranded infrastructure. Strategic, targeted, and sufficient investment in helping ESJ communities electrify will help ensure that the communities that need the benefits the most are not left behind or displaced from their homes."[54]

The District should deploy the 'non-pipe alternative' (NPA) electrification solutions as frequently as possible to enable end-of-life gas networks to be safely and cost-effectively decommissioned, block by block and neighborhood by neighborhood. The Environmental Defense Fund summarizes the opportunity as follows: "Rather than simply replacing all leak-prone pipe with new pipe, deliberate planning to retire gas infrastructure will be necessary, including through demand reduction strategies such as fuel substitution including electrification… [R]egulators should explicitly consider the service of this leak-prone pipe… if the pipe is primarily serving residential or other distribution level assets, it may be more cost-effective to deploy a NPA and take the asset out of service. If the leak-prone pipe services backbone or transmission level uses, then prioritizing its replacement to eliminate

[54] Greenlining Institute, *Equitable Building Electrification: A Framework for Powering Resilient Communities* (2019), https://greenlining.org/wp-content/uploads/2019/10/Greenlining_EquitableElectrification_Report_2019_WEB.pdf.

these leaks should be a top priority."[55] A report on New York's gas system suggests taking a geo-targeted approach to retiring assets by supporting customers to electrify along a specific distribution line that is leaking, aging, or due to be replaced, and then retiring that line.[56] Similar geo targeting strategies have been proposed elsewhere in the country.[57,58]

The City of Palo Alto evaluated the costs of decommissioning its gas system (sealing valves to the gas mains, disconnecting gas service laterals to individual homes, and removing gas meters and risers) for 15,000 residents and found it to range between $1.1 million to $5.4 million per year over 10 years, compared to a gas utility's capital investment budget of approximately $8 million to $10 million per year plus an additional savings of $26 million to $34 million in total from not having to replace the PVC gas mains and service lines. Notably the lower bound estimates are for disconnecting an entire block from gas service at once, versus disconnecting one home at a time.[59]

Targeting & Priority Actions

This effort is targeted at buildings in the District that have end-of-life gas distribution infrastructure, high energy burdens, and high environmental burdens. The District should identify priority neighborhoods based on criteria to include the following:

- Pipe replacement schedules from WGL
- Methane leak data
- Housing stock characteristics gathered via Electrification Audits
- Energy burden data

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[55] Environmental Defense Fund, *Aligning Gas Regulation and Climate Goals* (Jan. 2021), http://blogs.edf.org/energyexchange/files/2021/01/Aligning-Gas-Regulation-and-Climate-Goals.pdf.
[56] Asa S. Hopkins et al., *Gas Regulation for a Decarbonized New York*, Synapse Energy Economics (June 29, 2020), https://www.synapse-energy.com/project/gas-regulation-decarbonized-new-york.
[57] Lucas Davis & Catherine Hausman, *Who Will Pay For Legacy Utility Costs?*, National Bureau of Economic Research (June 2021) (revised March 2022), https://haas.berkeley.edu/wp-content/uploads/WP317.pdf.
[58] Gridworks, California's Gas System in Transition (Sept. 2019), https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf.
[59] City of Palo Alto Utilities Advisory Commission, *Discussion of Electrification Cost and Staffing Impacts on the City of Palo Alto's Electric and Gas Distribution Systems* (Nov. 4, 2020) (ID # 11639), https://www.cityofpaloalto.org/files/assets/public/agendas-minutes-reports/agendas-minutes/utilities-advisory-commission/archived-agenda-and-minutes/agendas-and-minutes-2020/11-04-2020-special/id-11639-item-no-3.pdf.

- Environmental justice criteria

Community engagement is necessary for successful implementation of any plan to include low and moderate income (LMI) households, both because it will increase uptake and buy-in and will also help identify local barriers that prevent LMI customers from transitioning to all-electric buildings. Citizen engagement should include outreach and education in multiple languages; community meetings to provide input on plans and prompt responses from policymakers; and partnership with community-based organizations. Making the electrification process as simple as possible is also important. The District should consider establishing a "one-stop shop" for electrification customers, allowing them to pair electrification with other programs, such as weatherization and solar and storage installation.[60]

Once priority neighborhoods are identified, engaged, and committed to the District's electrification agenda, the following building types should be prioritized:

Proactive Electrification of Residential City Blocks

Single family and small multi-family buildings are among the easiest to electrify because they are typically served by individual heating, water heating, and cooking appliances. LMI families in single-family homes are particularly important because of the high average energy burdens these residents face. A recent evaluation[61] of the District's Low Income Housing Energy Assistance Program (LIHEAP) for FY2019 revealed the following: Most of these low-income households use natural gas (49 percent) or electric (47 percent) as their main heating fuel. Heating assistance recipients residing in single-family homes had about 50 percent higher bills, on average, compared to clients residing in multi-family buildings, and recipients who heat with natural gas had about 50 percent higher total residential energy bills than recipients heating with electric. While most households have a direct energy bill, about 40 percent have their main heating fuel included in their rent.

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[60] Gridworks, *California's Gas System in Transition* (Sept. 2019), https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf.

[61] Applied Public Policy Research Institute for Research & Evaluation, *District of Columbia LIHEAP Energy Burden Analysis* (Sept. 2020), https://doee.dc.gov/sites/default/files/dc/sites/ddoe/service_content/attachments/DC%20DOEE%202020%20LIHEAP%20Energy%20Affordability%20Study%20-%20Energy%20Burden%20Report%20-%20Final%20-%209-28-20.pdf.

The mean energy burdens of LIHEAP recipients in the District in FY2019 were 40 percent to 90 percent greater for gas and oil customers than they are for electric-only customers across single-family homes and small multi-family homes within the District, as seen in Figure 10 below. The burdens for gas and oil customers have surely increased dramatically over the past year, as fossil fuel prices have increased much more rapidly than electricity prices over the same period.

	Mean Energy Burden		
Main Heating Fuel	Single Family Homes	Small Multi-Family Homes	Large Multi-Family Homes
Utility Gas	15%	14%	12%
Electric	10%	10%	8%
* Fuel Oil	19%	N/A	N/A

Figure 10: Mean Energy Burden by Building Type and Heating Fuel[62]

** Small sample size*

Public Housing

The DC Housing Authority (DCHA) maintains a portfolio of 8,300 units in 52 traditional public housing developments (across 41 sites) and has responsibility and financial interest in an additional 23 mixed-income properties with nearly 4,500 units (3,900 of which are affordable).[63]

A substantial portion of DCHA's portfolio (14 buildings, comprising 2,610 housing units) has been identified as being in a state of extreme disrepair and requires urgent renovation. DCHA's 20-Year Transformation Plan states that "while the human need is clear, the financial need is unprecedented. The $2.2 billion needed to comprehensively modernize and/or redevelop these fourteen (14) sites and refresh the entire forty-one (41) site public housing portfolio is about 150 times the typical annual capital improvements funding HUD and the District of Columbia

[62] *Id.*

[63] DC Housing Authority, DCHA BY THE NUMBERS, https://webserver1.dchousing.org/?page_id=316 (last visited Mar. 11, 2022).

provide."[64] At the same time, the Plan acknowledges that "DC is better positioned than most regions to leverage these alternative strategies, building on strong land values and public-private engagement to turn the tide and meet our neighbors' housing needs safely and efficiently."[65]

DCHA's list of required renovations[66] illustrate that public housing renovation provides a perfect opportunity for holistic and comprehensive electrification that would benefit the District's most vulnerable residents. For example:

- Garfield Terrace Family (Ward 1) is a 50-unit property with 9 two-story townhomes and 41 apartment units in two three-story walk-up buildings. It receives heating and hot water via a shared boiler from an adjacent high-rise building. "This system has passed its expected life cycle by many years and has failed on numerous occasions due to ground settlement causing underground separations, collapse and holes. Six of the family townhouses are boarded and uninhabitable due to mold, mildew, and structural damage from piping failures." This site is proposed for demolition and rebuild as a new high-rise, with its own utilities and HVAC systems.
- Judiciary House (Ward 2) is a 10-story high-rise building with a total of 271 senior residences. DCHA's plan to renovate this building includes the following line items for replacement: HVAC PTAC units, HVAC riser piping, electrical risers and unit service panels, and kitchen appliances.
- Langston Terrace (Ward 5) is a 274-unit development that consists of a combination of three-story walk-up buildings and two-story townhouses. Langston Additions is a 34-unit townhouse property that was built in 1954 and is directly adjacent to Langston Terrace to the north. The renovation plan notes that DCHA has an existing contract to replace the existing central boiler plant with a variable-refrigerant flow (VRF) HVAC system to provide heat and central air-conditioning to all units and public spaces.

[64] DC Housing Authority, *20-year Transformation Plan*, Public Comment Version (Aug. 28, 2019), https://dcha.us/img/guest_uploads/temp_rimehhGVtC15670083132z6ZwtkqRDhoZKdydLeU.pdf.
[65] *Id.*
[66] *Id.*

Modernizing and electrifying DC's public housing will increase affordability by reducing energy bills for residents and operating costs for the District. Electric appliances will also reduce emissions, improve indoor air quality, and deliver public health benefits.

Other Medium and Large Multi-family Housing (10 units or more)

The same criteria used to identify neighborhoods of small housing units for proactive electrification can also be used to identify the best opportunities to electrify the District's stock of large multi-family buildings. These include buildings adjacent to end-of-life gas infrastructure in neighborhoods with high environmental and energy burdens. Multi-family buildings that participate in the District's Inclusionary Zoning Affordable Housing program[67] in any part of the District should also be prioritized for electrification efforts. Notably the mean energy burden for low-income District residents in gas-heated multi-family buildings is also 50 percent higher than for residents of buildings with electric heat (as shown in Figure 10).

A study of multi-family residential buildings in New York City identified three additional criteria for identifying good candidates for electrification: "First, projects in owner-occupied properties will largely avoid issues that arise in rental buildings, such as resistance to submetering and billing directly for heating use. Condo and co-op owners have a vested interest in improving their units, and with electrification they benefit directly from improved comfort, control, and air quality in addition to lower costs after the payback period. Second, properties with expensive energy sources like fuel oil… can lower their utility costs by electrifying their heating. Buildings that use electric resistance heat rank even higher, since they will not require electrical upgrades and will realize big savings from heat pumps. Lastly, buildings with systems that are hard to upgrade should be considered, such as those with one pipe steam heating systems. These systems are typically inefficient, and there are fewer ways to improve them compared to other heating systems."[68]

[67] DC Department of Housing and Community Development, Inclusionary Zoning (IZ) Affordable Housing Program, https://dhcd.dc.gov/service/inclusionary-zoning-iz-affordable-housing-program (last visited Mar. 11, 2022).
[68] Urban Green Council, *Going Electric: Retrofitting NYC's Multifamily Buildings* (Apr. 2020), https://www.urbangreencouncil.org/sites/default/files/urban_green_going_electric_4.22.2020.pdf.

The Bay Area Renewable Energy Network (BayREN) has developed an electrification and efficiency program for owners of multi-family buildings that can be used as a model for efforts in the District. The Clean Heating Pathway[69] initiative addresses all fossil fuel end uses within multi-family buildings (including common area heating, laundry facilities, and pool heaters) and starts with a hands-on direct consultation with building owners. The program is designed to deliver financial incentives for every housing unit on a per-unit basis, even for those served by central space and water heating systems.

The conversion of residential buildings from shared to independent space and water heating systems opens new pathways for reducing overall energy use, since occupants will be less likely to waste energy if they are responsible for paying the monthly bill. However, as noted in the Clean Energy DC Plan, "residential submetering… can be particularly sensitive—and important—for affordable housing. As buildings increase in their efficiency toward net-zero energy levels of performance, developers of affordable housing must be able to provide a reduced utility allowance and proportionally increase the rent. However, the District should ensure that the net level of affordability for the tenant remains the same."[70]

Commercial & Municipal Buildings

The same criteria used to identify residential buildings for proactive electrification can also be used to identify the best opportunities to electrify commercial and municipal buildings in the District. These include buildings adjacent to end-of-life gas infrastructure in neighborhoods with high environmental and energy burdens. Depending on the building type and use, individual leased units may be best electrified one at a time, and concurrent with tenant turnover. For example, in a multi-story office building served by a central boiler it may be most cost-effective and least disruptive to convert partial floors to rooftop VRF heat pump systems.

[69] BayREN, Clean Heating Pathway, https://www.bayren.org/multifamily-property-owners/clean-heating-pathway (last visited Mar. 11, 2022).
[70] DC Department of Energy & Environment, *Clean Energy DC Plan* (Aug. 2018), https://doee.dc.gov/sites/default/files/dc/sites/ddoe/page_content/attachments/Clean %20Energy %20DC %20- %20Full %20Report_0.pdf.

The Clean Energy DC Plan notes that "many commercial tenant spaces, including office and retail, turn over an average of once every seven years. This makes tenant turnover a key opportunity to improve efficiency…. Time is a key consideration at tenant build-out, when both landlords and tenants are typically eager to complete the process as quickly as possible. Incentives should include simple set payments (e.g., $0.30 per square foot) for pre-determined packages for each major commercial tenant type (e.g., specific lighting densities for office, retail, etc.)"[71]

While the District has a current goal of lowering GHG emissions at least 50 percent below 2006 levels by 2032 on a path to carbon neutrality by 2050,[72] the DC Climate Commitment Act of 2021 pending before DC Council[73] would revise the 50 percent goal to 2030, set interim emission reduction targets, and require that emissions attributable to District government operations, including those related to dispositions of government property are reduced to a level consistent with carbon neutrality by 2040. Electrification is the only option for zeroing out emissions from public buildings in the District by 2040.

District-owned buildings including schools, libraries, and community centers across should be given additional priority for electrification retrofits. These buildings will provide a showcase for electrification success and serve as a starting point for community engagement that will aid in the District's efforts to gain public support for the electrification transition. The District of Columbia Public School System, for example, operates 117 facilities that serve more than 49,000 students.[74] As noted by the New Buildings Institute, "public K-12 schools are highly visible and cherished components of our public infrastructure. The K-12 sector offers an opportunity to showcase in every community in America that building efficiency, building electrification, green and resilient school facilities and grounds, and electric bus

[71] *Id.*
[72] CleanEnergy DC Omnibus Amendment Act of 2018, DC Law 22-257, https://code.dccouncil.us/us/dc/council/laws/22-257.
[73] Climate Commitment Act of 2021, Bill 24-420, 24th Council (as introduced on Oct. 1, 2021), https://lims.dccouncil.us/Legislation/B24-0420.
[74] DC Public Schools, DCPS at a Glance: Enrollment, https://dcps.dc.gov/page/dcps-glance-enrollment (last visited Mar. 11, 2022).

deployment are both within reach and massively beneficial from economic, health, climate, and equity points of view."[75]

Alignment

Implementation plans for residential full electrification should leverage the Department of Energy & Environment *Partnership for Healthy Homes* initiative to promote electrification, particularly targeted at the replacement of gas cooking appliances which are known to substantially increase the incidence of childhood asthma. "Illnesses and injuries impacted or caused by an environmental hazard are far and away the number one reason why children are hospitalized in the District of Columbia. What many parents do not know is that the number one place a child is likely to be harmed by an environmental health hazard is in his or her own home. Asthma, lead poisoning, unintentional injuries and other harmful health effects can all be linked to problems within the home. The most common culprits include peeling and/or deteriorating paint, mold, insect and rodent infestation, overuse of pesticides and other chemicals, poor ventilation, water leaks, trip and fall hazards, and malfunctioning cooling and heating systems."[76] This program can serve as an entry point for the Electrification Audit program.

Implementation should also involve enhanced cooperation with Department of Housing & Community Development's *Single Family Residential Rehabilitation Program* (SFRRP),[77] which provides grants of up to $20,000 to replace and/or repair a building's roof and grants up to $30,000 for accessibility modifications needed to adjust most physical barriers within a home for persons with mobility or other physical impairments. This program could be expanded to include gas stove retrofits which will improve the health of District residents by improving indoor air quality and could also be a gateway to the proposed Electrification Audits scheme recommended previously.

[75] New Buildings Institute, *Why K-12 Should Feature in America's National Climate Strategy* (Apr. 2021), https://newbuildings.org/wp-content/uploads/2021/04/Schools_WhitePaper_202104.pdf.
[76] DC Department of Energy & Environment, DC Partnership for Healthy Homes, https://doee.dc.gov/service/dc-partnership-healthy-homes (last visited Mar. 11, 2022).
[77] DC Department of Housing & Community Development, Single Family Residential Rehabilitation Program (SFRRP), https://dhcd.dc.gov/SFRRP (last visited Mar. 11, 2022).

The Department of Energy & Environment *Weatherization Assistance Program (WAP)* has in recent years funded energy improvements in multi-family buildings in partnership with other local agencies. For example, "In FY20, DOEE continued its partnership with DCSEU, DHCD, Community Forklift's Home Essentials Program, and Yachad's Single Family Home Repair Program. DOEE has leveraged over $200,000 in heating system installations in four multi-family buildings, addressed health and safety measures in a multi-family building, and leveraged over $60,000 to address rehab work and materials for clients that would have been deferred otherwise."[78] Future multi-agency multi-family building rehabilitation efforts should require electric-only retrofits.

As a point of consideration for any full-electrification programs in the District, we note evidence that 'direct installation' electrification retrofits by government and/or utility managed staff can be highly cost effective. In Sacramento, CA, it has been reported that "the average low-income direct installation cost for a heat pump water heater is $3,500, whereas for our market rate program… the average total cost is close to $3,800. The cost savings may be even greater if the direct-install contractor is able to go door-to-door and convert multiple adjacent homes. SMUD estimates that similar savings may be achieved with respect to heat pump space heating installations (e.g., an estimated $13,000 for direct install versus approximately $15,000 for market rate). To date, SMUD's direct installation program has only been offered to low-income customers, but it could be equally beneficial when applied to any home or neighborhood. Direct installation can be cost-competitive for the utility in sufficient volume."[79]

4. The Enabling Environment

Substantial planning and coordination among utilities, government agencies, building owners, advocates, and residents will be necessary to ensure effective

[78] U.S. Department of Energy, Weatherization Assistance Program (WAP) Annual File Worksheet (2021) (Grant Number: EE0007911, State: DC), https://doee.dc.gov/sites/default/files/dc/sites/ddoe/service_content/attachments/Approved%20WAP%20State%20Plan%20for%20Fiscal%20Year%202022.pdf.

[79] Comments of Sacramento Municipal Utility District Sacramento Municipal Utility District on Building Decarbonization and Energy Efficiency, Docket No. 21-IEPR-06 (Cal. Pub. Utils. Comm'n Sept. 2, 2021), https://efiling.energy.ca.gov/GetDocument.aspx?tn=239579&DocumentContentId=73012.

implementation of the District's electrification agenda and maximize beneficial outcomes for the District and its residents. Following are some key points for consideration in future planning activities.

Plan for Simultaneous Electrification & Gas Decommissioning

The DCPSC should make use of the current Climate Business Plan docket to plan a managed decommissioning of the existing gas distribution network as electrification efforts take hold across the District. Gas planning should be conducted with full transparency, minimizing redactions based on claims of confidential data which obscure the reasoning behind decisions and make stakeholder participation difficult. Ongoing planning will enable more focused and frequent input on barriers and potential solutions to electrification for LMI and other customers as plan implementation begins. Ongoing planning will also help the District manage the equitable allocation of costs across the system and enable independent validation of assumptions related to energy demand, consumer costs, and other important factors.

Allocate Costs Equitably

The District should evaluate and allocate costs across the energy system as a whole throughout the electrification transition. Holistic planning and cost allocation will enable costs to be distributed equitably among gas and electric utilities and their customers over the full transition period. For example, depending on the pace and success of District efforts to proactively electrify neighborhoods with high environmental and energy burdens, there is a risk that a disproportionate number of LMI ratepayers will be left to cover the existing high costs of the gas network, and their bills may eventually skyrocket.[80] With regular planning the District can, for example, consider accelerating the depreciation of selected gas investments, thereby increasing costs for all current ratepayers but reducing the costs left for households that are late to the energy transition, as well as the taxpayers that may subsidize them.

[80] Lucas Davis & Catherine Hausman, *Who Will Pay For Legacy Utility Costs?*, National Bureau of Economic Research (June 2021) (revised March 2022), https://haas.berkeley.edu/wp-content/uploads/WP317.pdf.

Second, holistic planning and cost allocation will facilitate fuel switching. Jurisdictions around the country have explored several strategies for meeting utility "obligation to serve" requirements without further expanding their gas systems. A study[81] on updating gas utility regulations in New York recommends that lawmakers alter the state's obligation to serve given the high financial and social costs of further investing in the natural gas distribution network. NRDC submitted testimony[82] saying the obligation could be generalized to ensure that utilities provide hot water and heat, rather than specifically gas. Also in New York, the Pace Energy and Environment Center recommended "changing the gas service application process to require developers and consumers to adopt alternatives to gas wherever feasible."[83]

Facilitate Gas Utility Business Model Diversification

Gas utilities around the country are considering alternative business models that can effectively leverage their existing customer relationships, workforce skills, and infrastructure assets in the decarbonized energy system of the future. A variety of options may be available, for example, as described in a Business Diversification Study[84] for Philadelphia Gas Works:

- Weatherization services, wherein the gas utility delivers services that improve building energy efficiency for their existing customers.
- Strategic Electrification services, wherein the gas utility sells and installs heat pumps and other electric appliances to their existing customers.
- Heat as a Service, wherein the gas utility finances the cost of electric appliances and incorporates equipment costs, fuel, and maintenance costs into monthly payments.

[81] Asa S. Hopkins et al., *Gas Regulation for a Decarbonized New York*, Synapse Energy Economics (June 29, 2020), https://www.synapse-energy.com/project/gas-regulation-decarbonized-new-york.
[82] Emily Pontecorvo, *Does your state want to cut carbon emissions? These old laws could be standing in the way*, Grist (Aug. 10, 2020), https://grist.org/energy/does-your-state-want-to-cut-carbon-emissions-these-old-laws-could-be-standing-in-the-way-buildings-heat-pumps/.
[83] Pace University, *Pace Energy and Climate Center Recommends Decarbonizing Buildings and Gas Utility Sectors* (July 29, 2020), https://law.pace.edu/news-and-events/news/pace-energy-and-climate-center-recommends-decarbonizing-buildings-and-gas.
[84] Energy & Environmental Economics, *Philadelphia Gas Works Business Diversification Study* (Dec. 2021), https://www.phila.gov/media/20211207134817/PGW-Business-Diversification-Study-2021-12.pdf.

- Networked Geothermal, wherein the gas utility repurposes segments of its distribution network to deliver hot water from large centralized geothermal heat pumps to individual buildings.

These and other zero-carbon business model options should be thoroughly evaluated for their applicability and feasibility for WGL.

Support Workforce Development

Regional electrification efforts have acknowledged the opportunity to promote local workforce development and the generation of new skilled jobs, particularly in underserved communities that stand to benefit the most from electrification. For example, the Sacramento Municipal Utility District reports that, "building decarbonization will result in the creation of thousands of new jobs. The largest decarbonization job growth is expected from the manufacturing, project development and operations, and construction sectors. It is vital that our underserved communities have awareness, skills training, and access to these jobs. For example… 'Earn and Learn' programs (e.g., apprenticeships, paid internships, and project-based learning) combine applied learning in a workplace setting with paid wages, which in turn allow workers to gain work experience and develop skills and competencies." Further, "development of new technologies to support decarbonization efforts will provide additional employment opportunities. The evolution and development of new technologies to support the state's building decarbonization goals present a prime opportunity for workforce development. Investments in small businesses located in underserved communities should be part of the equation. This will ensure that participation in the resulting economic growth in commercialization is accessible to everyone."[85]

Corresponding workforce reductions for gas utility employees are unlikely to come soon. As summarized in Gridworks' 2019 report, California's Gas System in Transition, "a [gas system] workforce will still be needed over the longer term, which means the transition is unlikely to significantly impact current employees in

[85] Comments of Sacramento Municipal Utility District Sacramento Municipal Utility District on Building Decarbonization and Energy Efficiency, Docket No. 21-IEPR-06 (Cal. Pub. Utils. Comm'n Sept. 2, 2021), https://efiling.energy.ca.gov/GetDocument.aspx?tn=239579&DocumentContentId=73012.

the next decade."[86] The report notes that gas workers will have an important, long-term role in the process of both safely maintaining remaining gas infrastructure and decommissioning segments of the gas system where appropriate.

Facilitate EV Charging

As electric vehicle (EV) technology matures, the EV market proliferates with more diverse and affordable models, and the benefits of EVs continue to lead consumers and fleet managers toward EV purchases, the District should ensure that the built environment presents as few barriers to EV adoption as possible. Assuming that load growth due to electrification will be effectively managed with minimal additional investment beyond that required of traditional load growth, policies that help eliminate other structural barriers to EV charger readiness and installation must be implemented.

New residential construction that can accommodate individual charger installations should be outfitted with sufficient electric service in order to adequately host an EV charger in addition to the full suite of electric appliances. As to commercial and multi-unit new construction, the existing environment is moving in the right direction, but more can be done. Several analyses have shown that including EV charging at the time of construction is much more cost effective than adding charging in a later retrofit. One study found that "[f]or a parking lot with 10 total spaces and two charging stations, the estimated EV infrastructure costs amount to $920 per charger during new construction, versus $3,710 per charger for a retrofit, largely because of trenching, demolition, and additional permitting costs."[87] An estimate by the California Air Resource Board found that significantly higher retrofit costs between $7,000 and $8,000 per parking space could be avoided by installing EV charging infrastructure in new construction.[88] Requiring or properly incentivizing EV charger readiness will save money and reduce barriers to EV decision making.

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[86] Gridworks, California's Gas System in Transition (Sept. 2019), https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf.

[87] Matt Frommer, *Cracking the Code on EV-Ready Building Codes*, Southwest Energy Efficiency Project (Oct. 23, 2018), https://www.swenergy.org/cracking-the-code-on-ev-ready-building-codes.

[88] California Air Resources Board, *EV Charging Infrastructure: Nonresidential Building Standards* (Nov. 15, 2019), https://ww2.arb.ca.gov/sites/default/files/2020-09/CARB_Technical_Analysis_EV_Charging_Nonresidential_CALGreen_2019_2020_Intervening_Code.pdf.

Pursuant to DC's EV Readiness Amendment Act of 2020[89] requiring that for permits issued after January 1, 2022, all new construction or substantial improvement of commercial buildings and multi-unit buildings that have 3 or more automobile off-road parking spaces shall include electric vehicle make-ready infrastructure to accommodate the future installation of an electric vehicle charging site at least 20 percent of the parking spaces. Incentives should be provided for developers to build out charging infrastructure beyond the 20 percent spot minimum in the EV Readiness Act. These could include waiving certain developer fees, or other monetary incentives.

Retrofits present electrification challenges that encompass EV readiness, but they are not insurmountable. As noted above, given the average age of DC residences, it is likely that they have inadequate electrical panels and wiring for electrification, including sufficient EV readiness. As with the decision point of switching to electric appliances, the additional cost and effort of upgrading an electric service and panel may dissuade a customer from purchasing an EV.[90] The proposed Electrification Audits should include a detailed accounting of necessary upgrades for EV charging that will allow District residents and building owners to select the most cost-effective approach to EV charging at the time they consider purchase of an EV. The Electrification Audits should also be coupled with aggressive incentive packages that are menu-based, which would include incentives matched to EV readiness. Incentives for low-income residents must be higher to ensure that program benefits are equitably distributed and, if incentives are menu based, that low-income residents are not priced out of the full offerings of incentives across categories.

[89] Chairman Phil Mendelson & Committee of the Whole, *Report on Bill 23-193, 'Electric Vehicle Readiness Amendment Act of 2020'* (Nov. 17, 2020), https://chairmanmendelson.com/wp-content/uploads/2020/11/B23-193-Electric-Vehicle-Readiness-Draft-Committee-PACKET.pdf.

[90] DC Department of Housing and Community Development, Home Investment Partnerships (HOME) Program, https://dhcd.dc.gov/page/home-investment-partnerships-home-program (last visited Mar. 11, 2022).

Part 3: Gas is Not the Solution to the District's Climate Challenges

Gas and gas alternatives are a major contributor to GHG emissions across the District. Emissions occur whenever and wherever gas is burned. You just can't work your way out of a fossil fuel problem with more fossil fuels.

Gas is Expensive & Prices are Volatile

The price of fossil fuels like natural gas is inherently volatile[91] due to a variety of factors, including geopolitical events, macroeconomic trends, and weather.[92] This price volatility leads to uncertainty in energy bills, creating real hardship for millions of American households, particularly the 15 million below the federal poverty line, who spend on average 17 percent of income on energy bills[93] and have little financial capacity to deal with price spikes.

Figure 12 shows historical estimated winter season heating bills by fuel for the average American household at left.[94] Variations in fuel prices and average temperatures give rise to significant variance in energy bills, especially for fossil fuels. The right-hand graph shows the twenty-year average volatility of these bills, defined as the expected year-over-year absolute change in bill. The greatest offenders are heating oil and propane, with a volatility of $200-300. Electric heat pumps are the hands down winner, with a volatility of $35, roughly 38 percent less than that of natural gas.

[91] U.S. Energy Information Administration, *Oil market volatility is at an all-time high* (Mar. 27, 2020), https://www.eia.gov/todayinenergy/detail.php?id=43275.
[92] U.S. Energy Information Administration, *Natural gas explained: Factors affecting natural gas prices*, https://www.eia.gov/energyexplained/natural-gas/factors-affecting-natural-gas-prices.php, (last updated Oct. 5, 2021).
[93] U.S. Department of Energy, LEAD Tool, https://www.energy.gov/eere/slsc/maps/lead-tool (last visited Mar. 11, 2022).
[94] Sam Calisch et al., *Energy Bill Security for American Households Through Electrification*, Rewiring America (Dec. 9, 2021), https://www.rewiringamerica.org/policy/energy-bill-security.

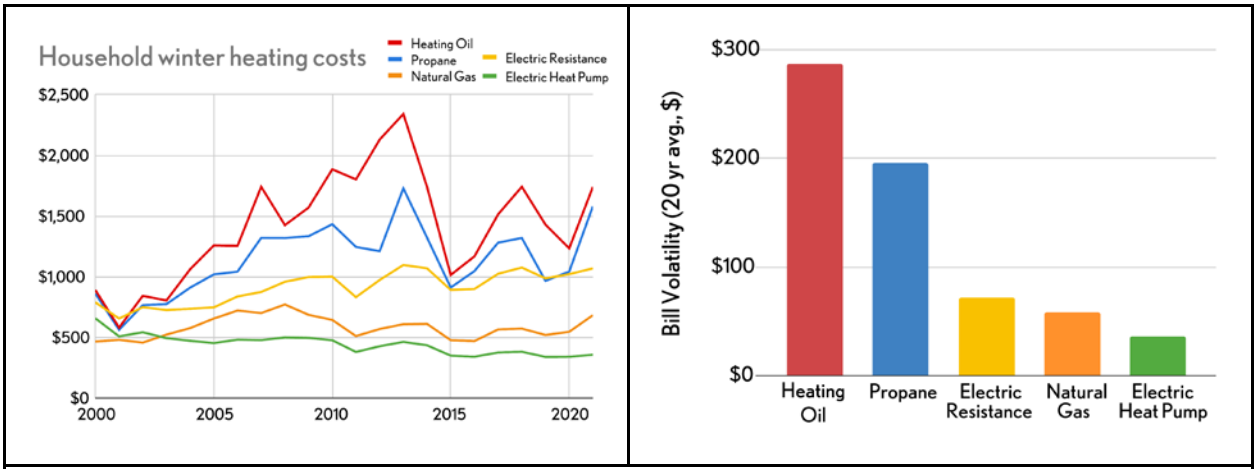

Figure 12: 20-year Heating Bill Volatility, US Average

Similarly, Figure 13 shows the same quantities, but only for the South Atlantic region, of which DC is a part. Again, households utilizing electric heat pumps for heating experience the most stable, predictable bills. These market dynamics and realities have only been thrown into greater relief with the current Russian invasion of Ukraine and associated oil and gas price volatility.

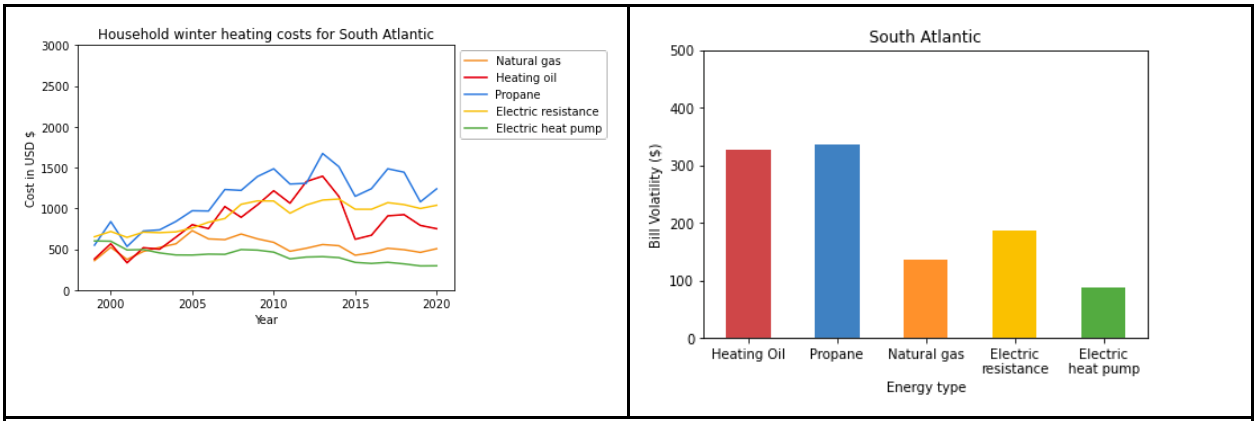

Figure 13: 20-year Heating Bill Volatility, South Atlantic Census Region Average

Gas is a Costly 'Buried Asset'

The projected costs to repair and replace Washington Gas & Light's (WGL) gas distribution network are significant and, based on recent performance, there is reason to believe that those costs will grow. WGL provides an estimated cost of $397 million for the next 6 years of PROJECTpipes that accounts for "jurisdictional

requirements" (e.g., saw cutting and breakage, paving and restoration, and traffic control requirements), inflation, and potential project scope expansion. However, the full plan runs through 2054 and three extensions granted to the first five years of the plan have already increased the projected cost by 28 percent from $110 million to $141 million, and total costs may reach $4.5 billion. Cost overruns are common across many natural gas projects nationwide, from Pittsburgh[95] to Chicago.[96]

Most notably, on March 2, 2022, the Maryland Public Service Commission issued findings[97] that WGL was well behind schedule and well over budget on its Maryland pipeline replacement plan, known as STRIDE. The Commission found that WGL was on pace to complete less than 60 percent of its forecast pipeline replacements while exceeding its 5-year budget, noting that "Washington Gas has effectively and unilaterally amended the plan the Commission approved in 2018, by materially deviating from its projections regarding the amount of work that would be completed, the costs of the projects, and the benefits. In essence, the company has overpromised and under-delivered, depriving customers of the benefits anticipated under the STRIDE statute, including accelerated pipeline replacement."

Whether for traditional methane gas or RNG, these massive and escalating infrastructure costs all come at the expense of additional investments in electric infrastructure.

While ratepayers knowingly pay for maintenance and upgrades to the gas system, they also bear other, often hidden costs due to natural gas's unreliability and dangerous properties.

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[95] Daniel Moore, *Facing cost overruns, Columbia Gas asks for customers to pay more*, Pittsburgh Post-Gazette (Jan. 26, 2016), https://www.post-gazette.com/business/powersource/2016/01/26/Facing-cost-overruns-Columbia-Gas-asks-for-customers-to-pay-more-Pennsylvania/stories/201601260004.

[96] Robert Channick, *Peoples Gas is spending billions to replace miles of aging pipe below Chicago by 2040*, Chicago Tribune (Dec. 22, 2020), https://www.chicagotribune.com/business/ct-biz-peoples-gas-pipeline-replacement-renewable-energy-20201222-i6er5w2abjeazg34ywajhfvg7q-story.html.

[97] Order Approving 2022 Stride-2 Project List and Amending Stride Surcharge, Case No. 9486 (Md. Pub. Serv. Comm'n Mar. 2, 2022), https://www.psc.state.md.us/wp-content/uploads/Washington-Gas-STRIDE-Order.pdf.

Methane Leaks & Associated Risks

The District's gas distribution network is notoriously leaky. In its recently filed Fugitive Methane Leak Study, the DC Department of Energy and the Environment stated that "[i]n 2019, the most recent reporting year, the District of Columbia had the highest percent lost gas (6.2 percent) among the U.S. states and the District of Columbia. The volume of lost gas in 2019 (19 million therms), at a nominal price of natural gas in the District of $1.25/therm, represents a lost value of approximately $24M."[98]

That study, conducted from April to June of 2021, found 3,346 surface leaks (an average of 4.7 emission points per road mile) that were verified to be coming from the natural gas delivery system.[99] Another recent public-led survey and study conducted by members of the Sierra Club, Washington Interfaith Network, and Interfaith Power and Light found nearly 400 active methane gas leaks coming from gas distribution infrastructure, including over a dozen at levels at which explosion was possible.[100]

Gas leaks can also lead to fire and explosions. While infrequent, destructive gas explosions do happen regularly. Recent examples abound, including some close to home: Just this month, a cut gas line was found at the site of an explosion just over the District line in Silver Spring, MD destroyed an apartment complex and sent 12 people to the hospital.[101] A 2020 gas explosion in Baltimore leveled three homes and killed two;[102] a 2014 New York City gas explosion[103] killed eight and leveled two

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[98] *Formal Case No. 1154*, 2021 Fugitive Methane Emission Survey of the District of Columbia for the District of Columbia Department of Energy and Environment, filed Nov. 30, 2021, https://edocket.dcpsc.org/apis/api/filing/download?attachId=143587&guidFileName=d93076fd-4fbd-4537-9947-27db2f19f967.pdf.

[99] *Id.*

[100] Beyond Gas DC, *Neighborhood Researchers Find Hundreds of Methane Gas Leaks Across DC* (Feb. 25, 2022), https://www.sierraclub.org/sites/www.sierraclub.org/files/sce/washington-dc-chapter/Methane-Leaks-Across-DC-FINAL.pdf.

[101] Jack Moore & Colleen Kelleher, *Silver Spring explosion: Investigators find cut gas line; search of rubble continues*, WTOP (Mar. 4, 2022), https://wtop.com/montgomery-county/2022/03/human-error-possible-in-friendly-garden-apts-explosion/.

[102] Julio Cortez & Nathan Ellgren, *Death toll rises to 2 people from Baltimore gas explosion*, ABC News (Aug. 11, 2020), https://abcnews.go.com/US/wireStory/death-toll-rises-people-baltimore-gas-explosion-72304639.

[103] Marc Santora & Patrick McGeehan, *Search for Bodies Yields to Hunt for a Cause of East Harlem Explosion*, The New York Times (Mar. 14, 2014), https://www.nytimes.com/2014/03/15/nyregion/new-york-city-to-arrange-housing-for-families-displaced-in-blast.html.

apartment buildings; and a 2018 Massachusetts gas explosions[104] killed one person, injured 22, and forced thousands to temporarily evacuate their homes. Many smaller incidents are less widely reported. Like all costs of maintaining the gas system, the fines and legal damages covered by the offending gas companies are largely borne by local ratepayers.[105]

Health

Methane leaks from gas appliances, along with combustion emissions from gas stoves, and gas and oil heating appliances, all contribute to local indoor and outdoor air pollution. Health impacts from local pollution sources are known to disproportionately affect vulnerable communities.[106] Figure 14 illustrates the high degree of correlation between air pollution mortality from PM2.5 emissions and the percentage of black residents in communities across the District. With this evidence in mind, we support the Office of People's Counsel recommendation that the District should "consider whether beneficial electrification could be enacted with a prioritization of areas that could most benefit from localized air pollution reductions."[107]

[104] Mihir Zaveri & Jacey Fortin, *Massachusetts Gas Company to Plead Guilty After Fatal Explosion*, The New York Times (Feb. 26, 2020), https://www.nytimes.com/2020/02/26/us/columbia-gas-massachusetts.html.
[105] Elizabeth Lesly Stevens & Katharine Mieszkowski, *Gas Explosion Prompts Scrutiny of PG&E's Profits*, The New York Times (Sept. 19, 2019), https://www.nytimes.com/2010/09/19/us/19bcpge.html.
[106] American Lung Association, State of the Air: Populations at Risk, https://www.lung.org/research/sota/key-findings/people-at-risk (last visited Mar. 11, 2022).
[107] *Formal Case No. 1167*, The Office of the People's Counsel for the District of Columbia's Comments on Pepco's Climate Solutions Plan, filed Sept. 20, 2021, https://edocket.dcpsc.org/apis/api/Filing/download?attachId=141443&guidFileName=34d3d56f-449f-4847-8321-302bb4d84c5f.pdf.

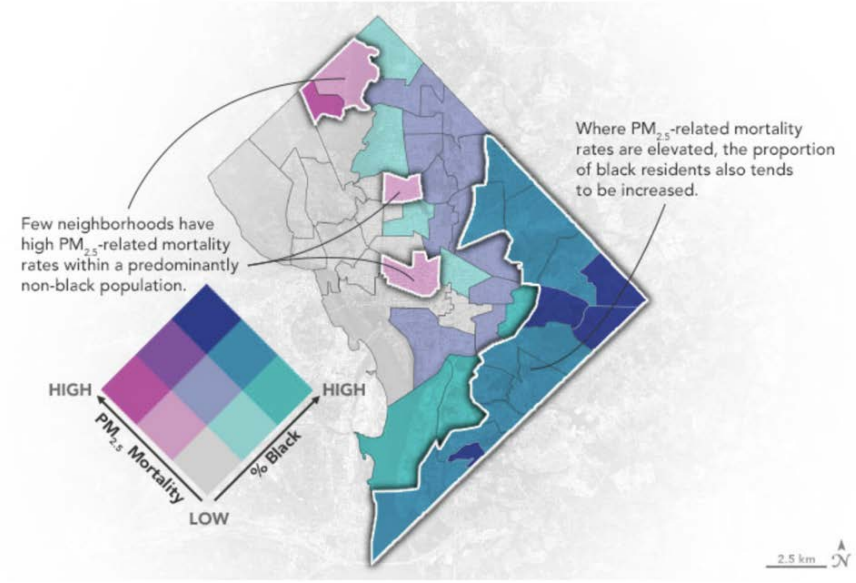

Figure 14: Correlation Between PM2.5 Mortality and Black Resident Population

A recent study from Stanford University found that gas stoves are particularly dangerous sources of GHG emissions and, especially in homes with poor ventilation, harmful indoor air pollution. In terms of climate impacts, the researchers noted that "annual methane emissions from all gas stoves in U.S. homes have a climate impact comparable to the annual carbon dioxide emissions of 500,000 cars," and in terms of health impacts, "families who don't use their range hoods or who have poor ventilation can surpass the 1-hour national standard of NO2 (100 ppb) within a few minutes of stove usage, particularly in smaller kitchens."[108] The concentration of NO2 in homes is even higher during winter months, when windows are closed and ventilation in homes is at its lowest. A study by the Lawrence Berkeley National Laboratory found that 51 to 64 percent of homes using gas stoves during winter regularly experienced household NO2 levels that exceeded health-based outdoor air standards.[109] It is reasonable to expect that other gas appliances also contribute to methane emissions and harmful indoor air pollution across the District. Even the most successful gas distribution maintenance

[108] Eric Lebel et al., *Methane and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes* (Jan. 27, 2022), https://pubs.acs.org/doi/10.1021/acs.est.1c04707.
[109] Andee Krasner et al., *Cooking with Gas, Household Air Pollution, and Asthma: Little Recognized Risk for Children*, 83 J. Env't. Health 8, 14 (2021) (citing Jennifer M. Logue et al., *Pollutant Exposures from Natural Gas Cooking Burners: A Simulation-Based Assessment for Southern California*, 122 Env't. Health Persps. 43 (2014)).

program will not be able to find and fix indoor methane leaks, and even assuming the highly implausible zero-leak scenario, continuing to burn methane for appliance usage is a well-documented cause of degraded indoor air quality and negative health outcomes.

Reliability & Resilience

Furthermore, even as the gas industry touts the fuel's dependability,[110] it has consistently proven unreliable during extreme weather events, which are projected to increase in frequency and strength[111] because of climate change. A February 2021 cold snap in Texas[112] caused power outages that lasted as long as four days for 4.5 million people, led to the deaths of approximately 200 people, and caused more than $100 billion in property damage. The main driver was frozen gas plants: 38 of 176 of Texas' gas processing plants shut down and natural gas production dropped 45 percent[113] during the freeze, causing the majority of the outages.[114] Another gas outage caused over 7,000 Rhode Island homes to lose power and heat in single-digit weather in 2019.[115]

"Renewable" Gas is Even More Expensive than Fossil Gas

Renewable natural gas (RNG) is often hailed as a panacea for climate worries: an ostensibly climate-friendly fuel that can be used with the same piped distribution network, same meters, same furnaces, same boilers, with no sacrifices. Technically, RNG is any piped gas derived from organic sources like agricultural wastes, garbage in landfills, wastewater, or manure, instead of conventional fossil natural gas. As the reasoning goes, these sources took their carbon from the atmosphere via photosynthesis, so burning the derived gas re-releases this gathered carbon, and

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[110] American Petroleum Institute, Natural Gas Solutions, https://www.api.org/news-policy-and-issues/natural-gas-solutions (last visited Mar. 11, 2022).
[111] Intergovernmental Panel on Climate Change, *Climate Change 2021: The Physical Science Basis* (Oct. 2021), https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf.
[112] Jeff St. John, *The Texas energy system faces a winter reckoning — again*, Canary Media (Feb. 2, 2022), https://www.canarymedia.com/articles/policy-regulation/the-texas-energy-system-faces-a-winter-reckoning-again?.
[113] Garrett Golding et al., *Cost of Texas' 2021 Deep Freeze Justifies Weatherization*, Federal Reserve Bank of Dallas (Apr. 15, 2021), https://www.dallasfed.org/research/economics/2021/0415.aspx.
[114] Federal Energy Regulatory Commission, *Final Report on February 2021 Freeze Underscores Winterization Recommendations*, (Nov. 16, 2021), https://www.ferc.gov/news-events/news/final-report-february-2021-freeze-underscores-winterization-recommendations.
[115] Ryan Belmore, *Report details causes of January natural gas outage*, What's Up Newp (Oct. 30, 2019), https://whatsupnewp.com/2019/10/report-details-causes-of-january-natural-gas-outage/.

hence the direct combustion is carbon neutral on balance. The real story is much more complicated. In truth, RNG is an expensive fuel with limited supply that's not actually clean and will continue to require significant infrastructure investment. For all but a handful of hard-to-decarbonize uses, electrification is a more cost-effective, cleaner option.

A 2019 report[116] by the American Gas Foundation found that RNG is likely to be available at costs of $7/MMBtu to $45/MMBtu. A 2016 report[117] for the California Air Resources Board found that costs per MMBTU for RNG ranged from $30 to over $100 for dairies, $15 to $22 for municipal solid waste, $7 and over $50 for landfills, and between $9 and over $50 for wastewater treatment plants. According to the EIA, the city gate price of fossil gas is about $3.30/MMBTU.[118] In short, the price of RNG varies between 2 and 15 times as expensive as fossil gas.

Under the most optimistic circumstances at very low production volumes, these data imply that RNG is over twice as expensive as fossil gas. As more RNG is produced, less optimal sources must be used, driving up the price and exacerbating the differential with fossil gas. For example, just 20 percent of the potential RNG resource is accessible at two times the price of fossil gas. In producing just half of the potential RNG resource, the price jumps to four times the price of fossil gas. By the time we are producing nearly the total technical potential, the price is over 15 times as expensive.

Given that heat provided by high performance electric heat pumps is approximately at cost parity with that provided by fossil gas today, a transition to RNG would increase household energy bills by several fold, tipping the scales heavily in favor of electrification.

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[116] American Gas Foundation, *Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment* (Dec. 2019), https://www.gasfoundation.org/wp-content/uploads/2019/12/AGF-2019-RNG-Study-Full-Report-FINAL-12-18-19.pdf.
[117] Amy Myers Jaffe, *Final Draft Report on The Feasibility of Renewable Natural Gas as a Large-Scale, Low Carbon Substitute*, California Air Resources Board, Contract No. 13-307 (2016), https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/13-307.pdf.
[118] U.S. Energy Information Administration, Natural Gas Prices, https://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_a.htm (last visited Mar. 11, 2022).

RNG and Fossil Gas Alternatives are Not Clean

Despite their branding, RNG and other fossil gas alternatives - e.g., 'Certified' gas or gas blended with hydrogen - are not clean like other forms of renewable energy. Because these products are still chiefly methane, the unavoidable leaks in transmission and distribution along with their ultimate combustion are significant sources of emissions.

Recent data shows methane leaks are extensive. A 2021 study[119] found that the majority of U.S. urban natural gas emissions were not accounted for in greenhouse gas inventories, finding an average leak rate between 3.3 and 4.7 percent from well to urban customer. A 2018 study[120] found that methane emissions were 60 percent higher than previously estimated by the EPA, estimating approximately 2.3 percent of the U.S. gross gas production is lost to leaks. Other studies have found even higher values, for example a 2011 study[121] estimated the leak rate at 3.6 percent to 7.9 percent. When factored into residential natural gas heating, these leaks account for roughly one-half of equivalent emissions,[122] Thus, in the most optimistic case, RNG still causes approximately 50 percent of the emissions of conventional gas.

However, research indicates that leakage rates among RNG facilities may be even higher than the fossil gas industry at large, leading to higher emissions from RNG. In a 2019 survey[123] of biogas plants, the average leakage rate was 4.6 percent, roughly double the gas industry average even before including transmission, distribution, and combustion. At this leakage rate, RNG retains over two-thirds the emissions of fossil gas. Wastewater treatment plants, a major source of biogas, were even higher at 7.5 percent on average with some plants as high as 15 percent.

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[119] Maryann R. Sargent et al., *Majority of US urban natural gas emissions unaccounted for in inventories* (Oct. 25, 2021), https://www.pnas.org/content/118/44/e2105804118.
[120] Ramon Alvarez et al., *Assessment of methane emissions from the U.S. oil and gas supply chain*, 361 Sci. 186 (June 21, 2018), https://www.science.org/doi/10.1126/science.aar7204.
[121] Robert W. Howarth et al., *Letter: Methane and the greenhouse-gas footprint of natural gas from shale formations*, 106 Climatic Change 679, 679–690 (Apr. 12, 2011), https://link.springer.com/content/pdf/10.1007 %2Fs10584-011-0061-5.pdf.
[122] Diana Burns & Emily Grubert, *Attribution of production-stage methane emissions to assess spatial variability in the climate intensity of US natural gas consumption*, 2021 Environ. Res. Lett. 16 044059 (Apr. 8, 2021), https://iopscience.iop.org/article/10.1088/1748-9326/abef33.
[123] Charlotte Scheutz & Anders M. Fredenslund, *Total methane emission rates and losses from 23 biogas plants*, 97 Waste Management 38 (Sept. 2019), https://www.sciencedirect.com/science/article/abs/pii/S0956053X19304842.

A 2020 report[124] found that for leakage rates above 6 percent, the equivalent emissions of intentionally produced RNG is higher than that of conventional fossil gas. That is, for leakage rates observed in existing facilities, emissions from RNG are just as high as fossil gas.

As for other fossil gas alternatives, we note that even the highest grades of 'certified gas' - which refers to gas from a facility with a low rate of methane leakage - still allow for some methane leakage. Further, certification only focuses on methane leakage from production and does nothing to address leaks in distribution.[125] For hydrogen blends, the problem is even more complex. Earthjustice reports that even "the most optimistic scenarios estimate that the gas system that serves homes and most businesses could only handle up to 20% hydrogen by volume—representing just 7% of the energy in the gas pipeline system because hydrogen is less energy dense than methane."[126] Furthermore, "because hydrogen molecules are much smaller than methane molecules, utilities may also need to upgrade their infrastructure to prevent it from leaking into the atmosphere. When a pipeline carries a blend of hydrogen and methane, hydrogen can leak at three times the rate of methane."[127] These are not clean alternatives to traditional fossil gas.

Proponents of RNG often tally potential large emissions reductions by assuming the biogas waste stream being turned into RNG would otherwise be vented directly to the atmosphere. This is disingenuous in two ways. First, the total amount of capturable methane sources currently being vented is less than 1 percent of the current fossil gas resource.[128] Applying the climate benefits of these sources to a hypothetical RNG system capable of meeting any significant portion of current fossil gas demand is not realistic. To have an RNG system that can meet our demands, the feedstocks would very likely be intentionally produced.[129] Because RNG from such intentionally produced methane streams does not mitigate an

[124] Emily Grubert, *At scale, renewable natural gas systems could be climate intensive: the influence of methane feedstock and leakage rates*, 2020 Environ. Res. Lett. 15 084041 (Aug. 11, 2020), https://iopscience.iop.org/article/10.1088/1748-9326/ab9335.
[125] MiQ, MiQ Standards, https://miq.org/document_categories/miq-standards/ (last visited Mar. 11, 2022),
[126] Sasan Saadat & Sara Gersen, *Reclaiming Hydrogen for a Renewable Future: Distinguishing Oil & Gas Industry Spin from Zero-Emission Solutions,* Earthjustice (Aug. 2021), https://earthjustice.org/sites/default/files/files/hydrogen_earthjustice_2021.pdf.
[127] *Id.*
[128] Emily Grubert, *At scale, renewable natural gas systems could be climate intensive: the influence of methane feedstock and leakage rates*, 2020 Environ. Res. Lett. 15 084041 (Aug. 11, 2020), https://iopscience.iop.org/article/10.1088/1748-9326/ab9335.
[129] *Id.*

existing source of emissions, it has approximately equivalent emissions to fossil gas.

Second, even with existing methane waste streams, emissions would likely be eliminated by flaring (i.e., burning) rather than by production of RNG.[130] Because the emitted carbon dioxide is approximately 75 times less potent than methane,[131] nearly all the equivalent emissions are eliminated by this method. Such flaring is commonplace at landfills across the country. If methane can be captured for RNG, then it can also be captured for flaring. Critically, given that the leakage rate of downstream gas infrastructure is generally larger than the combustion efficiency of flaring, flaring delivers at least as much emissions reduction as RNG.

There is Not Enough RNG to Go Around

Besides the fact that RNG is not clean, there's also not enough of it to be relevant to meeting current demand for fossil gas. Argonne National Lab tracks RNG facilities and maintains up-to-date counts of existing and planned facilities.[132] As of 2020, there were approximately 60 trillion BTU per year of RNG produced. Of these, approximately 46 trillion BTUs came from landfills, 7 trillion from livestock, 4 trillion from food waste, and 3 trillion from wastewater treatment. This amounts to approximately 0.2 percent of U.S. natural gas consumption, according to the EIA.[133]

If all the potential sources of RNG in the U.S. were developed (requiring building out massive new gas infrastructure to do so), the RNG has the potential to meet just 1 percent of U.S. fossil gas consumption. The USDA's Biogas Opportunities Roadmap[134] estimates there exist about 13,000 sites in the U.S. that could host a biogas system (about 2,000 of them are currently built out). Taken together, these potential sites could generate 650 billion cubic feet of gas per year (or about 350 trillion BTU per year). Critically, this biogas is made up chiefly of methane (40-60

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[130] *Id.*
[131] Sam Abernethy & Robert B Jackson, *Global temperature goals should determine the time horizons for greenhouse gas emission metrics*, 2022 Environ. Res. Lett. 17 024019 (Feb. 9, 2022), https://iopscience.iop.org/article/10.1088/1748-9326/ac4940.
[132] Argonne National Laboratory, Renewable Natural Gas Database, https://www.anl.gov/es/reference/renewable-natural-gas-database (last visited Mar. 11, 2022).
[133] U.S. Energy Information Administration, Natural Gas Consumption by End Use, https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm (last visited Mar. 11, 2022).
[134] U.S. Department of Agriculture, *Biogas Opportunities Roadmap* (Aug. 2014), https://www.usda.gov/sites/default/files/documents/Biogas_Opportunities_Roadmap_8-1-14.pdf.

percent) and carbon dioxide (30-50 percent). This means the usable (methane) portion of this biogas is roughly 360 billion cubic feet. In NREL's Biogas Potential of the United States,[135] the authors estimate the methane potential from landfill material, animal manure, wastewater, and industrial, institutional, and commercial organic waste at 420 billion cubic feet (430 trillion BTU per year).

While this may sound like a lot of gas, the U.S. consumption of fossil gas in 2020 was over 30 trillion cubic feet per year according to the EIA.[136] This means if the infrastructure required to convert, harvest, collect, transport, and distribute the biogas from all potential sources in the U.S., the total technical potential of methane production by organic sources is just 1.3 percent of national consumption. Note that some studies have quoted higher percentage estimates, but this generally refers to the percentage of natural gas used for electricity generation (about 11 trillion cubic feet), rather than the full set of uses including residential, commercial, industrial, and transportation sectors.

Additionally, a California study[137] found the state had the theoretical potential to produce approximately 90 billion cubic feet. In 2020, California consumed 2.1 trillion cubic feet of fossil gas, an upper bound of 4 percent of the supply that could potentially be met with RNG. A study for Philadelphia Gas Works found that "decarbonized gasses…are limited in terms of commercialization or total availability" and that "a full transition to decarbonized gasses in Philadelphia would likely require significant amounts of synthetic natural gas, a source of methane that is not yet commercialized."[138]

Despite the limited resource, proponents of RNG count it as a key component of any net-zero target. For instance, a 2021 American Gas Association report[139]

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[135] National Renewable Energy Laboratory, *Biogas Potential in the United States* (Oct. 2013), https://www.nrel.gov/docs/fy14osti/60178.pdf.
[136] U.S. Energy Information Administration, Natural Gas Consumption by End Use, https://www.eia.gov/dnav/ng/ng_cons_sum_dcu_nus_a.htm (last visited Mar. 11, 2022).
[137] Amy Myers Jaffe, *Final Draft Report on The Feasibility of Renewable Natural Gas as a Large-Scale, Low Carbon Substitute*, California Air Resources Board, Contract No. 13-307 (2016), https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/13-307.pdf.
[138] Energy & Environmental Economics, *Philadelphia Gas Works Business Diversification Study* (Dec. 2021), https://www.phila.gov/media/20211207134817/PGW-Business-Diversification-Study-2021-12.pdf.
[139] ICF International for the American Gas Association, *Net-Zero Emissions Opportunities for Gas Utilities* (2021), https://www.aga.org/globalassets/research--insights/reports/aga-net-zero-emissions-opportunities-for-gas-utilities.pdf.

assumes over 5 quadrillion BTUs of RNG will be used (excluding any used for electricity generation), over ten times higher than the NREL bound on maximum methane potential quoted above.

Given the limited supplies of methane waste streams capable of supporting RNG production, and the remaining hard-to-decarbonize industries and processes that could use such fuels, we cannot afford to use RNG where electrification is a clean, affordable alternative, as is the case for residential and commercial heat.

Conclusion

As demonstrated throughout this report, the extraordinary benefits of electrification - in terms of GHG emissions reductions, energy bill savings, air pollution, public health, and other factors - stand in stark contrast with the extraordinary costs and ever-present risks of long-term fossil fuel use in the District. Clearly gas of any type or brand - biogenic, natural, certified, or otherwise - is incompatible with the District's climate goals due to its emissions impacts and is incompatible with the interests of District residents due to its negative health, environmental, equity, and economic impacts.

Electrification is the only way forward. The District's climate leadership and vision is well established, and the necessary technologies exist. As long as electrification efforts are coupled with managed decommissioning and downsizing of gas distribution there will be plenty of funding available to support the District's continued progress toward a clean energy future.