Ms. Christine Knapp
Director, Office of Sustainability City of Philadelphia
One Parkway Building
1515 Arch Street, 13th Floor
Philadelphia, PA 19102

May 28, 2021

Re: Vicinity Energy Comments – Draft PGW Diversification Study

Dear Ms. Knapp,

Thank you for the opportunity to provide feedback on the PGW Diversification Study. Comments from Vicinity Energy are below. To summarize, we offer the following recommendations to accelerate the decarbonization of Philadelphia:

- **Better Capital Allocation: PGW Should Invest in Current Philadelphia Ratepayers:** Redirect PGW's capital dollars toward improving and greening the existing gas system. This would reduce carbon emissions by reducing existing methane leakage and benefit ratepayers and workers.
- **Partner with Vicinity to Target Existing Building Stock:** Vicinity offers a simple, centralized solution to rapidly decarbonize buildings that have been challenging to address.
- **Leverage Existing Infrastructure:** Many of the proposed options in the PGW Diversification study would require expensive retrofits for existing buildings. The expansion of Vicinity's existing infrastructure allows for adoption with minimal disruption or costs.
- **Incentivize New Connections to the District Energy Loop to Avoid Stranded Assets:** Any increase to PGW's footprint and existing fossil-fuel based infrastructure also increases the magnitude of stranded asset risk.

Vicinity Energy Moving to a Zero-Carbon Future in Philadelphia

Vicinity Energy's district energy system in Philadelphia serves over 100 million square feet of office, residential, educational, public safety, hospital and laboratory space in Center City and adjacent neighborhoods. The district system distributes thermal energy in the form of steam for heating, cooling, sterilization and humidification to over 400 buildings in downtown Philadelphia. With multiple power supplies, back-up generation, and several water and fuel sources, the Vicinity district system provides superior resiliency and 99.99% reliability to its customers.

The Vicinity district energy system is comprised of two key components for decarbonization: 1) two central generating facilities that produce steam, including the Grays Ferry combined heat and power (CHP) plant and 2) a network of robust underground pipes that deliver our steam to end-use customers. This established "energy district" and the many buildings connected our system allow Vicinity to move the City of Philadelphia rapidly towards lower carbon emissions. Not only is CHP technology the most efficient use of hydrocarbon-based fuels today, every "greening" investment made at one of Vicinity's central facilities immediately benefits every square foot of building space connected to the system.

Vicinity's sustainability goals are aligned with the City of Philadelphia's Climate Action Playbook, and we recently formalized our commitment to achieve net zero carbon emissions by 2050 with our Clean Energy Future vision and roadmap. Vicinity has a history of innovation for the benefit of the environment and our communities. We've transitioned our operations many times in the past, from coal to oil, oil to gas, gas to gas/CHP and now we're moving on to low/no carbon solutions. As part of our Clean Energy Future, we are replacing our current natural gas

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feedstock with alternate energy inputs and electrification to generate our steam, benefiting our customers and the city.

Vicinity has invested over $60 million in its energy infrastructure in recent years, resulting in carbon emissions reductions by over 300,000 tons per year – the equivalent of removing almost 65,000 cars from the roads annually. Further reductions have occurred with the introduction of biogenic fuel derived from waste vegetable oil and fats discarded by the food service industry. Used as a feedstock, renewable biogenic fuel is now replacing conventional petroleum based liquid heating oil use at the Edison generating facility. This conversion not only reduces carbon emissions but also eliminates the need for oil and supports the environment by using a product that would otherwise be discarded in landfills or city sewers, which burdens these municipal assets.

Vicinity's existing network of underground steam pipes is a highly efficient energy solution and delivery system that can connect to new and existing buildings at low capital cost. Every one million square feet of building space converted to district energy cuts carbon emissions by 3,100 to 4,500 tons per year. Furthermore, these estimates are based on current CHP technology and feedstock. As Vicinity continues to implement net zero carbon emissions systems and technologies that reduction will increase. We're committed, invested and prepared to quickly respond to Philadelphia's urgent need to reduce carbon emissions.

Vicinity's ability to adapt its centralized steam generating facilities to achieve a net zero carbon future means that the system avoids the stranded asset risk that most users of natural gas, coal, and oil face as conventional fossil fuels are phased out. This represents a huge liability and risk to any new user of natural gas in the city. Every time a new gas boiler is installed in an individual building, the capital investment and the assets run the risk of becoming stranded and obsolete. By connecting to district energy, these critical dollars could be put towards better use, including building energy efficiency projects and improving existing leaky gas infrastructure.

Vicinity Currently Reduces Carbon Emissions in Philadelphia

Philadelphia is home to one of the largest CHP-fed district energy systems in the nation. CHP technology is currently the most carbon-efficient option for heat and electric generation. In conventional generation, heat and power are produced separately, resulting in wasted energy and carbon emissions. Conversely, CHP generates both heat (in the form of steam) and electricity for beneficial and economical use. The result of this simultaneous generation is a significant reduction in carbon emissions. Fortunately, this proven technology already exists in Philadelphia and leveraging Vicinity's existing efficient infrastructure is a fast and smart investment decision.

According to ICF International, a leading technology consulting firm that has modeled carbon emissions extensively for the federal EPA and other public bodies, CHP will be a net contributor to reducing carbon emissions through 2040 given current natural gas inputs.

https://www.icf.com/insights/energy/chp-reducing-emissions

Recognizing the importance of CHP for lower carbon emissions, the Pennsylvania Department of Environmental Protection (PA DEP) recently modified its proposed final Regional Greenhouse Gas Initiative (RGGI) rule where it explicitly incentivized the production of electricity via CHP as a critical tool in reducing carbon emissions. In addition, the PA DEP explicitly recommends "incentivizing and increasing the use of CHP" as an important tool to reduce carbon emissions in its Climate Action Plan.

While CHP is an important solution as Philadelphia transitions to a clean energy future, the district energy loop will continue to green as natural gas is replaced by technologies like biogenic fuels, renewable natural gas, hydrogen or electrification.

Partnering with Vicinity for a Zero-Carbon Philadelphia

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The draft PGW Diversification Report recommends partnering with Vicinity's district energy steam loop. However, the report does not elaborate on the advantages of such a partnership and how Vicinity can significantly advance the City's goal of carbon neutrality by 2050. In addition, the report overlooks the fact that the existing Vicinity infrastructure can significantly reduce carbon emissions well before its 2050 goal. Given the importance of reducing carbon emissions, it is vital to accelerate these reductions as soon as possible and leverage efficient infrastructure that already exists.

How a Partnership with Vicinity Can Significantly Advance Carbon Neutrality

A collaborative partnership between the City of Philadelphia and Vicinity will enable significant progress toward citywide carbon neutrality by 2050, protect jobs, avoid tax increases for taxpayers and keep costs controlled for ratepayers.

Better Capital Allocation: PGW Should Invest in Current Philadelphia Ratepayers: In its regulatory filings, PGW refers to 2.6% of its gas as LAUF ("Lost and Unaccounted For") gas. This is methane that simply leaks into the atmosphere due to an old and inefficient distribution system and contributes over 1.1 million metric tons of equivalent GHG carbon. Rather than subsidizing new gas connections and increasing the stock of potentially stranded assets, Vicinity suggests that PGW allocate its capital toward improving and greening its existing system. This would not only be highly beneficial in reducing carbon emissions by reducing existing methane leakage from its own system, it would also create new jobs and cut back on the economic loss of LAUF. This re-allocation of resources would benefit ratepayers, PGW's workforce and the environment.

Target: Buildings and Industry: 72% of carbon emissions are from buildings and industry sectors, which has been difficult to address (source: PGW Diversification Report). Vicinity directly serves this existing building stock. As stated previously, every one million square feet that converts to district energy reduces carbon emissions by 3,100 to 4,500 tons per year. A less than 5% increase in Vicinity's Philadelphia footprint would result in a reduction of 15,000 to 25,000 tons per year, and 120,000 to 200,000 tons per year by 2030.

Fast Adoption: Vicinity's distribution network covers much of Center City and adjacent areas. Connections to the system can be done quickly; a building connection and conversion can be completed in as little as a few days to 6 months. Furthermore, the underground network of pipes can easily be extended on a project-by-project basis, both rapidly and efficiently reaching more buildings in Philadelphia to decarbonize. Incentivizing connections to district energy will yield near-immediate carbon reduction benefits.

Existing Infrastructure: Many of the proposed options in the PGW Diversification study would require expensive retrofits for existing buildings. The expansion of Vicinity's existing infrastructure allows for adoption with minimal disruption or costs.

No Stranded Assets, Unlike PGW: As discussed above, Vicinity's customers in Philadelphia do not face the risk of stranded assets as our facilities have the ability to shift to zero-carbon fuel sources, biogenic fuels, electrification and hydrogen, as they become technologically and economically feasible. The Diversification Report notes that PGW will have a very difficult to near-impossible task of shifting its assets to carbon neutrality without significant cost to ratepayers and impacts to employees. Any increase to PGW's footprint and existing fossil-fuel based infrastructure also increases the magnitude of stranded asset risk. Ratepayers throughout the United States have been saddled with large rate hikes due to stranded power generation assets. PGW ratepayers could face this same fate.

PGW Currently Subsidizing Rising Carbon Emissions and Expansion of Stranded Assets: PGW currently operates an aggressive incentive and subsidization program aimed at increasing its commercial gas connections in Center City. Not only does that mean PGW is actively subsidizing increased carbon emissions, but also it is subsidizing the

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continued build-out and investment of potentially stranded assets, paid for by the ratepayers in Philadelphia. In addition, the PGW subsidy program presumably weakens its current financial position and adds to its future existential financial risk. This program is also actively targeting existing customers of our low-carbon CHP-fed district, each time it succeeds carbon emissions increase as well the stranded asset risk noted above.

Department of Energy's "National Roadmap For Grid-Interactive Buildings" Embraces CHP: It should be noted that on May 17, 2021 the Biden administration's Department of Energy released its comprehensive initiative to decarbonize the buildings sector in a 150-page plan titled "A National Roadmap For Grid-Interactive Efficient Buildings." The Report states that combined heat and power should be among the tools to be used for decarbonization of buildings. (p. 25) In addition, district energy systems are rated as "high" in the key decarbonization attribute of "demand flexibility," which is shifting electricity consumption to coincide with times when electricity is clean and inexpensive. (Table 16, p. 133)

Conclusion

Vicinity appreciates the opportunity to file these comments and we look forward to working with the city and city stakeholders to help Philadelphia achieve its carbon emissions reduction goals.

Respectfully,

William DiCroce
Chief Executive Officer

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CENTENNIAL PARKSIDE
COMMUNITY DEVELOPMENT CORPORATION

Philadelphia Office of Sustainability
One Parkway Building
1515 Arch St., 13th Floor
Philadelphia, PA 19102

May 27, 2021

Re: Public Comment on the PGW's Business Diversification Study

To whom it may concern:

Thank you for the opportunity to provide public comment on the Philadelphia Gas Works (PGW) Business Diversification Study. As a representative of a low-income community of color in West Philadelphia, part of the mission of the Centennial Parkside CDC is to ensure that our residents have access to clean, affordable energy that does not adversely impact human health or the environment. We have also found that the renewable energy sector provides workforce training and job opportunities for our community that is badly in need of wealth generation. So much so that we have started our own company, Centennial Solar, which works with the Philadelphia Energy Authority to lower the cost for low-income residents installing solar panels on their roof. For these reasons, we are pleased that a study is happening and that the study is examining ways to decarbonize while improving air quality and health, protecting jobs, and ensuring that people can afford heat. We urgently need to plan solutions that meet all those criteria. It is also good to see that the study recognizes the essential role that electrification will play in the coming years.

In reviewing the study so far, we feel that the draft materials are a good start in addressing urgent questions, but much more work is needed. We need a sustained, participatory, community-based process for creating a plan to transform PGW and transform buildings across the city. In conversations with my colleagues, it has been noted that the draft materials say very little about options for repairing buildings and making them highly energy efficient. We would like to see the completed report address those possibilities in more depth. A bold, comprehensive city-wide repair/retrofit program would improve residents' health, make our homes more comfortable and resilient, bring down energy bills, create jobs, and reduce displacement. It would also limit the cost of the new equipment and infrastructure that will be needed for heating and cooling buildings as we decarbonize. Repairing and retrofitting buildings city-wide will be a huge undertaking, requiring careful planning and a strong workforce. Additionally, we need a much more serious analysis of possibilities for PGW to build and operate networked geothermal systems that can provide cooling and well as heat. This would be extremely beneficial for our Parkside residents whose homes are excessively hot in the summer.

In summary, we appreciate the efforts to study business diversification but feel that this could provide far more impact to communities like Parkside through taking the steps to ensure a new and healthy economic future for our communities. Please feel free to reach out to me with any questions you may have.

Sincerely,

Chris Spahr

Chris Spahr, Ph.D., AICP
Executive Director

Testimony submitted by: abustamante507@gmail.com (No name or organization provided.)

Thank you. In my view there is way too much attention paid to home heating electrification which is trying to solve the wrong problem. Gas to heat conversion has "waste heat" of roughly one third, modern technology in high efficiency has reduced that to 5 percent or less. I put this in quotes because the heat is mostly lost to my basement. If I were to install a high efficiency boiler I'd need to add a heat source there. Anyway, gas to electricity has waste heat of two thirds (only a third becomes electricity) even before line losses which are typically higher than a well maintained gas network. Oil loses 80 percent of energy as waste heat when trying to produce motive power. As a result it is more beneficial to electrify transportation than home heating and to the extent that moving heating off of electricity to gas to make room for transportation you will see a net reduction in carbon emissions. The problem in Texas is directly tied to the fact that people heat with electricity which is increasingly inefficient as it gets colder and you need two thirds more gas to generate electricity than you do for gas home heating

Most importantly, the problem isn't the mechanical system but home improvements. Many homes simply leak a lot of heat which dramatic increases bills. Rebates are available but for me to be incentivized to switch to a high efficiency boiler the rebates would need to be double. Moreover, most rebates are not targeting landlords. Landlords have the capital expense while tenants have the operating expense so it makes sense for landlords to put in wasteful electric water heaters and inefficient furnaces and boilers. Moving them to more efficient gas appliances can help both the environment and renters who tend to be less wealthy than homeowners. It probably involves doing a politically unpopular thing which is to make rebates or incentives more generous for landlords than homeowners but it's the right thing to do. This also replies to insulation and windows which can dramatically reduce per capita demand. Federal deductions are capped at 500 bucks but efficient windows are more than that per window.
Lastly, pgw is the most expensive utility in the state. That needs to be fixed. Take on more billing responsibilities for the city and lobby for payment from pha for gas they use.

To Whom it May Concern at the Philadelphia Office of Sustainability,

My name is Brooke Garcher and I am a Philadelphia resident and member of Sunrise Philadelphia on the Green New Deal for Housing Campaign Team. One major goal of our campaign is to decarbonize and democratize utilities so they are affordable for all Philadelphians and reduce the threat of climate change. That is why I am writing to you regarding PGW's Diversification Study because it acknowledges the imminent threat of climate change and promotes a just transition for PGW, a very much needed study to improve air quality and health, protect jobs, and ensure all people can afford to heat their homes. This work is needed TODAY - we urgently need to plan solutions that meet all those criteria. We believe electrification will be critical in the just transition for PGW.

I also write to you in hopes that the work does not end with this study, there is so much work to do! We need a sustained, participatory, community-based process for creating a plan to transform PGW and transform buildings across the city. We hope you bring climate justice organizations to the table and work with us. Lastly, PGW should not be allowed to lobby for policies that block the kind of transformation in utilities that we need!

Thank You.

Brooke Garcher

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Brooke Garcher
Sunrise Philadelphia, Green New Deal for Housing Team
brooke.garcher.1@gmail.com

THE CHAMBER
of Commerce for Greater Philadelphia

Wednesday, May 12, 2021

The Chamber's Statement on the Philadelphia Gas Works Business Diversification Study

On behalf of the Chamber of Commerce for Greater Philadelphia, I am writing to address our organization's concerns regarding the Philadelphia Gas Works Business Diversification Study. The Chamber shares the same priorities outlined in the study that any changes to PGW's system must safeguard ratepayers, maintain system reliability, retain workforce, and ensure the health and safety of our cities' residents. Unfortunately, the recommended strategies in this study fail to feasibly meet those goals.

We understand the primary motivation for the recommended strategies is the potential for reducing overall GHG emissions. However, it is well known that the resulting increase in electricity demand from the displacement of natural gas can lead to increases in greenhouse gas (GHG) emissions from the power generation sector. The diversification study asserts that 2020 emissions from a customer heating their home with electricity are lower than the emissions of a customer using a gas furnace—and that heating a home with a heat pump is significantly more efficient on a site-energy basis than heating with a gas furnace. The study only accounts for site energy which does not include the losses incurred in the production, transmission, and delivery of that energy to the home or building.[1] The natural gas we all use to heat our homes and cook is more than 91 percent efficient, compared to electricity produced by natural gas, which is only 45 percent efficient.[2] In short, electricity is an inefficient form of energy because it loses power as it travels over distance to reach homes and buildings.

To understand the net gains of residential electrification scenarios, it is essential to consider the generation mix. Currently, natural gas generation makes up 43 percent of PJM's grid mix.[3] The diversification study anticipates that overtime emissions benefits of electrification will increase as the PJM system decarbonizes under potential future policy regimes. If all generation resources were renewable or zero-emitting alternatives, displacing direct-use natural gas with electricity would result in net emission benefits, regardless of transmission and related losses.

However, this does not reflect the current reality of the electric grid or a realistic expectation of the grid mix for the foreseeable future. According to projections from the National Renewable Energy Laboratory (NREL), in a low-cost renewable energy scenario, the electric generation grid mix in Pennsylvania is projected to be 52 percent renewables, 48 percent non-renewables, with natural gas making up 39 percent of the non-renewable mix in the year 2050.[4] The current end-use consumption mix in the City of Philadelphia is currently 65 percent natural gas and 35 percent electricity.[5] Meaning, if electrification or a hybrid scenario were implemented in the City of Philadelphia, even under the most favorable scenarios for renewables, natural gas for electric generation would need to be increased significantly to account for its displacement as an end-use source. We know that residential natural

[1] The Difference Between Source and Site Energy. *ENERGY STAR Buildings and Plants.* www.energystar.gov/buildings/benchmark/understand_metrics/source_site_difference.
[2] More than 60% of energy used for electricity generation is lost in conversion. EIA, July 21, 2020. https://www.eia.gov/todayinenergy/detail.php?id=44436.
[3] Forward Together 2020 PJM Annual Report. PJM.https://services.pjm.com/annualreport2020/static/PJM_AR2020_Editorial-5e6b4e7ad93658023d9789ac0761f5fb.pdf.
[4] Murphy, Caitlin, Trieu Mai, Yinong Sun, Paige Jadun, Matteo Muratori, Brent Nelson, and Ryan Jones. 2021. Electrification Futures Study: Scenarios of Power System Evolution and Infrastructure Development for the United States. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-72330. https://www.nrel.gov/docs/fy21osti/72330.pdf.

gas consumption only accounts for 4.6 percent of U.S. emissions.[6] Even assuming a 100 percent clean energy grid mix, the GHG emissions reductions are marginal. Put simply, the strategies outlined in the study demonstrate the least cost-effective methods of reducing emissions.

Further, the study does not provide an accurate assessment of the costs of these strategies. For instance, the cost estimates for both the electrification and hybrid scenario do not account for the cost of local electricity distribution system upgrades necessary to meet the growth in electricity demand. A study commissioned by the American Gas Association found that in the East Coast region, policy-driven electrification would increase average residential household energy-related costs (amortized appliance and electric system upgrade costs and utility bill payments) of affected households by $960 annually.[7]

We know that natural gas is the lowest-cost source of energy. Recently the Federal Register included a notice from the Office of Energy Efficiency and Renewable Energy at the Department of Energy, which forecasted the representative average unit costs of residential energy sources for the year 2021. The forecast shows that on an energy equivalent basis, electricity will cost $39 per million BTU, while natural gas costs $11 per million BTU.[8] The difference in energy costs have meaningful consequences, especially in Philadelphia. Ultimately, affordability must be the determining factor when considering new efforts to address emissions. Currently, Philadelphia has a poverty rate of 25.7 percent, meaning over 400,000 households are eligible for low-income energy assistance.[9]

Retrofitting an existing home with electric appliances, especially an older home, is considerably more expensive than installing electric appliances in new homes. The study fails to recognize the potential upfront cost discrepancies for customers, especially those in lower-income groups. We strongly advise that the study consider a more accurate assessment of the potential costs of these strategies and provide more transparency in the methodology and data used to render these conclusions.

The study's recommendation to inject renewable natural gas (RNG) or biogas into the gas supply provides the best near-term emissions reductions with the least disruption. Nevertheless, a complete decarbonized gas supply is an unlikely scenario. Similar to the other recommended strategies, the market conditions, technology development, and policy regimes will determine the extent to which RNG can be utilized. However, it's worth noting that a lower percentage of RNG in the existing natural gas supply is likely to have comparable GHG emissions benefits to electrification scenarios given the current and expected electric generation grid mix in Pennsylvania.

The California Utility SoCal Gas found that by replacing 20 percent of their natural gas supply with RNG captured from organic sources like dairies, wastewater treatment plants, and landfills, they can achieve emissions reductions equivalent to converting 100 percent of buildings to electric-only energy by 2030.[10] That's because when RNG is produced organically, by re-purposing the methane that otherwise would be escaping into the atmosphere, it becomes carbon negative.

Moreover, many of these recommendations fail to accurately assess the challenges with a service transition. A hybrid scenario where consumers adopt heat pumps paired with a gas furnace to meet

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[6] American Gas Association 2021 Playbook. http://playbook.aga.org/.
[7] Implications of Policy-Driven Residential Electrification an American Gas Association Study prepared by ICF. July 2018, https://www.aga.org/globalassets/research--insights/reports/aga_study_on_residential_electrification.pdf.
[8] Federal Register / Vol. 86, No. 50 / Wednesday, March 17, 2021 / Notices. https://www.govinfo.gov/content/pkg/FR-2021-03-17/pdf/2021-05482.pdf.
[9] Philadelphia's Poor Who they are, where they live, and how that has changed. https://www.pewtrusts.org/-/media/assets/2017/11/pri_philadelphias_poor.pdf.
[10] Analysis of the Role of Gas for a Low-Carbon California Future. https://www.socalgas.com/1443741887279/SoCalGas_Renewable_Gas_Final-Report.pdf.

THE CHAMBER
of Commerce for Greater Philadelphia

"peak heat" demands during the coldest periods assumes that PGW maintains its existing revenues despite lower natural gas consumption. But when the volume of sales in gas decreases, rates will have to increase to cover the cost of infrastructure maintenance of two redundant systems.

The study highlights the impacts of non-participants in the various scenarios assuming that non-participants will reduce over time. Yet, the study fails to address the effects of these scenarios on existing CHP customers, some of which require continuous on-site energy. The study must examine the costs to commercial and industrial customers that cannot electrify their systems and continue to rely on the natural gas grid.

We know that Philadelphia Gas Works, alongside the city, have made tremendous strides to reduce emissions. From 2015-2019, PGW's energy efficiency programs have helped Philadelphians offset over 449,000 metric tons of Co2e—the equivalent of taking more than 97,000 passenger cars off the road for an entire year. During the same time, PGW's pipeline replacement program has helped prevent over 1,500 metric tons of methane from entering the atmosphere. The city and its ratepayers cannot afford to discard these investments, any new pathways for the utility should build on these successes.

As we collectively work towards a more inclusive economic recovery for the City of Philadelphia, we need prudent decision-making that balances the environmental and economic costs. We look forward to our having our organization's concerns addressed in the final study recommendations.

Sincerely,

Rob Wondering
President & CEO
The Chamber of Commerce for Greater Philadelphia

May 28, 2021

Office of Sustainability
Via email: **sustainability@phila.gov**

Re: Written Comments by Clean Air Council on the Business Diversification Study for Philadelphia Gas Works (PGW)

Clean Air Council (the Council) submits the following comments on the report commissioned by the Office of Sustainability (OOS) on diversification options for Philadelphia Gas Works (PGW). The Council is a non-profit environmental health organization headquartered in Philadelphia. The Council has been working to protect everyone's right to a healthy environment for over 50 years and has many members in Philadelphia.

According to the Intergovernmental Panel on Climate Change, we have less than 9 years to cut greenhouse gas emissions 45% to avoid catastrophic climate change. This includes a 35% or more reduction of methane, the main component of natural gas, by 2050 relative to 2010 levels. The City has set a number of climate-related goals to address the climate crisis. In July 2017, Mayor Kenney committed to reduce carbon emissions in Philadelphia 80% from 2006 levels by 2050. On June 21, 2017, Mayor Kenney committed to sourcing 100% of municipal operations from renewable energy and to work toward a goal of 100% clean energy citywide. In August 2018, the Office of Sustainability released its long-term clean energy vision called *Powering Our Future*. In order to meet the city's climate goals and vision, PGW must quickly transition to a sustainable energy utility that no longer uses or provides fossil fuel or fossil fuel-derived gas and contributes zero greenhouse gas emissions. Anything less will not adequately address Philadelphia's greenhouse gas contributions towards the climate crisis.

Figuring out how to transition PGW into an environmentally sustainable utility is a complex topic and requires a robust and inclusive planning process. The Council is happy to see the strong stakeholder and public engagement in this process, especially the outreach to the most energy-burdened communities, as well as transparency before a final report is completed. The process includes many elements the Council had advocated for in early 2019. It's promising to see that the analysis criteria appeared to be informed by the stakeholder engagement process.

The Council encourages the report consultants to continue to refer to and incorporate past and ongoing public input for the duration of the project.

The Council is glad to see that public health, safety, and equity were guiding principles of this analysis and that the report considered how PGW could transition to renewable energy while reducing air pollution and providing ongoing energy needs and job opportunities.

The Council offers the following suggestions on the draft report:

- Under the hybrid electrification model, the report envisions customers adopting heat pumps paired with a gas furnace to meet “peak heat” demands during the coldest periods of winter. This analysis did not consider the latest research and information about this technology and the assumption about needing backup gas is inaccurate. In the last two years, the technology for electric heat pumps has improved to the point where they function at 100% efficiency down to -13 degrees Fahrenheit. Additionally, the Biden administration just announced that there will be new ENERGY STAR standards for electric heat pumps and that the Department of Energy will be "putting $10M toward accelerating the research and adoption of heat pump technologies." There is little doubt that there will be a huge leap forward on heat pump technology and building electrification technology within the next few years. There is no need, in Philadelphia’s climate, for any gas backup for electric heat pumps. The report consultants should include the latest research on this technology in their analysis and confirm that no backup gas would actually be needed.

- The Council is glad that the analysis correctly recognized that relying exclusively on decarbonized gas is risky, poses unsustainable and long-term bill impacts to PGW customers, and, importantly, does not address City and stakeholder priorities of improving air quality and addressing climate change.

- The analysis found that exclusively relying on electrification can reduce energy bills for households that electrify, but increase energy bills for customers remaining on the gas system, which can pose equity challenges unless mitigated. The Council asks that the report consultants analyze options for how to mitigate potentially high energy bills for non-participating customers during the transition period and how PGW could ensure full and equitable participation in a future scenario in which PGW completely stops supplying natural gas.

- Please clarify in the updated report if the list of diversification options on p.45 of the report are “under consideration” by the report consultants or by PGW. The Council recommends modeling how much revenue PGW could make from these diversification options (especially weatherization services, community solar, microgrids, and on-bill financing) to see if they could fill potential revenue gaps in the electrification and hybrid electrification with geothermal mico-districts scenarios.

- While the Council understands that PGW is already involved with liquefied natural gas facilities, this option, along with compressed natural gas facilities, conflict with the criteria of protecting public health, safety, and addressing air pollution and climate change, so should be removed from any further consideration in this analysis about future options for PGW.

- The report states that hybrid electrification with geothermal mico-districts are a promising option, but that the costs are highly uncertain and dependent on local characteristics, such as geology and building type. The Council recommends that the report consultants do a deeper analysis of what the costs and benefits of this option would be in Philadelphia so that the public has a more accurate understanding of them. After this analysis is completed, and if the results show that this technology is appropriate for the Philadelphia context, the OOS should consider using geothermal mico-districts as a pilot project to test out this concept.

The Council urges the OOS and its consultants to complete its diversification analysis in a timely manner while addressing the public's concerns and incorporating their ideas and perspectives. In addition, OOS should work with the Gas Commission, City Council, PGW and other necessary stakeholders to advance a pilot project, analyze the effectiveness of the project, and eventually make a publicly-informed decision about the best pathway for transitioning PGW off of natural gas. As part of the next phase of transitioning PGW, these decision-making entities must ultimately work with PGW to map out a PGW transition plan with specific timelines and milestones.

With Philadelphia residents already experiencing the negative effects of climate change, PGW must transition completely off of natural gas as quickly as possible. Thank you for your consideration of these comments and for all of your ongoing work on this critical issue.

Joseph Otis Minott, Esq.
Executive Director and Chief Counsel

Matt Walker
Advocacy Director

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To Whom It May Concern at the Philadelphia Office of Sustainability,

My name is Helen Mitchell and I'm a Philadelphia Resident and member of Sunrise Philadelphia on the Green New Deal for Housing Campaign Team.

I write to you today regarding Philadelphia Gas Works' Diversification Study. This study rightly acknowledges the impending threat of climate change and the need for a just transition for PGW. Philadelphians need and deserve improved air quality, improved health, job protection, and access to affordable and sustainable ways to heat their homes. A just transition at PGW, focusing on home electrification, would be a critical part of meeting these needs. The study has laid out some important data that points to the need to shift PGW toward electrification, but the work cannot stop there. It is critical that we develop and plan solutions today to meet the needs of Philadelphians.

To develop and implement such solutions, it's critical that the process be participatory and community-based. The Office of Sustainability should work to bring climate justice and other community organizations to the table to create a solution-based plan for transforming PGW. PGW should also not be allowed to lobby for policies that block the kind of transformation we need for utilities.

Thank you,

Helen Mitchell

Inflection Point:

When Heating with Gas Costs More

January 2021 – White Paper

Applied Economics Clinic

Prepared for: HEET

Authors:
Joshua R. Castigliego
Sagal Alisalad
Tanya Stasio
Elizabeth A. Stanton, PhD

www.aeclinic.org
January 13, 2021
[AEC-2021-01-WP-01]

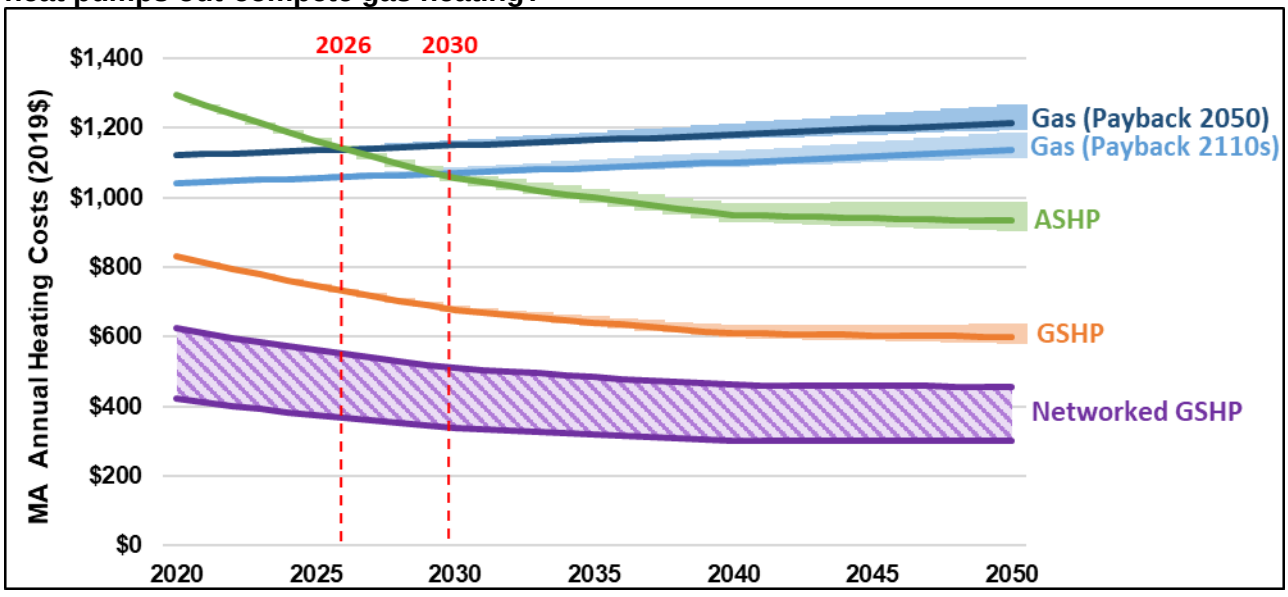
Executive Summary

Roughly half of Massachusetts households (1.4 million households) currently use piped gas to heat their homes. As Massachusetts moves towards its net-zero emissions mandate by 2050, households currently heating with fossil fuels like gas will need to transition to other energy sources with lower greenhouse gas emissions. The economic impact of this transition on Massachusetts households is a key factor for both household decision-making and state policy-making.

This Applied Economics Clinic white paper—prepared on behalf of HEET—compares the annual energy cost of heating the average-sized home in Massachusetts using either a gas furnace or electric heat pumps. This analysis focuses exclusively on a home's annual heating bill as it is the most relevant measure for Massachusetts households. The size of a household's energy bill can determine fuel choice and can be a large burden on families, particularly the low- and moderate-income families that spend a larger share of their income to pay their energy bills.

Today, gas heating bills are less expensive than the electricity needed to run an air-source heat pump (ASHP). Our analysis shows that this relationship will reverse. Heating with ASHPs will become less expensive than heating with gas, with an inflection point occurring at some point between 2026 and 2030 (see Figure ES-1). The time of the inflection point depends on how much is added to monthly gas bills to pay off current efforts to replace the Commonwealth's leaking pipelines.

Figure ES-1. Inflection points for an average-sized Massachusetts home: When do electric heat pumps out-compete gas heating?



Unlike ASHPs, ground-source heat pumps (GSHP) are already less expensive than heating with gas. Our analysis shows the expense of heating with GSHPs will continue to decrease over time and includes the newer networked type of GSHPs as this technology is predicted to lower heating bills for households even more.

Electrification—switching from burning fossil fuels to using electricity—is an essential strategy to achieve the Commonwealth's 2050 climate goals. This white paper finds that the electric heat pumps needed for this electrification will outcompete gas heating, in terms of annual heating bills, within the next decade. They are already the least expensive way to cool a home. Yet the necessary widespread modernization of home heating (and cooling) with heat pumps is obstructed by physical, economic, and informational barriers, including high upfront costs.

The following policy options can help meet state emissions mandates, while making clean energy and lower heating bills accessible to all:

- **Incentives for heat pump purchase.** These incentives need to be large enough to ensure that fewer households are negatively impacted by a rising cost of heating with gas. Heat pump adoption in the Commonwealth will lead to growing emission reduction benefits as the grid becomes more renewable each year, as mandated by state law.
- **Subsidies for low-income and rental housing heating and insulation upgrades.** Installing heat pumps in rental housing—and low- and moderate-income housing more generally—may require state subsidies that cover the entire cost of equipment and installation. In addition, for the Commonwealth to achieve net-zero greenhouse gas emissions by 2050, every household will need to improve their home's insulation through building shell upgrades. Inclusion of electric capacity and wiring upgrades may be necessary as there are substantial building infrastructure barriers in Massachusetts' housing stock. For many families, such retrofits will require an outside funding source.
- **Education and outreach to increase information availability and access.** Homeowners, renters, landlords, real estate agents, heating technicians and general contractors need more and better information regarding the many benefits of heat pumps, including inexpensive cooling, technological improvements, and the long-term economic impacts of heating with gas versus heat pumps. Additional benefits of heat pumps, not related to energy bills, include improved air quality and very low-cost cooling. These benefits add value not discussed in this analysis.

These types of state policies can encourage widespread heat pump adoption, including among renters and low- and moderate-income households, by making accurate information on the economic impacts of different heating systems more accessible to the public and by stepping in to shift these economics where and when necessary. Since gas furnaces have an average lifespan of 15 to 30 years, without such deliberate and intentional action, many households will buy gas heating systems now and end up paying rising energy costs over that lifespan.

Table of Contents

I. Introduction

As Massachusetts makes the changes needed to achieve net-zero emissions by 2050,[1] households will need affordable heating and cooling solutions with low or no greenhouse gas emissions. This Applied Economics Clinic white paper explores the costs of several home heating options for an average-sized home. While the cost of heating with piped gas rises over time, the cost to heat with a modern electric heat pump falls well below that of all other heating technologies in every future scenario. And there is a lot of room for Massachusetts heat pump ownership to grow: Heat pumps accounted for only 0.8 percent of all residential heating systems in Massachusetts in 2019.

AEC compared the cost to customers heating with a gas furnace in Massachusetts to those heating with old-fashioned electric baseboard heaters and modern electric heat pumps. This analysis focuses exclusively on energy bills, the cost measure that is most relevant to renters and many low- and moderate-income households. We do not include the costs of purchasing and installing a new heating system, a once-in-15-to-30-years investment for most homeowners.[2]

Nationally, the vast majority of low- and moderate-income households, minority households, and renting households pay more for their energy (as a share of their income) than the average household.[3] A recent American Council for an Energy-Efficient Economy (ACEEE) report notes that in Boston, the median low-income household spends about 10 percent of its income on energy, compared to the median household's spending of 3 percent.[4]

[1] The Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs. April 22, 2020. "Determination of Statewide Emissions Limit for 2050". Available at: https://www.mass.gov/doc/final-signed-letter-of-determination-for-2050-emissions-limit/download

[2] (1) Consumer Reports. November 21, 2019. "Gas Furnace Buying Guide." Available at: https://www.consumerreports.org/cro/gas-furnaces/buying-guide/index.htm; (2) Griffith Energy Service, Inc. January 27, 2017. "The Average Age for Gas Furnaces." Available at: https://www.griffithenergyservices.com/articles/furnace-30-years-old-long-gas-furnaces-last; (3) Valley Service. May 19, 2020. "How long does a furnace last? - Average Lifespan Expectancy." Available at: https://valleyservice.net/blogs/how-long-does-a-furnace-last#:~:text=Average%20Furnace%20Lifespan,-Wondering%20what%20the&text=Although%20some%20furnaces%20can%20last,easily%20last%20over%2015%20years.

[3] American Council for an Energy-Efficient Economy (ACEEE). September 2020. "How High Are Household Energy Burdens? An Assessment of National and Metropolitan Energy Burdens across the U.S." Available at: https://www.aceee.org/research-report/u2006 p. 3.

[4] Ibid. p. 44.

Energy bills are especially relevant for the 38 percent of Massachusetts' households who rent their homes[5] and to homeowners (and landlords) who purchased their heating system recently (with many years of operational "life" left in it). Without significant assistance from the state, these types of heating customers will be stuck using the heating system that they already have. This white paper investigates whether a gas or electric heating system offers the lowest energy bill costs over the next three decades, with the goal of informing policy decisions regarding what types of heating systems should be subsidized.

Comparing heating fuels

We compare the cost of heating an average-sized household with a gas furnace or an electric heat pump. In our analysis we ask: In what year do electric heat pumps become the most economic choice? That's the inflection point.

Comparison of costs across different heating fuels can be complicated: Gas use is measured in therms; heating oil in barrels; electric use in kilowatt-hours. Regardless of the heating fuel, however, a particular building's needs the same amount of heat, which can be measured in "British thermal units (Btus)". (Technically, a Btu is the quantity of heat required to raise the temperature of one pound of water by 1 degree Fahrenheit.) In New England, an average-sized home requires 59 million Btus of heat each year. (A detailed explanation of Btus is provided in Appendix A: Measuring Energy Use in "Btu".)

This white paper estimates how much it would cost to heat an average-sized home in Massachusetts using different heating fuel options, and how those utility bill costs are expected to change in the future. Today, comparatively high electric prices in Massachusetts mean that, for the average-sized home, gas heating bills are lower than the cost of electricity needed to run a heat pump. In the future, this will change: Electric heat pumps will have lower utility bills than gas heating alternatives. Our analysis shows that electric heat pumps become the most economic heating option in 2030 (or sooner, if necessary gas-system pipe replacements are fully accounted for in customers' gas bills).

Section II addresses the state's current heating profile, electric heating options, and growth in heat pump adoption. Section III offers a brief overview of how this analysis was constructed. Section IV provides a detailed look at cost variation among heating options and identifies the least-cost option for customers. Section V discusses barriers to home electrification, and Section VI presents an overview of networked heat pump systems and their potential for lower customer costs. Section VII discusses potential policy options to promote heat pump adoption in Massachusetts and beyond.

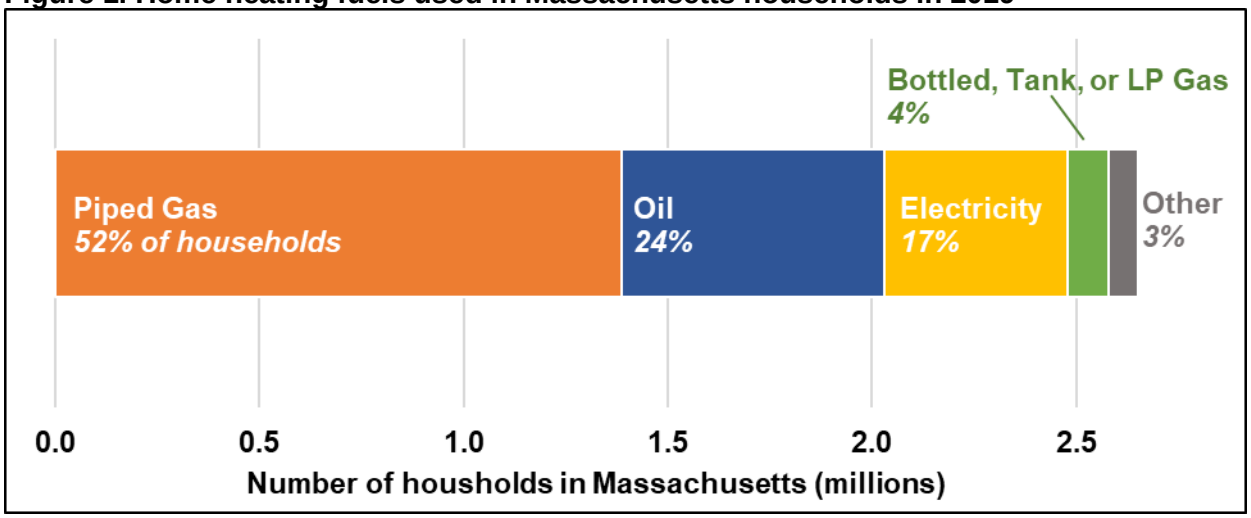
[5] U.S. Census Bureau. 2019. American Community Survey 1-Year Estimates [Table]. Demographic Characteristics for Occupied Housing Units (Table ID: S2502). Available at: https://data.census.gov/cedsci/table?q=renter&g=0400000US25&tid=ACSST1Y2019.S2502&hidePreview=true

II. Massachusetts Heating

Massachusetts has a relatively cold climate with average January temperatures around 26 degrees Fahrenheit. (The contiguous United States averages 33 degrees Fahrenheit in January).[6] With such cold winters, the Commonwealth requires a lot of space heating, which makes up the largest portion of energy use in homes (59 percent),[7] and households in Massachusetts spend 22 percent more on their energy bills than the U.S. average.[8]

Today, about half of Massachusetts households (52 percent or 1.4 million) use gas as the primary fuel to heat their homes (see Figure 1). Another 650,000 households use oil; 450,000 use electricity (mostly old-fashioned baseboard heating); and the remaining 170,000 rely on propane or other fuel sources such as wood.[9]

Figure 1. Home heating fuels used in Massachusetts households in 2019



Data source: U.S. Census Bureau. 2019. American Community Survey 1-Year Estimates [Table]. House Heating Fuel (Table ID: B25040). Available at: https://data.census.gov/cedsci/table?q=heating%20fuels&g=0100000US_0400000US25&tid=ACSDT1Y2019.B25040&hidePreview=true

[6] NOAA National Centers for Environmental information, *Climate at a Glance*. Available at: https://www.ncdc.noaa.gov/cag/

[7] Commonwealth of Massachusetts. "Mass. Home Heating Profile Background." Available at: https://www.mass.gov/service-details/mass-home-heating-profile-background

[8] Commonwealth of Massachusetts. "Mass. Home Heating Profile Background." Available at: https://www.mass.gov/service-details/mass-home-heating-profile-background

[9] U.S. Census Bureau. 2018. American Community Survey 5-Year Estimates [Table]. House Heating Fuel (Table ID: B25040). Available at: https://data.census.gov/cedsci/table?q=heating%20fuels&g=0400000US25_0100000US&tid=ACSDT5Y2018.B25040&hidePreview=true

The main heating technologies used in Massachusetts are gas and oil furnaces or boilers, old-fashioned electric resistance heating, and modern electric air-source and ground-source heat pumps. (We exclude heating oil from our cost analysis because it is already more expensive to heat with oil than with gas or electric heat pumps.[10]) Both electric resistance and heat pumps utilize electricity to provide heat, but in different ways.

Electric heating technologies currently used in Massachusetts

Electric Resistance (efficiency 90%):[11] Electric resistance heaters create heat by passing electricity through wires, which shed some energy as heat. Electric baseboards are typically zoned heaters controlled by thermostats in each room.[12] These systems lose 10 percent of the electricity used: only 90 percent becomes heat (90% efficiency).

Air-source heat pumps (ASHP) (efficiency 300%): ASHPs heat and cool a building by using electricity to pump heat either inside or outside the building.[13] Temperature control comes from tweaking the difference between the outside and inside temperature—not from the electricity itself. In this way, ASHPs generate three units of heating energy for every one unit of electric energy used to run them (300% efficiency).

Ground-source heat pumps (GSHP) (efficiency 450%): GSHPs rely on the consistent underground temperature maintained just below the ground surface or in a body of water. Like other heat pumps, GSHPs operate by transferring heat either into or out of a building. GSHPs generate four and a half units of heating energy for every one unit of electric energy used to run them (450% efficiency).

Networked GSHPs (efficiency 600-800%): Interconnecting GSHPs in multiple buildings throughout a neighborhood using an underground shared loop of ambient-temperature water can further improve the efficiency of this technology. A networked GSHP system allows for excess energy not needed by one building to be moved to networked buildings that do need that energy. Networked GSHPs generate 6 to 8 units of heating energy for every one unit of electric energy used to run them (600-800% efficiency).

[10] Commonwealth of Massachusetts. “Household Heating Costs.” Available at: https://www.mass.gov/info-details/household-heating-costs

[11] M.J. Bradley & Associates, LLC. 2019. *Life Cycle Analysis of the Northeast Supply Enhancement Project*. Available at: https://www.mjbradley.com/sites/default/files/MJBA_NESE_LCA_06112019.pdf

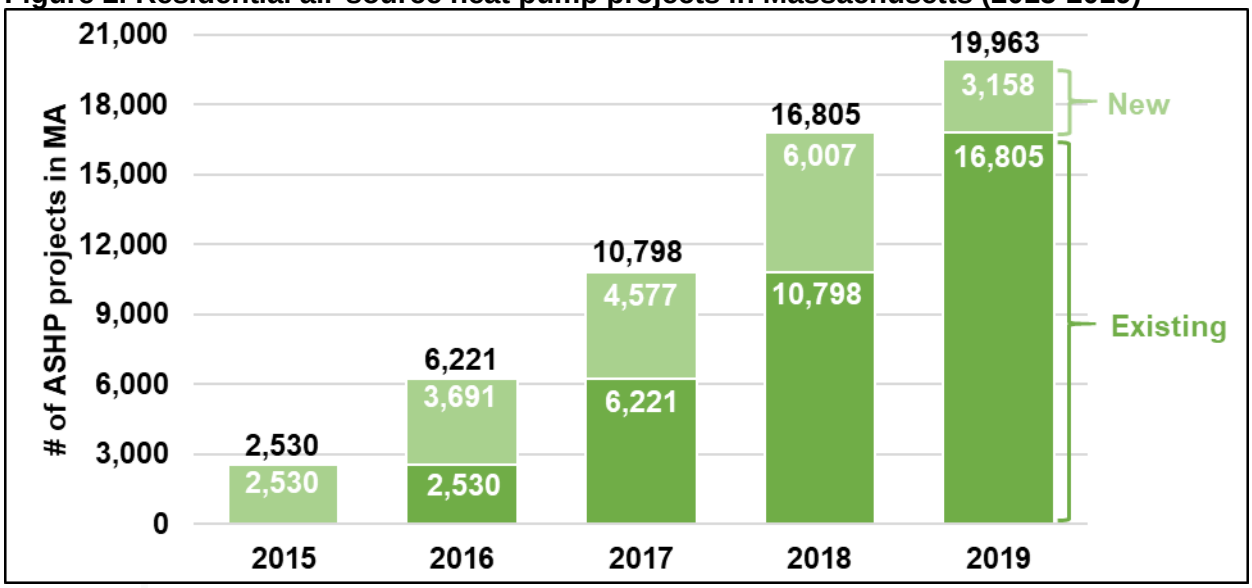
[12] U.S. Department of Energy (DOE). n.d. “Electric Resistance Heating.” Available at: https://www.energy.gov/energysaver/home-heating-systems/electric-resistance-heating

[13] Commonwealth of Massachusetts. “Air and Ground Source Heat Pumps.” Available at: https://www.mass.gov/service-details/air-and-ground-source-heat-pumps

Increasing popularity of heat pumps

From 2014 to 2019, the Massachusetts Clean Energy Center (MassCEC) offered rebates to promote residential ASHP installations. In mid-2019, this rebate program was replaced by the Whole-Home Air-Source Heat Pump pilot program.[14] MassCEC has also offered rebates to support residential and other small-scale GSHP installations since 2015. Between 2015 and 2019, ASHP installations increased by 68 percent per year on average (see Figure 2) while GSHP installations increased by 53 percent per year (see Figure 3).[15,16] This rapid growth has brought total installed heat pumps to a minimum of 20,427 (the number of heat pumps installed before 2015 is unknown, but likely small). But even with this accelerating rate of growth, heat pumps only accounted for 0.8 percent of all residential heating systems in Massachusetts in 2019. There is a lot of room for Massachusetts heat pump ownership to grow, and state incentives—to date—have not provided the stimulus needed to achieve widespread adoption.

Figure 2. Residential air-source heat pump projects in Massachusetts (2015-2019)



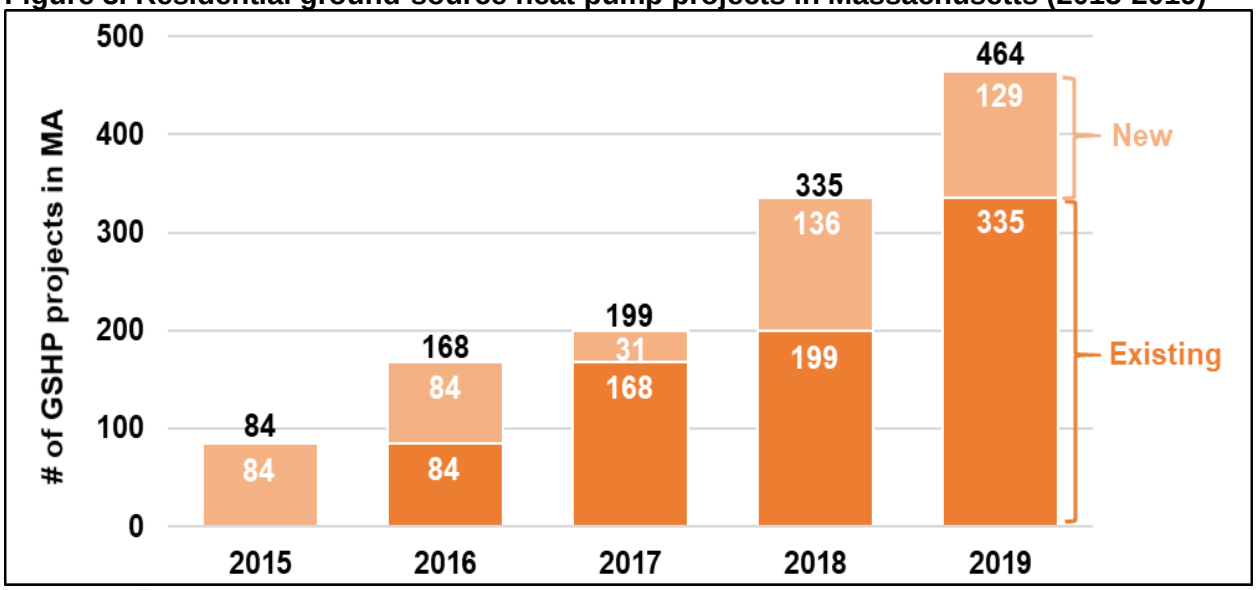
Data source: MassCEC. 2020. Residential and Small-Scale Air-Source Heat Pumps Database. Available at: https://www.masscec.com/heat-pumps/

[14] MassCEC. "Air-Source Heat Pumps." Available at: https://www.masscec.com/air-source-heat-pumps-1

[15] MassCEC. 2020. Residential and Small-Scale Air-Source Heat Pumps Database. Available at: https://www.masscec.com/heat-pumps/

[16] MassCEC. 2020. Residential and Small-Scale Ground-Source Heat Pumps Database. Available at: https://www.masscec.com/ground-source-heat-pumps

Figure 3. Residential ground-source heat pump projects in Massachusetts (2015-2019)



Data source: MassCEC. 2020. Residential and Small-Scale Ground-Source Heat Pumps Database. Available at: https://www.masscec.com/ground-source-heat-pumps

III.Estimating Future Gas Bills

AEC compared the energy bill costs to customers of various residential heating options in Massachusetts and found important differences both between fuels and over time. We do not include the capital costs of purchasing and installing a new heating system in this analysis. (For a discussion of the complete customer costs of home heating see AEC's 2019 report entitled *Home Heat Pumps in Massachusetts*.)

Factoring in the cost of the upgrades to the gas distribution system

Massachusetts' leak-prone gas distribution system requires extensive repairs and infrastructure upgrades to improve safety. The current gas pipe replacement plan—to replace a quarter of all pipes in the state—is paid for by customers through an on-bill Gas System Enhancement Adjustment Factor (GSEAF) charge that amounts to about $49 per year for an average-sized home. As we explain in detail in our December 2020 policy brief, *Fixing Massachusetts' Leaky Pipes: When Will It Be Paid Off?*, at the current GSEAF rate, it would take until the 2110s to fully pay back these pipe replacement expenditures. However, these pipes will no longer be in use after Massachusetts reaches its net-zero greenhouse gas emissions target in 2050. To pay these costs off completely by 2050 (and avoid "stranded assets") would require that the GSEAF charge be increased from $49 to $128 per year for the average-sized home.

Factoring in the cost of the upgrades to the electric distribution system

Our analysis includes forecasts of future gas and electric prices for Massachusetts, and other normal elements of customer bills. (We present estimates for a range of future energy prices: Low, Reference, and High.) We do not, however, include any extraordinary upgrade charges for the electric distribution system in that way that we include GSEAF charges. The gas system's GSEAF charges are meant to correct a distribution system that is aging and riddled with leaks. While the Commonwealth's electric system needs normal annual maintenance and upgrades, we are not aware of any evidence of a need for widespread replacement of poles and wires in Massachusetts. For this reason, there is no parallel customer charge for electric system upgrades in our analysis.

Factoring in future energy costs and efficiencies

According to performance projections released by the National Renewable Energy Laboratory (NREL), air-source heat pump efficiency is expected to grow from an average of 300 percent in 2020 to between 440 and 530 percent by 2050, depending on the scenario of technological growth.[17] Our model accounts for these technological advancements by applying the trend of NREL's performance projections to the efficiency of air-source and ground-source heat pumps (see Appendix C: Sensitivity Analyses for a comparison of our results under different technological growth scenarios). Gas furnaces (currently 95% efficient) are not expected to increase in efficiency since they are already at their theoretical peak.

IV. Which Heating Option Will Cost the Least in the Future?

Figure 4 compares the costs of electric resistance heating, ASHPs, GSHPs, and the two scenarios for gas heating costs: *Gas* (*Payback 2110s)*, which uses the current GSEAF rate, and *Gas* (*Payback 2050)*, in which GSEAF is increased to pay off gas pipe replacement by 2050. By 2050, Massachusetts must achieve net zero emissions[18], rendering gas heating and its related infrastructure obsolete.

Throughout our 2020 to 2050 analysis period, GSHPs have the lowest energy bills and electric resistance heating has, by far, the highest. ASHPs bills are slightly more expensive than gas heating today (a difference of $260 per year for an average home). By the mid-2020s to early 2030s, however, ASHPs become less expensive than gas heating. Heat pumps also provide efficient, lower-cost air conditioning in the summer: an important source of potential savings not included in this heating-focused analysis.

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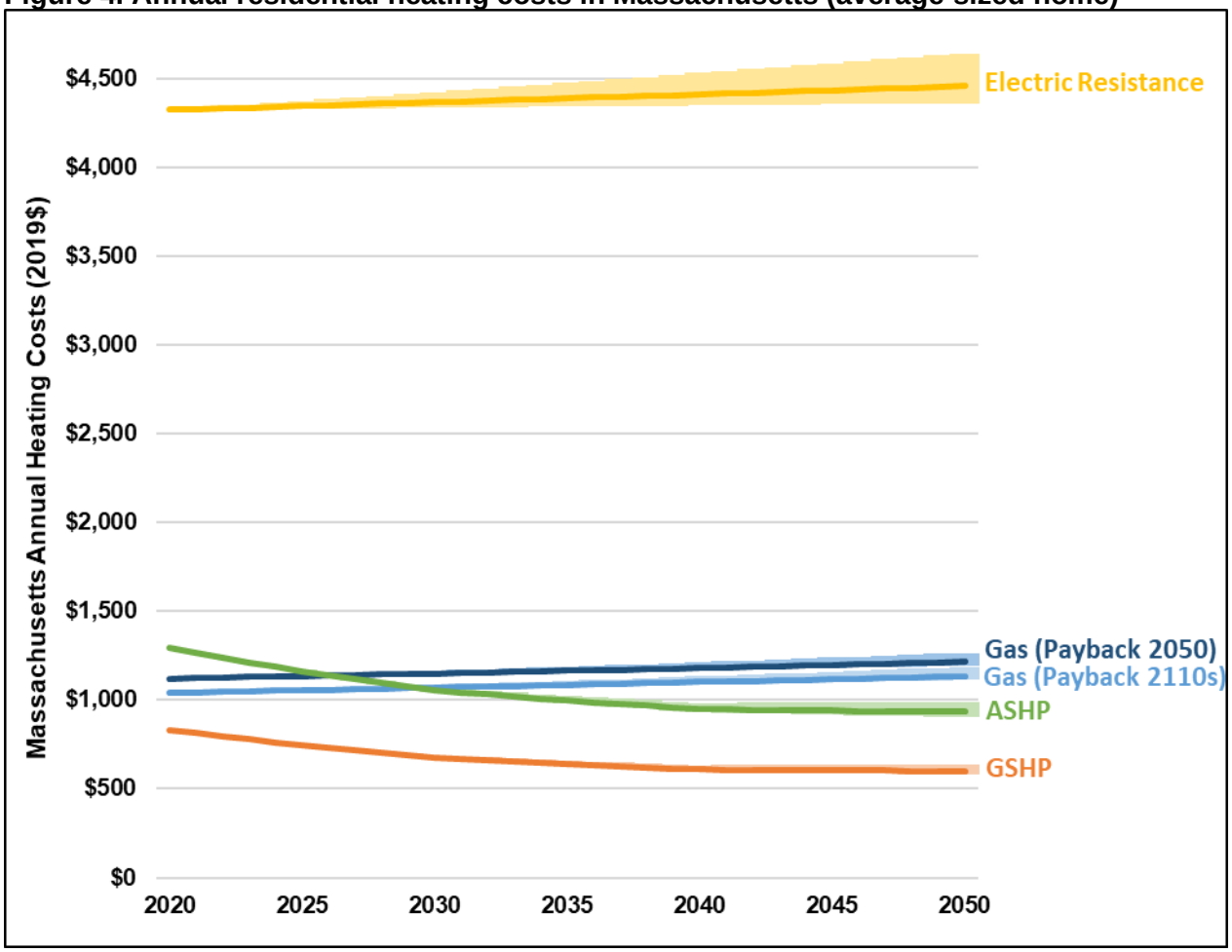
[17] Jadun, P. et al. 2017. Electrification Futures Study: End-Use Electric Technology Cost and Performance Projections through 2050. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-70485. Available at: https://www.nrel.gov/docs/fy18osti/70485.pdf.

[18] The Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs. April 22, 2020. "Determination of Statewide Emissions Limit for 2050". Available at: https://www.mass.gov/doc/final-signed-letter-of-determination-for-2050-emissions-limit/download

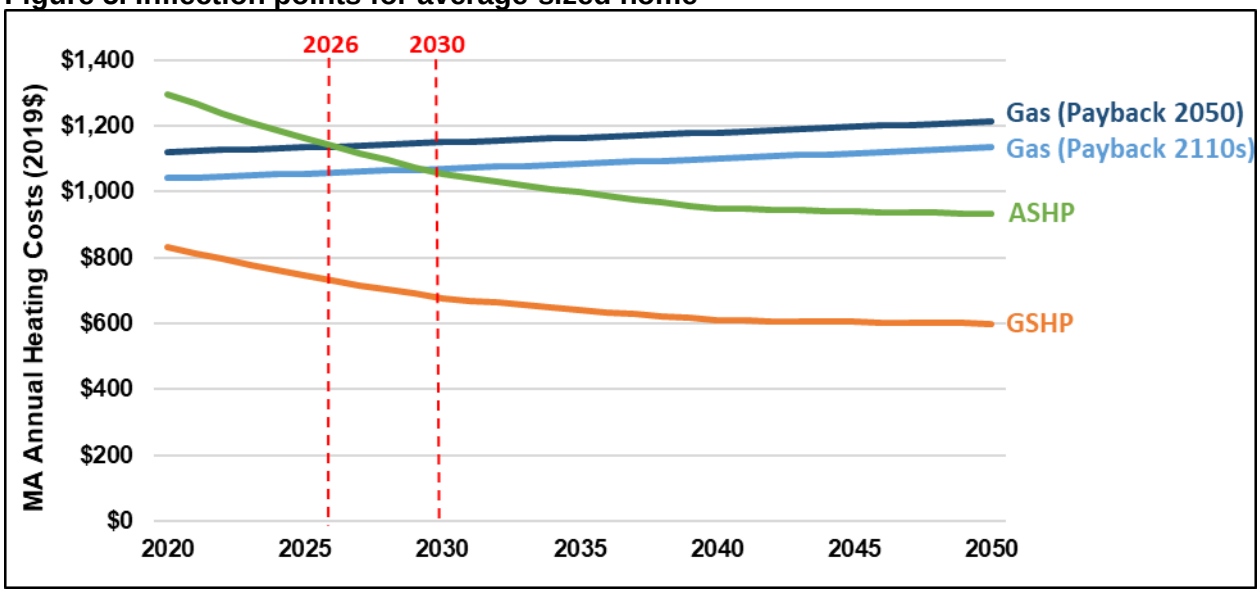
Figure 4. Annual residential heating costs in Massachusetts (average-sized home)



Note: The solid line represents the Reference Case for gas and electricity price projections. The shaded areas represent the uncertainty associated with forecasted energy prices. In this figure, the upper and lower limits of the shaded areas represent High and Low Case gas and electricity prices. See Appendix B: Methodology and Assumptions.

ASHPs will be cheaper to operate than gas heating by 2026 for the Gas (*Payback 2050*) scenario and by 2030 for the Gas (*Payback 2110s*) scenario (see Figure 5).

Figure 5. Inflection points for average-sized home



Annual heating costs differ depending (among other things) on the size of the home. In our analysis, we assumed an "average-sized" home of about 1,900 square feet. Table 1 presents analysis heating costs for two other home-sizes: a small apartment (750 square feet) and a large home (5,000 square feet).

Table 1. Annual heating costs by home size

Home Size	Heating Technologies	Annual Heating Costs (2019$)			
		2020	2025	2030	2035
Small Apartment (750 sq ft)	Gas (Payback 2110s)	$420	$430	$430	$440
	Gas (Payback 2050)	$460	$460	$470	$470
	ASHP	$520	$470	$430	$400
	GSHP	$340	$300	$270	$260
	Electric Resistance	$1,740	$1,750	$1,760	$1,770
Average Home (1,900 sq ft)	Gas (Payback 2110s)	$1,040	$1,060	$1,070	$1,090
	Gas (Payback 2050)	$1,130	$1,140	$1,160	$1,170
	ASHP	$1,300	$1,160	$1,060	$1,000
	GSHP	$830	$750	$680	$640
	Electric Resistance	$4,320	$4,340	$4,370	$4,390
Large Home (5,000 sq ft)	Gas (Payback 2110s)	$2,800	$2,840	$2,880	$2,920
	Gas (Payback 2050)	$3,030	$3,070	$3,110	$3,150
	ASHP	$3,480	$3,120	$2,840	$2,680
	GSHP	$2,240	$2,000	$1,820	$1,720
	Electric Resistance	$11,610	$11,670	$11,730	$11,790

Even though small homes have lower energy bills, families with lower incomes pay more for energy as a share of their income. Research from ACEEE found that the median Boston household pays just over 3 percent of its income in energy bills, while the median low-income family pays 10 percent, and a quarter of low-income households pay closer to 19 percent.[19]

Appendix C: Sensitivity Analyses reviews several additional uncertainties in these main findings, including:

- Less optimistic efficiency improvements for heat pumps, which delay ASHPs surpassing gas in cost effectiveness by one year;
- Biogas as a replacement for fossil-based "natural" gas in piped distribution systems. Biogas is costly and improves heat pumps' cost advantage over gas; and
- Networked geothermal heating systems (discussed in detail in Section VI), which outcompete even GSHPs.

V. Barriers to Heat Pump Installations

Physical, economic, and informational barriers all play a role in preventing or delaying the installation of residential heat pumps in Massachusetts (see Table 2). Low- and moderate-income households (defined as those with income at or below 80 percent of regional median income) are disproportionately affected by these obstacles because high upfront costs (to purchase and install the heat pump equipment) and unequal access to credit (to obtain low to no-interest loans) pose a greater burden to families with less income and savings.

Table 2. Potential barriers for heat pump installations

Barriers	Descriptions
Physical	Obstacles that hinder the retrofit of existing heating systems, such as: • substandard electrical systems, • incompatible infrastructure, and • limited workforce capacity.
Economic	Financial restraints that impede widespread adoption of heat pumps, particularly for low- and moderate-income households, such as: • high upfront costs, and • limited access to credit.
Informational	The perceptions of available heating options can limit heat pump installs due to: • inadequate information/misinformation, • status quo bias, and • slow stock turnover.

[19] American Council for an Energy-Efficient Economy (ACEEE). September 2020. "How High Are Household Energy Burdens? An Assessment of National and Metropolitan Energy Burdens across the U.S." Available at: https://www.aceee.org/research-report/u2006 pp. 44-47

Physical barriers, such as substandard wiring or incompatible infrastructure, make it difficult to retrofit existing heating systems. In 2019, the National Resources Defense Council found that the retrofitting process needed for existing heating systems to meet heat pump requirements varies based on site-specific concerns like the building's age, heating requirements, and existing heat distribution and electric wiring systems[20] that need to be addressed prior to retrofitting—especially when introducing heat pump systems to mixed-use buildings.[21] In addition, a lack of trained technicians can impede the growth of heat pump installations. In 2020, Efficiency Maine Trust found that in some parts of New England, it is not unusual to wait several months for a heat pump consultation because the local workforce is unable to keep up with demand, particularly in summer and fall months.[22]

Economic barriers impede the widespread adoption of heat pumps, especially for low- and moderate-income households. Efficiency Maine Trust found that even with financial assistance from state rebate programs or grant awards, heat pump installations are often prohibitively expensive for many low-income customers due to high upfront costs and imperfect access to credit.[23] Loans can help cover the upfront costs of heat pump purchase and installation, since payments can be spread out over a longer period of time. However, many loan options are not available to customers with poor or no credit—a significant barrier for low- and moderate-income families. These economic barriers disproportionately affect low- and moderate-income customers who already spend a larger share of their income on energy than customers with higher incomes. See Figure 6 for median energy burdens throughout different regions in the United States. The median energy burden for the low-income families in New England is the highest in the United States by over 1 percentage point.[24] The potential energy savings from a new heat pump system could play and important role in lowering this burden.[25]

[20] Steven Winter Associates. April 2019. *Heat Pump Retrofit Strategies for Multifamily Buildings. Natural Resources Defense Council*. Available at: https://www.nrdc.org/sites/default/files/heat-pump-retrofit-strategies-report-05082019.pdf. p. 2

[21] Ibid. p. 23

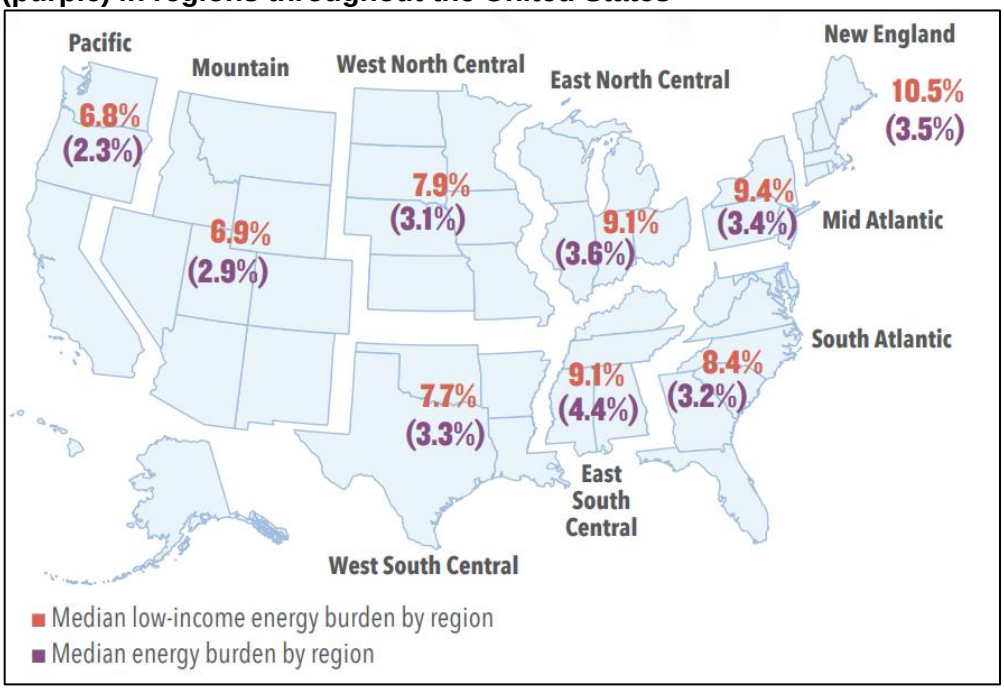
[22] Ibid. p. 35

[23] The Efficiency Maine Trust. January 31, 2020. *Beneficial Electrification: Barriers and Opportunities in Maine*. Available at: https://www.efficiencymaine.com/docs/EMT_Beneficial-Electrification-Study_2020_1_31.pdf p. 25

[24] American Council for an Energy-Efficient Economy (ACEEE). September 2020. "How High Are Household Energy Burdens? An Assessment of National and Metropolitan Energy Burdens across the U.S." Available at: https://www.aceee.org/research-report/u2006 p. 14

[25] The Efficiency Maine Trust. January 31, 2020. *Beneficial Electrification: Barriers and Opportunities in Maine*. Available at: https://www.efficiencymaine.com/docs/EMT_Beneficial-Electrification-Study_2020_1_31.pdf p. 31

Figure 6. Median low-income energy burdens (red) compared to median energy burdens (purple) in regions throughout the United States



Reproduced from: American Council for an Energy-Efficient Economy (ACEEE). September 2020. "How High Are Household Energy Burdens? An Assessment of National and Metropolitan Energy Burdens across the U.S." Available at: https://www.aceee.org/research-report/u2006. p. 14

A lack of certain kinds of information—as well as an abundance of misinformation—are also obstacles for heat pump adoption. Potential customers may be unaware of the latest heat pump technology advancements including extremely high efficiency and technologies that allow for operation in colder climates, causing them to pass over heat pumps as a viable heating option.[26] Recent analysis conducted at Columbia University's Center on Global Energy Policy found that "status quo bias" and "stock turnover" also add to the prevention or delay of residential heat pump installations.[27] Status quo bias refers to the likelihood that consumers will keep their existing equipment or decide to purchase the same equipment in the future. Stock turnover is a similar obstacle that impacts heat pump deployment. Slow stock turnover occurs when gas- and oil-fired heating systems are built to last for decades and are not replaced before the end of their physically useful lives.[28] Since most heating systems are replaced only after failure, homeowners are left with little time to purchase a replacement and forced to select the most readily available or highly recommended system. Due to status quo bias, these replacement systems will likely be the same technology as the existing equipment.

[26] Ibid. p. 34

[27] Kaufman, N. et al. December 2019. "Decarbonizing Space Heating with Air Source Heat Pumps." Columbia University Center on Global Energy Policy. Available at: https://energypolicy.columbia.edu/sites/default/files/file-uploads/HeatPump-CGEP_Report_010220.pdf. p. 15-16.

[28] Ibid.

Widespread heat pump adoption faces challenges from physical, economic, and informational barriers, especially for low- to moderate-income households. Even as heat pumps are becoming more and more competitive with gas heating, these obstacles continue to place heat pumps just out of reach for many of the households that would benefit the most from a transition away from gas.

VI. Networked Ground Source Heat Pump (GSHP) Technology[29]

An individual GSHP installed in a single building is one of the most efficient ways of providing heating and cooling (able to provide an average of 4.5 units of energy for 1 unit of energy used). A GSHP system pumps water through boreholes, allowing the water to absorb the temperature of the ground. The heat pump in the building then extracts from the water the heating or cooling needed. GSHPs achieve higher efficiencies than ASHPs because the temperature of the ground, unlike the air, stays year-round in the 50s, an optimum temperature for heat pump efficiency.

That efficiency can be improved on by interconnecting GSHPs in multiple buildings throughout a neighborhood using an underground shared loop of ambient-temperature water (see Figure 7). This networked GSHP system (also known as networked geothermal or a GeoMicroDistrict[30]), allows for excess energy rejected by one building to be moved to other buildings in the network that need that energy. If not needed now, the energy can be stored in the ground until needed, even across seasons.

There are a few dozen networked geothermal systems in the world, including a few systems in the United States.[31,32] Networked GSHP systems can achieve the highest energy efficiency in neighborhoods with heating and cooling use that is equal, or balanced, annually.[33] The most efficient systems combine decentralized thermal energy sources (such as boreholes) with central energy management, including centralized pumping.

[29] Acknowledgement: Section VI. research contribution by Ajinkya S. Kamat, Ph.D, Home Energy Efficiency Team.

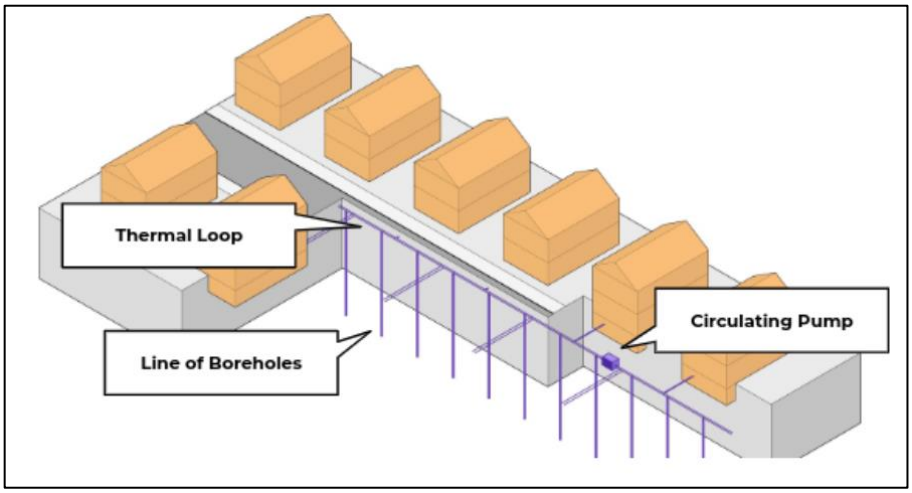
[30] BuroHappold Engineering. 2019. *GeoMicroDistrict Feasibility Study*. Prepared for HEET. Available at: https://heetma.org/energy-shift/geomicrodistrict-feasibility-study/.

[31] Ibid.

[32] The GreyEdge Group designed, built, and currently operate the networked GSHP system at Colorado Mesa University.

[33] BuroHappold Engineering. 2019. *GeoMicroDistrict Feasibility Study.* Prepared for HEET. Available at: https://heetma.org/energy-shift/geomicrodistrict-feasibility-study/.

Figure 7. Illustration of an example networked GSHP system



Reproduced from: HEET. "The GeoMicroDistrict." Available at: https://heetma.org/geomicrodistrict/

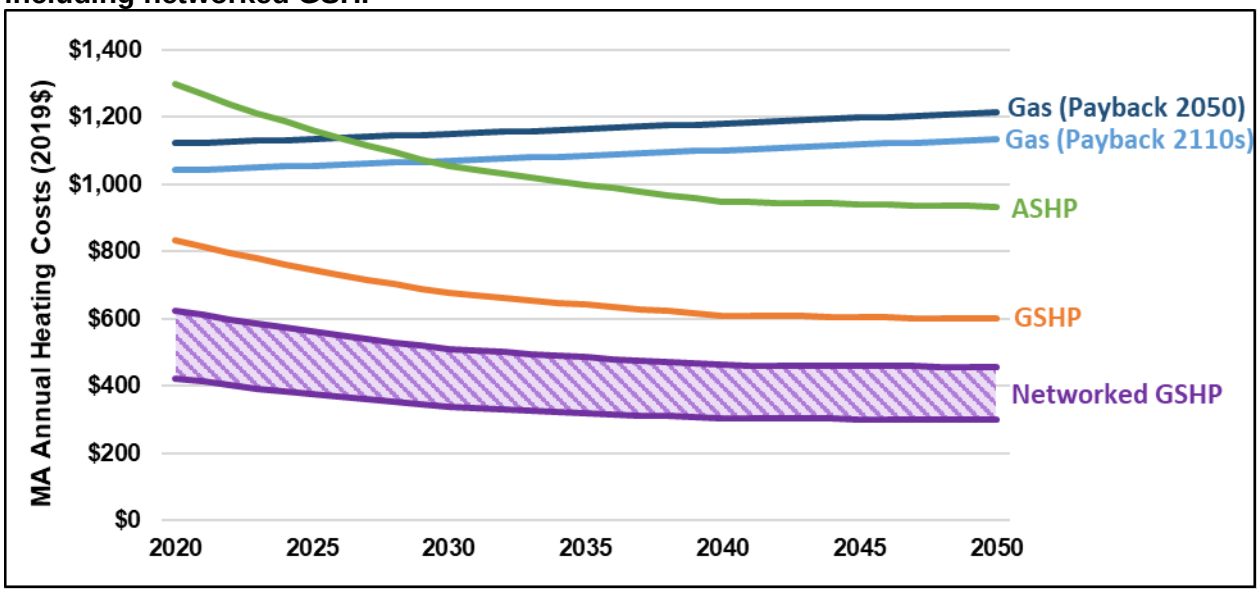
A "GeoMicroDistrict" is a scalable configuration of such a system. Each GeoMicroDistrict is a networked geothermal system serving a single street segment. Multiple GeoMicroDistricts can be interconnected, thus increasing the diversity of loads and in turn providing greater energy efficiency and resilience. Such expansion can create a "GeoGrid" built to the scale of a city.

The largest gas utility companies in Massachusetts are moving forward with pilot networked GSHP systems.[34] If installed by the gas utilities, the cost of this infrastructure could be spread across all customers and paid back over decades. As Massachusetts works to achieve net zero emissions by 2050[35], the opportunity to build and maintain networked GSHP systems in utilities' existing gas rights of way in the street could provide a fossil-free business evolution for these companies while lowering heating bills.[36]

[34] Massachusetts Department of Public Utilities (MA DPU). 2020. D.P.U. 20-59/D.P.U. 19-140/D.P.U. 19-141. Available at: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/12751142.
[35] The Commonwealth of Massachusetts Executive Office of Energy and Environmental Affairs. April 22, 2020. "Determination of Statewide Emissions Limit for 2050". Available at: https://www.mass.gov/doc/final-signed-letter-of-determination-for-2050-emissions-limit/download.
[36] BuroHappold Engineering. 2019. *GeoMicroDistrict Feasibility Study.* Prepared for HEET. Available at: https://heetma.org/energy-shift/geomicrodistrict-feasibility-study/.

Figure 8 shows a projection of operational costs of networked geothermal systems for Massachusetts in comparison with other technologies discussed in Section III of this paper. We forecast the operational costs of a GeoMicroDistrict system in Massachusetts using the most comparable systems' efficiency estimates available for the U.S. context. Installations at Colorado Mesa University and Weber State University inform an efficiency estimate of 600 percent and up to 800 percent for networked GSHP systems with very high waste energy recovery.[37] Due to their greater efficiency, networked GSHPs are by far the least expensive heating option for customers, costing just $420-$620 per year for an average-sized home.

Figure 8. Annual residential heating costs in Massachusetts (average-sized home) including networked GSHP



[37] Based on personal communication with The GreyEdge Group. The installations this estimate is based on are composed of arrays of boreholes and GSHPs serving individual buildings, interconnected through a shared ambient-temperature water loop with centralized pumping. It is of note that a comparison between a single ASHP or GSHP efficiency and a system efficiency of networked GSHPs is not exactly comparable given different boundaries for energy in and energy out.

VII. Policy Recommendations

GSHPs are already less expensive (in terms of customer energy bills) than gas. By 2030 (or sooner if gas system repairs are fully accounted for in gas bills). ASHPs will also be less expensive than heating with gas. Heat pumps run on electricity, and Massachusetts' electric supply grows cleaner every year due to state renewable energy mandates. The typical gas heating system operates for 15 to 30 years, meaning that a system installed today may last until 2050, affecting the Commonwealth's greenhouse gas emissions for decades to come. The installation of any heating system is a big, costly, long-term commitment. Careful, proactive policy design is needed to make the clean energy transition affordable for every household. In contrast, heat pump incentive policies that disproportionately benefit wealthier families cannot succeed in bringing low emissions heating into every home in the Commonwealth.

Heat pumps have lower greenhouse gas emissions than gas heating and, soon, both types of heat pumps (ASHPs and GSHPs) will outcompete gas in terms of annual energy costs. Our 2019 report on the economics of lifetime heat pumps costs (including equipment purchase, installation, and use in air conditioning) found that the least expensive heating choice for consumers depends on the design of state subsidies for heating system purchases.[38] When gas system purchases are subsidized (as they currently are in Massachusetts), gas heating equipment and operation (together) cost less over the lifetime of the system than electric heat pumps. However, if those subsidies were instead awarded to heat pumps, then heat pumps would have lower lifetime costs than gas. The Commonwealth's heating system subsidies are the determining factor for customers comparing costs and making decisions regarding which heating fuel to choose today to heat their home for the next 15 to 30 years.

Without state intervention, residents living in buildings with a heating system that still has years of operational "life" left, will be stuck with the heating system they have. For the vast majority of households, these heating systems are gas-fired and will become increasingly uneconomic to operate every year. States have the opportunity to affect consumer choices by making accurate information on the economic impacts of different heating systems more accessible to the public and by providing subsidies, especially to low- and middle-class families.

In order to decarbonize heating for Massachusetts households, state policy possibilities include:

- **Incentives for heat pump purchase.** These incentives need to be large enough to ensure that fewer households are negatively impacted by a rising cost of heating with gas. Heat pump adoption in the Commonwealth will lead to growing emission reduction benefits as the grid becomes more renewable each year, as mandated by state law.

[38] Lopez, R., T. Comings, E.A. Stanton, and E. Tavares. 2019. Home Heat Pumps in Massachusetts. Applied Economics Clinic. Prepared for Green Energy Consumers Alliance. Available at: https://aeclinic.org/publicationpages/2019/5/29/home-heat-pumps-in-massachusetts

- **Subsidies for low-income and rental housing heating and insulation upgrades.** Installing heat pumps in rental housing—and low- and moderate-income housing more generally—may require state subsidies that cover the entire cost of equipment and installation. In addition, for the Commonwealth to achieve net-zero greenhouse gas emissions by 2050, every household will need to improve their home's insulation through building shell upgrades. Inclusion of electric capacity and wiring upgrades may be necessary as there are substantial building infrastructure barriers in Massachusetts' housing stock. For many families, such retrofits will require an outside funding source.
- **Education and outreach to increase information availability and access.** Homeowners, renters, landlords, real estate agents, heating technicians and general contractors need more and better information regarding the many benefits of heat pumps, including inexpensive cooling, technological improvements, and the long-term economic impacts of heating with gas versus heat pumps. Additional benefits of heat pumps, not related to energy bills, include improved air quality and very low-cost cooling. These benefits add value not discussed in this analysis.

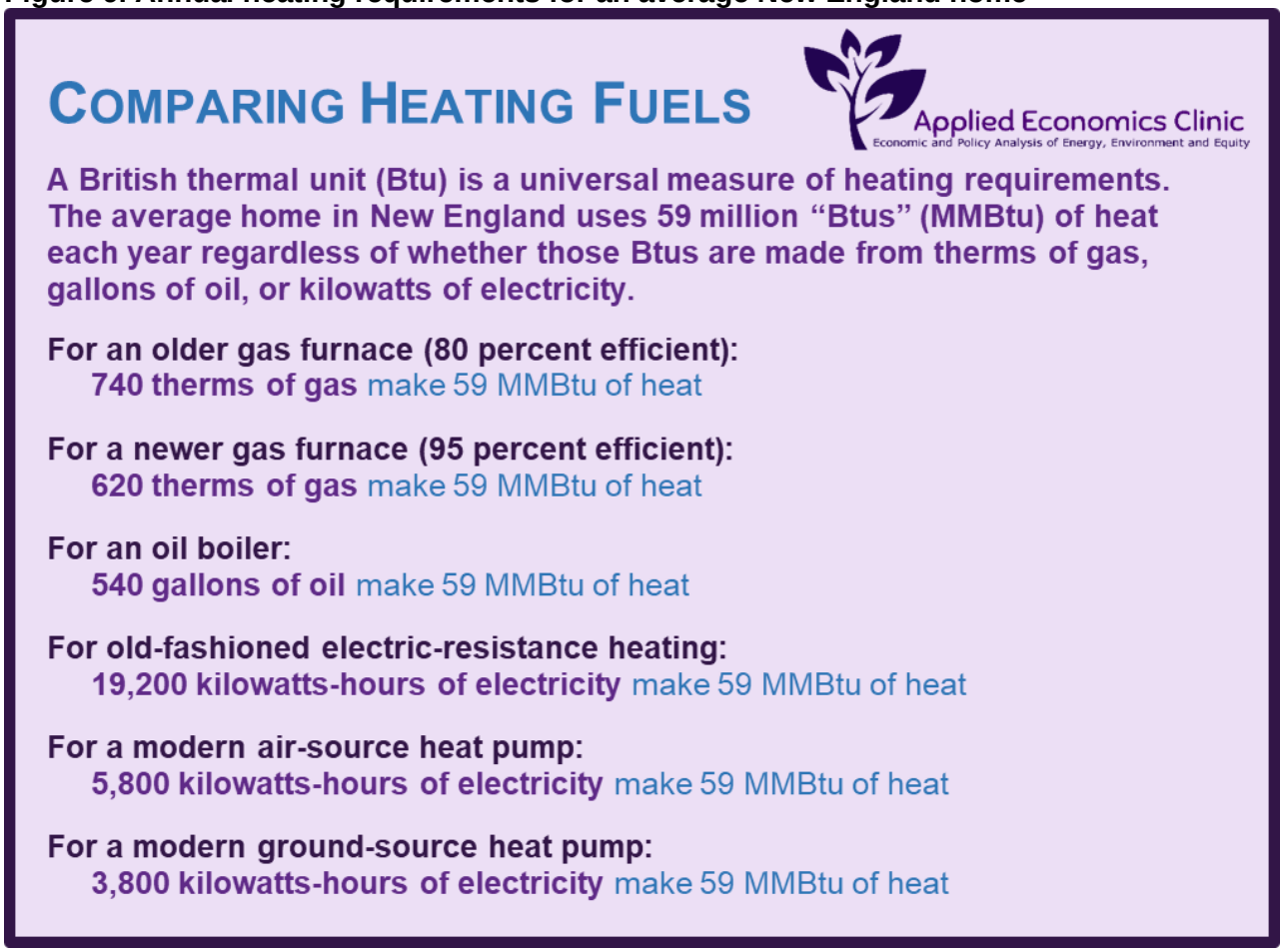
This white paper demonstrates benefits to both the Commonwealth and to consumers of a more rapid shift to heating with heat pumps. Given the lifespan of heating equipment and the time needed for the market and workforce to expand, it is critical to design policies and provide incentives well ahead of the predicted inflection point. Such action can benefit all, helping the state meet its emissions mandate and helping households lower their energy bills.

Appendix A: Measuring Energy Use in "Btu"

Energy used for heating is often measured in the physical units in which it is delivered to homes and businesses (e.g., therms of gas, gallons of oil, kilowatt-hours of electricity)—a practice that makes it difficult to directly compare how much energy is used by different kinds of heating systems. The British thermal unit (Btu) serves as a universal measure of heating requirements (i.e., how much "heat" is needed to warm a building), allowing easy comparison across various fuel options. (Technically, a Btu is the quantity of heat required to raise the temperature of one pound of water by 1 degree Fahrenheit.) In New England, an average-sized home requires 59 million Btus (abbreviated "MMBtu") of heat each year, regardless of the energy source that produces the heat.

Energy consumption varies widely among heating technologies: a new gas furnace requires 620 therms of gas to make 59 MMBtu of heat, while electric baseboards or space heaters require 19,200 kilowatt-hours (kWh) of electricity (see Figure 9). Note that some of these therms and kilowatt-hours are used to make Btus of actual heat, while some energy is lost to inefficiencies and leaks.

Figure 9. Annual heating requirements for an average New England home



Measuring heating requirements in Btus also makes it possible to see differences in efficiency among electric heating options. Compared to the 19,200 kWh of electricity required by electric resistance to provide 59 MMBtu of heat, air-source and ground-source heat pumps only require 5,800 and 3,800 kWh of electricity, respectively. Electric resistance heating is 90 percent efficient (that is, 10 percent of energy is lost), while heat pumps are 300 to 450 percent efficient—they create more heating energy than is directly supplied by electricity. Perfect efficiency—without any loss—would be 100 percent efficient. By drawing energy from ambient temperature differences in the ground or air, heat pumps yield three to four times (300 to 450 percent) more energy than what is contained in the electricity used to run them (see Table 3).

Table 3. Heating requirements and conversions by technology type

Heating Technology	*a* Energy Consumed	*b* Efficiency (%)	*c* Unit Conversion	*d* Heating Requirement (MMBtu) *d = (a * b) / c*
Gas Furnace (Old)	740 therms	80%	10 therms per MMBtu	59 MMBtu
Gas Furnace (New)	620 therms	95%	10 therms per MMBtu	59 MMBtu
Oil Boiler	540 gallons	80%	7 gallons per MMBtu	59 MMBtu
Electric Resistance	19,200 kWh	90%	293 kWh per MMBtu	59 MMBtu
Air-Source Heat Pump	5,800 kWh	300%	293 kWh per MMBtu	59 MMBtu
Ground-Source Heat Pump	3,800 kWh	450%	293 kWh per MMBtu	59 MMBtu

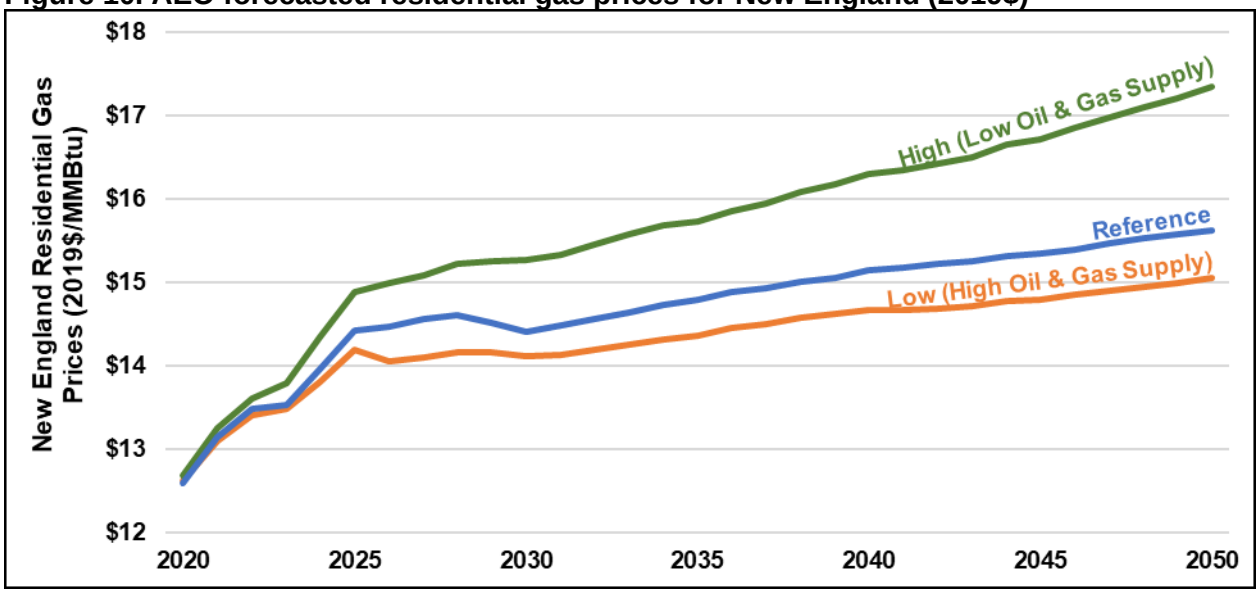
Appendix B: Methodology and Assumptions

To determine the associated utility bills, or cost to customers, for various residential heating options in Massachusetts, AEC compared heating costs on a $ per MMBtu basis (which were then scaled up to the annual heating costs for an average-sized home with a heating requirement of 59 MMBtu). The cost to customers includes all fixed and variable costs that residential customers would pay on their monthly gas or electric bill. The baseline year for this analysis is 2020.

Gas and Electric Prices

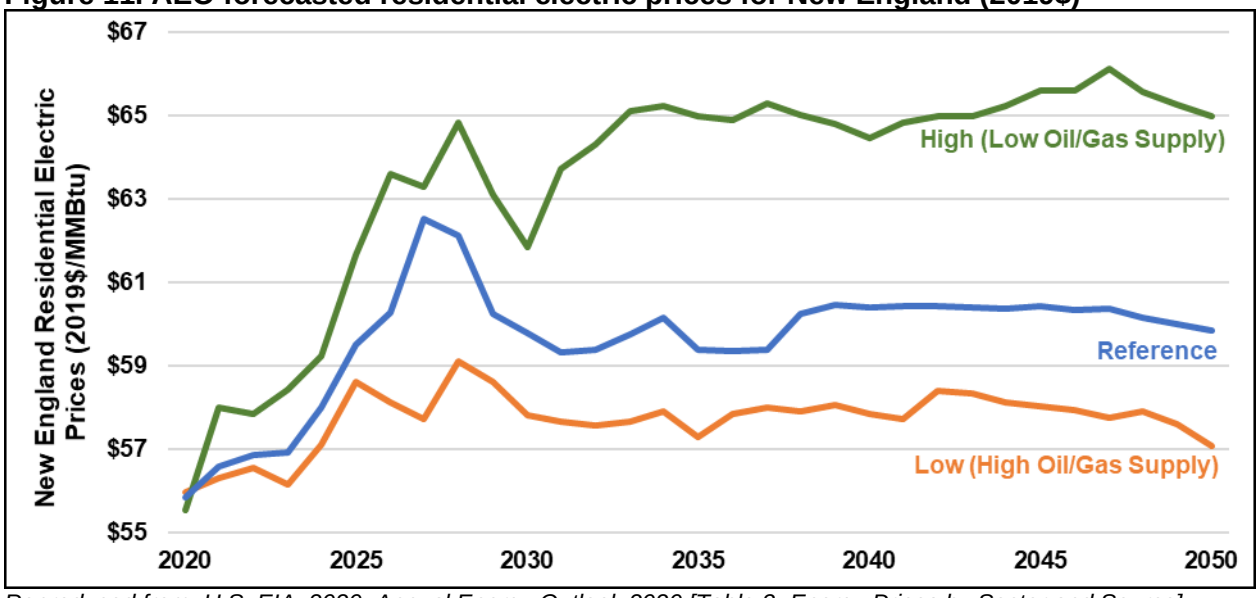
Annual growth rates in residential gas and electric prices are calculated using price forecasts from the U.S. Energy Information Administration's (U.S. EIA) *2020 Annual Energy Outlook (*AEO) for the Reference, High ("low oil and gas supply"), and Low ("high oil and gas supply") cases (see Figure 10 and Figure 11).

Figure 10. AEO forecasted residential gas prices for New England (2019$)



Reproduced from: U.S. EIA. 2020. Annual Energy Outlook 2020 [Table 3. Energy Prices by Sector and Source]. Available at: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2020&region=1-1&cases=ref2020~highogs~lowogs&start=2018&end=2050&f=A&linechart=&map=highogs-d112619a.3-3-AEO2020.1-1&sourcekey=0

Figure 11. AEO forecasted residential electric prices for New England (2019$)



Reproduced from: U.S. EIA. 2020. Annual Energy Outlook 2020 [Table 3. Energy Prices by Sector and Source]. Available at: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2020&region=1-1&cases=ref2020~highogs~lowogs&start=2018&end=2050&f=A&linechart=&map=highogs-d112619a.3-3-AEO2020.1-1&sourcekey=0

Table 4 reports the annual growth rate in residential gas and electric prices for each price forecast scenario.

Table 4. Average Annual growth rates for AEO price forecasts

2020 Annual Energy Outlook	Case/Scenario	Annual Growth Rate (2020-2050)
New England Residential Gas Price	Reference Case	0.7%
	Low Case (High Oil & Gas Supply)	0.6%
	High Case (Low Oil & Gas Supply)	1.1%
New England Residential Electricity Price	Reference Case	0.2%
	Low Case (High Oil & Gas Supply)	0.1%
	High Case (Low Oil & Gas Supply)	0.5%

Gas Rates

Gas rates for 2020 are based on the most recent service and delivery rates for each Massachusetts' gas utility and include the following charges and adjustment factors:[39]

[39] Charges and adjustment factors are sourced from utility-specific documentation. See Appendix D: Utility-specific resources for gas and electric rates for a full list of utility-specific resources.

- Fixed Monthly Customer Charge (converted from a fixed monthly charge to an inferred $ per therm charge by dividing the equivalent annual customer charge by the U.S. EIA's 2018 annual residential gas sales[40] in therms for each utility)
- Distribution Charge ($ per therm)
- Revenue Decoupling Adjustment Factor (RDAF, $ per therm)
- Local Distribution Adjustment Factor (LDAF, $ per therm)
- Gas System Enhancement Adjustment Factor (GSEAF, $ per therm)
- Gas Adjustment Factor (GAF, $ per therm)

Using the appropriate efficiency rate for a new gas furnace (95 percent)[41] and the U.S. EIA's conversion factor (10 therms per MMBtu)[42], these utility-specific gas charges and adjustment factors were then converted from $ per therm to the more universal measure of $ per MMBtu.

The cost of electricity used in residential gas furnace operations was also included in total customer charges. This cost was calculated by multiplying by the U.S. EIA's typical electric consumption for a gas furnace (322 kWh per year) by the weighted average[43] of variable residential electric charges ($0.21 per kWh) and then dividing that product by the U.S. EIA's 2018 annual residential gas sales in MMBtu for each utility.

In Massachusetts gas rates, the GSEAF is the charge on a customer's monthly bill used to recover the costs associated with leak-prone gas infrastructure replacement under the Gas System Enhancement Program (GSEP). In this analysis, we considered two gas rate scenarios to evaluate various GSEP cost recovery mechanisms:

- **Gas (Payback 2110s):** GSEAF values are equal to those reported in the 2020 GSEP filings, adjusted for inflation. This scenario results in the complete recovery of costs for replacing leak-prone infrastructure by the 2110s.

[40] U.S. EIA. 2018. *EIA Natural Gas Annual Respondent Query System*. Available at: https://www.eia.gov/naturalgas/ngqs/#?year1=2018&year2=2018&company=Name

[41] M.J. Bradley & Associates, LLC. 2019. *Life Cycle Analysis of the Northeast Supply Enhancement Project*. Available at: https://www.mjbradley.com/sites/default/files/MJBA_NESE_LCA_06112019.pdf

[42] U.S. EIA. Last Updated June 3, 2020. "Units and calculators explained". Available at: https://www.eia.gov/energyexplained/units-and-calculators/energy-conversion-calculators.php

[43] U.S. EIA. 2018. Technology Forecast Updates - Residential and Commercial Building Technologies - Reference Case. p. 8. Available at: https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/full.pdf. *See* Electric Rates for further details. The weighted average of variable residential electric charges is calculated based on the relative annual residential electric sales for 2018 as reported by each utility to the U.S. Energy Information Administration.

- **Gas (Payback 2050):** GSEAF values from the 2020 GSEP filings are multiplied by 2.63. This factor represents the required increase in customer charges to completely recover the costs associated with leak-prone infrastructure replacement by 2050. (For a discussion of our methodology in calculating leak-prone gas infrastructure replacement costs see AEC's December 2020 policy brief entitled *Fixing Massachusetts' Leaky Pipes: When Will It Be Paid Off?*)

The total residential customer charge for each gas utility is the sum of all utility-specific gas charges and adjustment factors and the cost of electricity needed to run gas furnaces. A residential customer charge for Massachusetts was then calculated by averaging the utility-specific gas rates weighted by each utility's annual residential gas sales for 2018 as reported to the U.S. EIA.

To project residential customer charges into the future, the Gas Adjustment Factor (GAF) and cost of electricity for gas furnaces were escalated based on the annual growth rates for gas and electric prices projections from the U.S. EIA's 2020 AEO. All other components of gas customer charges were assumed to be unchanged (in real, inflation-adjusted terms) in future years.

Electric Rates

Electric rates for 2020 are based on the most recent service and delivery rates for each of Massachusetts' electric utilities, which include the following charges and adjustment factors:[44]

- Fixed Monthly Customer Charge (converted from a fixed monthly charge to an inferred $ per kWh charge by dividing the equivalent annual customer charge by the U.S. EIA's annual residential electric sales[45] in kWh for 2018 for each utility)
- Basic Service Charge ($ per kWh)
- Distribution Charge ($ per kWh)
- Transition Charge ($ per kWh)
- Transmission Charge ($ per kWh)
- Energy Efficiency Charge ($ per kWh)
- Renewable Resource Charge ($ per kWh)
- Distributed Solar Charge ($ per kWh)
- Among other charges and adjustment factors

[44] Charges and adjustment factors are sourced from utility-specific documentation. See Appendix D: Utility-specific resources for gas and electric rates for a full list of utility-specific resources.

[45] U.S. EIA. 2018. *EIA-861 Annual Survey Data*. Available at: https://www.eia.gov/electricity/data/eia861/

Using the appropriate efficiency rate (see below) and the U.S. EIA's conversion factor (293.1 kWh per MMBtu)[46], these utility-specific electric charges were then converted from $ per kWh to the more universal measure of $ per MMBtu.

The total residential customer charge for each electric utility is the sum of all utility-specific electric charges. An average residential electric rate for Massachusetts was then calculated by averaging the utility-specific electric rates weighted by each utility's annual residential electric sales for 2018 as reported to the U.S. EIA.[47]

The unit conversion from $ per kWh to $ per MMBtu differs by technology:

- Electric resistance heating (90 percent efficiency)[48]
- Air-source heat pumps [97.7 kwh per MMBtu]
- Ground-source heat pumps [65.1 kwh per MMBtu]

Instead of having an efficiency rate, heat pump technologies have what is known as a coefficient of performance (COP):

- **Efficiency rate:** the net energy output for a given amount of consumed energy (i.e., some energy is lost in the conversion)
- **Coefficient of performance (COP):** the required amount of energy that is needed to yield the desired output.

Air-source and ground source heat pumps have COPs of 3.0 and 4.5, respectively, which translate to efficiency conversion factors of 97.7 and 65.1 kWh per MMBtu.[49]

To project residential customer charges into the future, the Basic Service Charge was escalated based on the annual growth rate for electric price projection from the U.S. EIA's 2020 Annual Energy Outlook (AEO). All other components of electric customer charges were assumed to be unchanged (in real, inflation-adjusted terms) in future years. To project the residential customer charges for heat pump technologies, the efficiency rate is also adjusted to increase over time based on the National Renewable Energy Laboratory's (NREL) performance projections (see Figure 12).

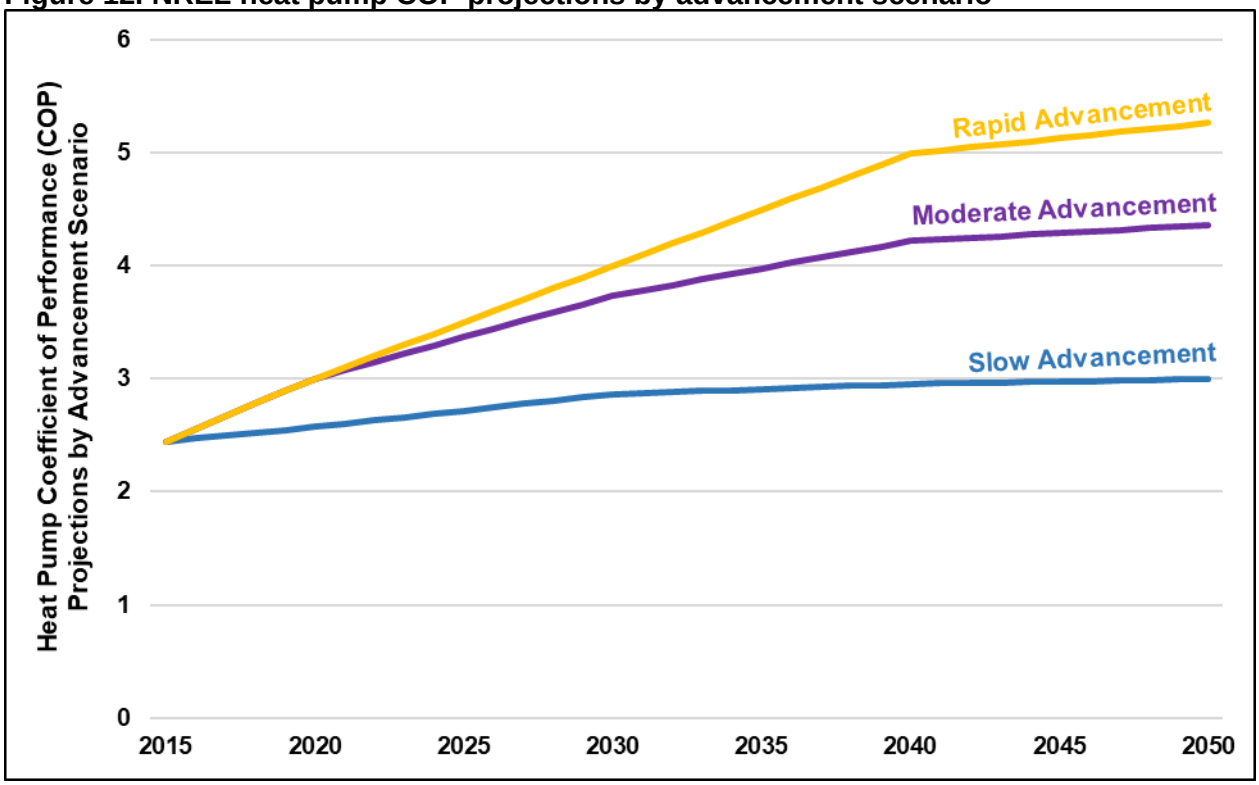
[46] U.S. EIA. Last Updated June 3, 2020. "Units and calculators explained". Available at: https://www.eia.gov/energyexplained/units-and-calculators/energy-conversion-calculators.php

[47] U.S. EIA. 2018. *EIA-861 Annual Survey Data*. Available at: https://www.eia.gov/electricity/data/eia861/

[48] M.J. Bradley & Associates, LLC. 2019. *Life Cycle Analysis of the Northeast Supply Enhancement Project*. Available at: https://www.mjbradley.com/sites/default/files/MJBA_NESE_LCA_06112019.pdf

[49] M.J. Bradley & Associates, LLC. 2019. *Life Cycle Analysis of the Northeast Supply Enhancement Project*. Available at: https://www.mjbradley.com/sites/default/files/MJBA_NESE_LCA_06112019.pdf

Figure 12. NREL heat pump COP projections by advancement scenario



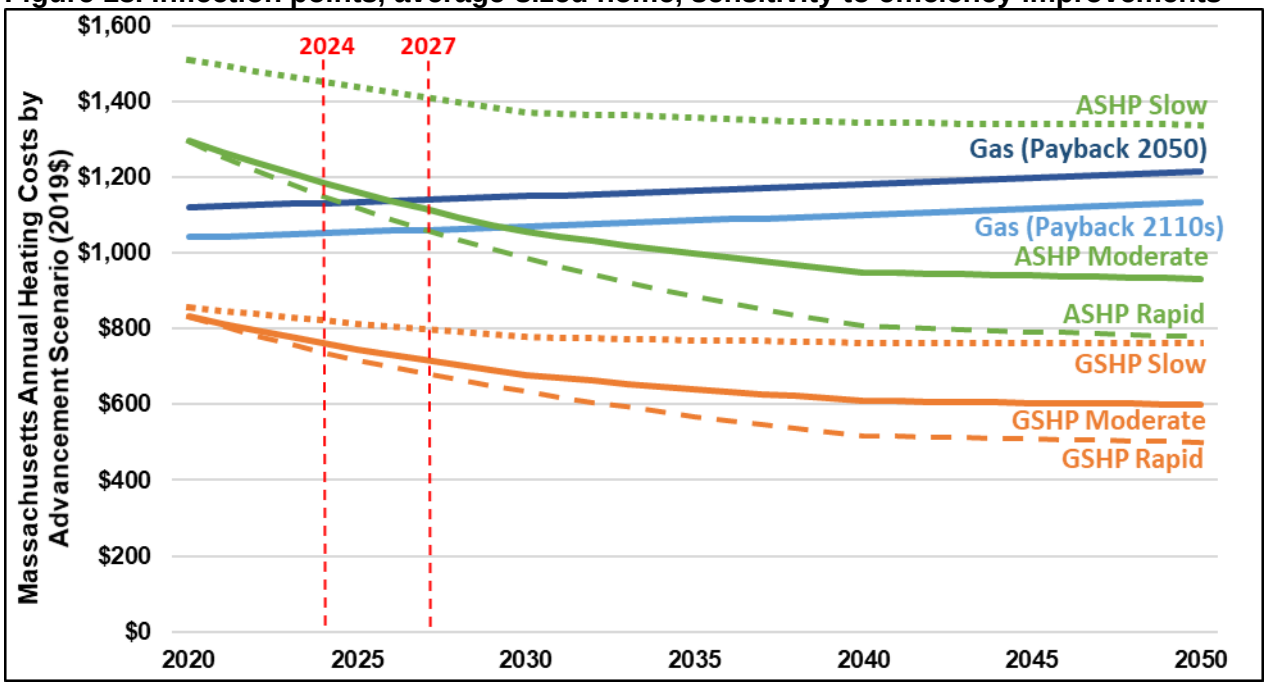
Reproduced from: Jadun, P. et al. 2017. Electrification Futures Study: End-Use Electric Technology Cost and Performance Projections through 2050. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-70485. Available at: https://www.nrel.gov/docs/fy18osti/70485.pdf.

Appendix C: Sensitivity Analyses

Improvements to efficiency over time

The heating costs shown above assume only a very moderate pace of technological development. A quicker pace of efficiency increase in ASHPs would mean that ASHPs out compete gas heating in 2024 (versus 2026) for the Gas (Payback 2050) scenario and 2027 (versus 2030) for the Gas (Payback 2110s) scenario (see Figure 13). Even in the least optimistic case for improvements to heat pump efficiency, slower advancement delays ASHPs by just a year or two in out-competing gas heating.

Figure 13. Inflection points, average-sized home, sensitivity to efficiency improvements

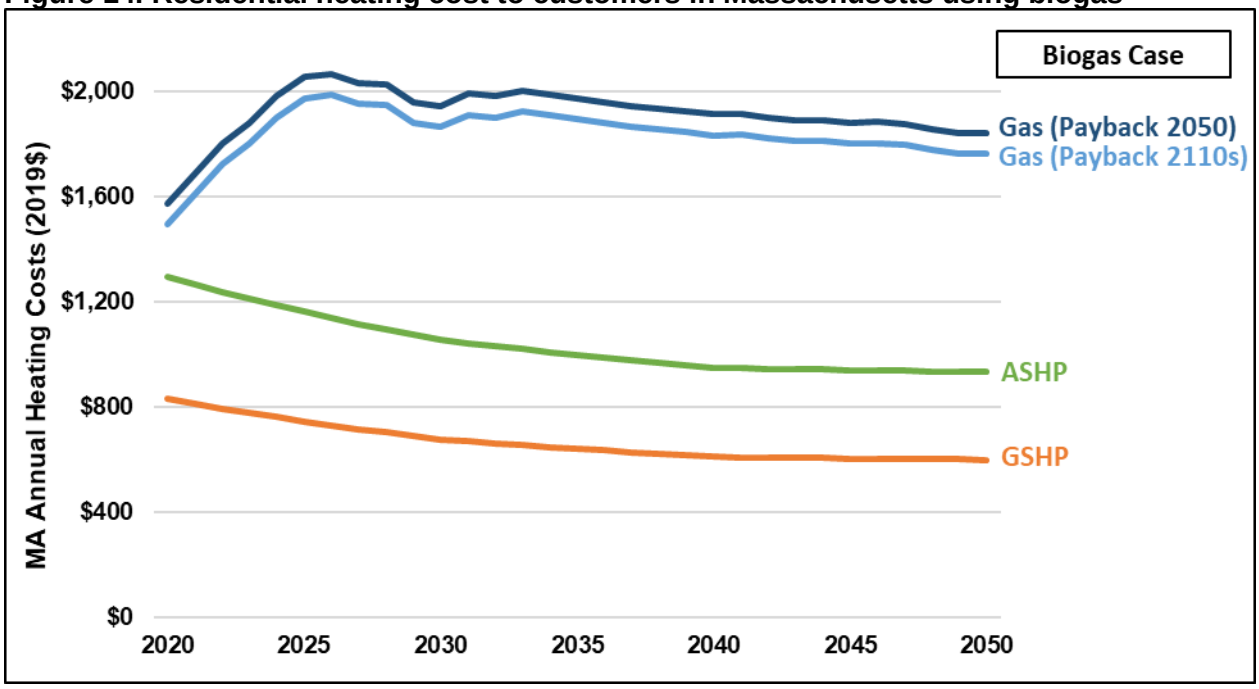


Biogas

Biogas (sometimes called “renewable” natural gas) is derived from biomass feedstocks (such as agricultural waste, forestry residues, or energy crops) through processes that include anaerobic digestion and thermal gasification. While biogas has the potential to be fully interchangeable with conventional gas in local distribution systems, it is not currently available at a scale necessary to replace fossil gas. In addition, the price and availability of biogas make it less cost-effective than conventional piped gas.

Massachusetts' gas utilities currently charge a Gas Adjustment Factor (GAF) to recover the costs associated with the supply of gas. Today the gas utilities charge a GAF that is approximately equal to $6 per MMBtu. According to ICF International's 2020 technical study report, *Opportunities for Evolving the Natural Gas Distribution Business to Support the District of Columbia's Climate Goals,* the marginal cost of biogas is estimated to be $14 per MMBtu today—more than twice the current expense for conventional gas supply.[50] Switching to biogas, raises the customer costs of both gas scenarios modeled in this report making gas heating even less competitive with heat pumps (see Figure 14). In 2020, gas heating with biogas would cost $1,500-1,580 per year (including all gas distribution charges), while ASHPs cost $1,300 per year. This cost difference continues to grow into the future with gas heating with biogas growing to $1,760-1,840 per year and ASHPs costs fall to $930 per year by 2050.

Figure 14. Residential heating cost to customers in Massachusetts using biogas



[50] ICF. 2020. *Technical Study Report: Opportunities for Evolving the Natural Gas Distribution Business to Support the District of Columbia's Climate Goals*. Prepared for AltaGas. Available at: https://washingtongasdcclimatebusinessplan.com/wp-content/uploads/2020/04/Technical-Study-Report-Opportunities-for-Evolving-the-Natural-Gas-Distribution-Business-to-Support-DCs-Climate-Goals-April-2.pdf. p. 14

Appendix D: Utility-specific resources for gas and electric rates

Gas Rates and Information

Base Rate Charges and Adjustment Factors

- The Berkshire Gas Company. 2020. *Residential Rate – Heating*. Residential Heating Rate Classification No. R-3. Available at: https://www.berkshiregas.com/wps/wcm/connect/www.berkshiregas.com16325/d537b847-1695-438e-b0ce-b4f5e76f5b50/Regular-Delivery-Tariffs-MDPU-537-Rate-R-3-05-20.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE.Z18_J092I2G0NODI40A73GVBIB3C13-d537b847-1695-438e-b0ce-b4f5e76f5b50-n7g4DLn
- Boston Gas Company. 2019. *Base Rate Tariffs*. Residential Heating Rate Classification No. R-3. Available at: http://gasrates.nationalgridus.com/ne/Web%20Boston%201119%20v3.pdf
- Colonial Gas Company. 2019. *Base Rate Tariffs*. Residential Heating Rate Classification No. R-3. Available at: http://gasrates.nationalgridus.com/ne/Web%20Colonial%201119.pdf
- Columbia Gas of Massachusetts. 2020. *Tariffs, Rate Schedules and Agreements*. Residential Heating Rate Classification No. R-3. Available at: https://www.columbiagasma.com/docs/librariesprovider15/rates-and-tariffs/massachusetts-tariff.pdf?sfvrsn=3
- Eversource Energy. 2020. *2020 Summary of Eastern Massachusetts Gas Rates*. Residential Heating Rate Classification No. R-3. Available at: https://www.eversource.com/content/docs/default-source/rates-tariffs/summary-rates-gas.pdf
- Liberty Utilities. 2019. *Sales Service Rates – Peak.* Residential Heating Rate Classification No. R-3. Available at: https://massachusetts.libertyutilities.com/uploads/LUC%20Peak%20Rates%20-%201119%20-%20Peak%20Rates.pdf
- Unitil. 2020. *Energy for Residents: Gas Information*. Residential Heating Rate Classification No. R-3. Available at: https://unitil.com/energy-for-residents/gas-information/rates
- Massachusetts Department of Public Utilities (MA DPU). December 2019. 2019-2020 Peak Gas Adjustment Factors. Available at: https://www.mass.gov/doc/gaf-historical-data-workbook-1999-2019/download

Gas System Enhancement Adjustment Factors (GSEAFs)

- MA DPU Docket No. 19-GSEP-01. *2020 Gas System Enhancement Plan, Exhibit Unitil-AFCG-3 (Determination of the GSEAF).* Filed by Unitil (Gas Division). Available at: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/12029500

- MA DPU Docket No. 19-GSEP-02. *2020 Gas System Enhancement Plan, Exhibit BGC-JB/RG-3 (Calculation of GSEAF).* Filed by The Berkshire Gas Company. Available at: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/11385561
- MA DPU Docket No. 19-GSEP-03. *2020 Gas System Enhancement Plan, Exhibit NG-AFS/TAU-5 (Calculation of GSEAF).* Filed by Boston Gas Company and Colonial Gas Company d/b/a National Grid. Available at: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/11400116
- MA DPU Docket No. 19-GSEP-04. *2020 Gas System Enhancement Plan, Exhibit LU-VPD-2 (GSEAF Rate Calculation).* Filed by Liberty Utilities. Available at: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/11389062
- MA DPU Docket No. 19-GSEP-05. *2020 Gas System Enhancement Plan, Exhibit CMA/CYL-2, Schedule #8 (GSEAF by Rate Class Sectors).* Filed by Columbia Gas of Massachusetts. Available at: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/12110501
- MA DPU Docket No. 19-GSEP-06. *2020 Gas System Enhancement Plan, Exhibit ES-BKR-1, Schedule #28 (Calculation of GSEAF by Rate Class Sectors).* Filed by NSTAR Gas Company d/b/a Eversource Energy. Available at: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/12108605

Electric Rates and Information

- Eversource Energy. January 2020. *2020 Summary of Eastern Massachusetts Electric Rates for Cape Cod and Martha's Vineyard Service Area*. Available at: https://www.eversource.com/content/docs/default-source/rates-tariffs/ema-cape-vineyard-rates.pdf?sfvrsn=d77ef362_32
- Eversource Energy. January 2020*. 2020 Summary of Western Massachusetts Electric Rates.* Available at: https://www.eversource.com/content/docs/default-source/rates-tariffs/wma-rates.pdf
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- Massachusetts Department of Public Utilities. May 2020. "Fixed Prices". Basic Service Prices. Available at: https://www.mass.gov/doc/view-basic-service-prices
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To whom it may concern at the Philadelphia Office of Sustainability,

My name is Lily Aparin-Buck and I am a member of Sunrise Philly. We were excited to learn about the PGW Diversification Study. It's good that this study is happening and that the study is examining ways to decarbonize while improving air quality and health, protecting jobs, and ensuring that people can afford heat. We also wanted to make sure that this study leads to action: the city needs urgent solutions that meet all those criteria. We need a sustained, participatory, community-based process for creating a plan to transform PGW and transform buildings across the city. We hope you bring climate justice organizations to the table and work with us.

Thank you,
Lily Aparin-Buck

PGW Business Diversification Study Comments

Lisa K Hastings

The city must transition PGW away from natural gas and into clean renewable, non-fossil fuel energy quickly while maintaining revenue, its workforce, and providing affordable energy service for its customers. That's a lot to ask, and while I think diversification of PGW has a critical role to play in this, I did not find the report, or at least the slide show that was made available to the public, very encouraging. However, I think this is due to weaknesses in the report and not the hopelessness of the situation.

The report was too negative about conversion to renewable energy and limited in its discussion of renewable energy and costs. It may have been better than it appeared because the entire draft report with supporting documentation was never released to the public. Since it wasn't, I can only assume that what was made public covered the scope of the report and accurately portrayed conclusions that were made.

In order to carry out the inevitable transition to clean energy, the first thing the city should do is to stop allowing PGW to keep expanding its natural gas infrastructure for delivery of natural gas to residential, commercial and industrial customers, including ceasing promoting the idea that stand alone natural gas generators are cleaner than grid electricity and that LNG is better than solar and wind energy. The "cleaner than electricity" was refuted on slides 19 and 20 with the statements that "emissions from a customer heating their home with electricity from the grid in 2020 are lower than the emissions of a customer using a gas furnace", PJM's grid is already cleaner than it was in 2014 and it is scheduled to become cleaner over time. While the report slides did not give the data for these statements, I have seen other data and have confidence these statements are correct. Clearly, these should be reasons enough for PGW to stop claiming otherwise while promoting large natural gas projects.

While immediate business concerns encourage PGW to try to make more customers dependent on natural gas for energy and supportive of increased fracking of natural gas, this approach will probably only make it more painful and costly—for PGW and its customers---when the status quo of relatively inexpensive and abundant natural gas ends. Meanwhile, PGW will have squandered millions more dollars replacing and repairing gas mains for no future benefit while continuing to increase pollution in our city and state. *PGW will lose more of its customer base, jobs and revenue if it delays transitioning than if it adopts new sources of energy and revenue as quickly as it can.* The report also continues to include CNG and LNG in PGW's future portfolio, even though these forms of natural gas still create GHG pollution and other serious environmental problems through fracking and methane transportation. LNG and CNG are already becoming economically obsolete and should not be encouraged for the future. (The global demand for LNG is weak and is expected to decrease, not increase. In my opinion, CNG is likely to be quickly replaced by electric and hydrogen-fueled vehicles, especially since both are being aggressively developed for heavy duty trucks through small vehicles.)

I think the best approach for diversification and eventual transition includes PGW starting, without delay, to adopt multiple other energy sources, including solar, wind, geothermal and hydrogen, using pilot projects as the report suggests for new technologies, and demonstration

projects that can be funded for more well-known ones like solar and geothermal. The technologies are available and are much more promising than the report implies. Pilot and demonstration projects will help educate everyone and ease the transition while providing cleaner energy and a cleaner environment for Philadelphia and reduced costs for those included in them. What are we waiting for? There is not one solution, so let's get started on multiple ones.

Philadelphia can look into a pilot project being started in California now, with planned expansion domestically and globally. [See attachment "Investment agreement.Raven" for one such pilot project. Philadelphia would be a good candidate for being a "hydrogen hubs".] While existing waste to hydrogen converters are mostly small, one-ton units, the pilot project units being planned will process up to 50 tons of solid waste into over 4 tons of clean hydrogen a day and be used to power Hyzon Motors commercial vehicles. This summer the first unit for the project is being built to turn 25 dry tons of municipal solid waste (in San Jose, CA) into 5000 kg/day of renewable, transportation grade hydrogen. This is the first of potentially hundreds across America and the globe. Philadelphia, with its growing regional warehousing industry and the need to cut vehicle emissions, could be a perfect location for hydrogen fuel production and use, as well as a port for hydrogen-fueled vehicles in the near future. The west coast has California; the east coast has Philadelphia. Philadelphia has plenty of extra solid and liquid waste, and the process also is proven to work on medical waste and plastics (even plastic bags); glass and metals are excluded.

In the discussion of "decarbonization" and renewable energy, besides being quite negative, the report was already outdated and does not look at emerging commercial technologies. For instance, instead of being limited to dirty combustion processes or expensive hydrolysis, hydrogen and hydrogen synthetic gas can be produced in the well-developed non-combustion process being implemented above. It is not only much cleaner, less expensive and less energy-consumptive than traditional processes, but produces superior products with higher hydrogen contents as well as transportation-grade hydrogen. (See attached PDF documents for the differences between the EPA-approved, non-combustion process being used in the pilot project, and the dirty, combustion "gasification" process the report indicates is the only option.) Creation of renewable gas with aerobic combustion and catalysts described in the report is not necessary, not supported by those interested in environmental improvement, and should not be seen as an alternative route for PGW. Expensive and energy-intensive hydrolysis or using natural gas as a feedstock are not needed to produce hydrogen or renewable hydrogen-based gas.

The same renewable energy company that is conducting the Hyzon pilot project is gearing up to manufacture other built-to-scale equipment for conversion of multiple types of waste, liquid to solid, into hydrogen syn-gas and hydrogen for commercial use. The equipment is portable, can be used on land or in water. It can be set up in neighborhoods, by sewage treatment and trash facilities, or used in the water to process out pollution, including plastics that are otherwise not normally recyclable. The products produced also have multiple uses, from being used as an additive to natural gas to create more and cleaner energy during the transition process, providing valuable fuel for hydrogen fuel-cell transportation of the near future, to directly generating electricity using microgrids. The syngas can be further transformed into other synthetic fuels, but that is not necessary. [The process is not new and units have been built and operated, but commercial production was stalled until after the intellectual property rights were purchased by an engineering/renewable energy firm a few years ago.]

I also encourage the city to provide financial assistance for electrification and renewable energy options for low-income households, possibly in a joint program between PGW, the Philadelphia Energy Authority and the federal government. This would be in keeping with both city and federal climate goals as well as with President Biden's commitment to low-income households. Some in PGW may see this as "giving away customers", but it would be better for PGW and its workers to be part of this inevitable and needed transition than to resist it and end up being dissolved.

Although the assumption was not included in the slides, when the report discusses revenue for PGW, revenue seemed to be reliant on PGW continuing to provide natural gas to some customers, with these customers handling more of the burden of supporting PGW. While *this is a common argument against transitioning*, it does not reflect the possibility that the business model of PGW can also transition from only providing natural gas to being a multi-energy provider and possibly even augmenting that with other energy-related businesses. [This may require changes in the official charter of PGW, but since PGW and it's governance are under the ultimate control of the city government, this seems doable and should be a prime consideration. PGW can even be decommissioned and reborn as "Philadelphia Energy Works" and be a multi-faceted business, while also remaining a key public energy provider in Philadelphia.]

After limiting the options of other energy sources, the report (p. 45) provides a table with very limited new business models for PGW. Many of us would like to explore the possibility that PGW could benefit by having a divisions that produced or installed renewable energy as well as one that manufactured renewable energy equipment, for itself and others. Why not? Depending on what renewable energy is used and what could be manufactured here, clean, renewable energy could provide plenty of jobs and money for PGW. The jobs won't be replacing dangerous and leaking natural gas mains, but many can still involve using skilled labor.

Throughout, the report referred to "participants" in other energy and "non-participants" who would still remain natural gas users, with "non-participants" and the revenue they create for PGW declining over time. It assumed that the "participants" would no longer be customers of PGW (or it's revised self), and thus would not contribute revenue. I know that those of us concerned about PGW, it's workers and its customers, want "participants" and "nonparticipants" to both remain PGW customers in some way. *People who electrify before PGW remakes itself into a clean energy provider will be lost to existing electric providers or solar energy installers,, but if PGW transitions into being a full-service energy provider, it can still receive revenue from and provide electricity to former natural gas customers.*

The ability to retain a customer base is an important reason that PGW needs to start diversifying and transitioning as soon as it can rather than delaying it as long as possible. The more quickly PGW transitions away from fossil fuel, the greater number of current customers they will be able to retain by providing replacement energy or renewable energy equipment. They may even develop new customers or revenue sources. Transitioning off natural gas does not mean the end of PGW; it is a new beginning.

The report's conclusions were biased toward continuing natural gas products and against renewables. This was evident in the discussion of geothermal grid technology and natural gas. It claimed that maintaining micro-districts of geothermal energy would be "costly compared to existing infrastructure", and would require neighborhood retrofits with "uncertain"

economics. OK, everything requires maintenance and replacement over time, but the report does not address the extreme costs of maintaining PGW's infrastructure…except to say that these would be less expensive than the unknown costs of maintaining geothermal systems. This statement is not valid. If costs are unknown, how can they be known to be greater or less than future costs of the existing system? Perhaps the consultants were unaware of the debt, costs and extent of repairs PGW is already facing without even factoring in future costs. It seems improbable to me that retrofitting geothermal would cost more over time.

On the undiscussed bright side, geothermal not only provides a lasting energy source for temperate control for public schools and other buildings, but the "field" version also uses pipes similar to natural gas pipes, and construction and maintenance of geothermal grids would not only clean the environment and provide affordable energy, they would provide PGW's skilled labor force with lots of good jobs when they are installed and, if the report is accurate, to maintain and retrofit them. Given that one downside of solar energy I hear from workers is that it doesn't sustain their jobs, this may be music to PGW workers ears. Many could continue to use their skills on an ongoing basis, even after geothermal energy was installed everywhere it could be.

In addition to looking into being a pilot hydrogen hub, PGW can also consider producing hydrogen synthetic gas from many solid or liquid wastes as a pilot project of its own, at this time to product hydrogen to make burning natural gas more efficient and less polluting. As hydrogen fuel cell technology improves, which is expected for both large trucks through passenger vehicles in the very near future, perhaps PGW could transition a "pilot hub" into being a permanent manufacturer and provider of hydrogen to run transportation and delivery trucks in the region. This could also help the city deal with its municipal solid and liquid waste excesses and biomasses above what will hopefully be composted, without "waste to energy" incineration, sending it to landfills or using aerobic conversion (combustion) to renewable gasses.

Perhaps PGW could partner with SEPTA and provide non-fossil fuel to run SEPTA vehicles or power regional rail trains.

PGW could potentially work with the school district and the city to use federal or other funds to install geothermal field systems and/or solar systems in public schools that lack air conditioning and heat control. The ongoing costs would be reduced over regular electricity, and not improving the climate control in city schools, especially as extreme temperatures become more common, is also not an acceptable option. Perhaps a demonstration project using federal funds can be implemented at a school in an EJ neighborhood that needs climate control badly but lacks the electric power and money for regular air-conditioning. Some schools might be appropriate for solar or geothermal; others might benefit from both, but PGW can be part of clean, renewable energy solutions.

With the expected explosion of renewable energy, perhaps PGW could become a provider and installer for solar panels for existing or new construction, or a paid partner with the city and Philadelphia Energy Authority programs to help lower the costs of installing solar energy in lower income households and elsewhere.

There are many locations in Philadelphia where field geothermal could be installed, including in brown fields and in areas with major construction. PGW may want to work with developers and remediation projects to install geothermal while the ground is exposed and disturbed, and then

sell the energy to the final project or to other customers. I think in the current climate, developers would be open to including low-cost, clean energy in their marketing.

Perhaps a renewed PGW could partner with the Philadelphia Housing Authority to install geothermal energy when new low-income housing is built. This would lower ongoing energy costs, improve indoor and outdoor air quality compared to natural gas, and provide jobs for PGW workers.

Down the line, PGW could consider expanding to manufacturing energy equipment, from solar panels to EV chargers. The possibilities are many and varied, and are limited mostly by political will, not by technology or even money. There can be jobs and revenue, and PGW's customers and city will be well-taken care of---if the PGW acts, voluntarily or in response to a city mandate.

Thank you.

Lisa K Hastings

Fueling a Greener Future

Every Year **in the USA**

34.5 billion tons unrecycled municipal solid waste (MSW) are buried in landfills

10 million tons bio-hazardous waste are incinerated

30 billion tons organic & dairy waste are generated

1.5 million tons of plastics enter the oceans

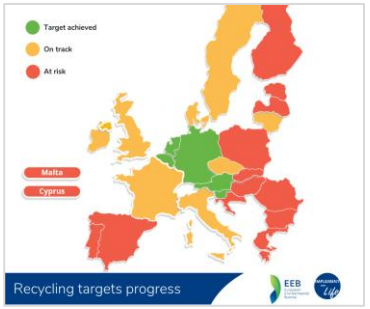
while **1,300 superfund sites** need cleaning

RAVENSR is the solution.

While In **Europe**

45.5% of waste in the EU is landfilled

With Spain and Eastern Europe lagging in recycling



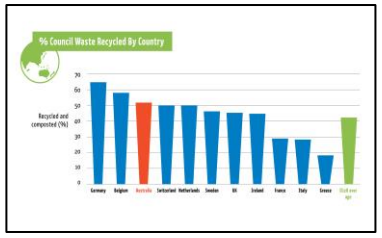
40m tonnes of waste are exported

And **60m tonnes** are incinerated, creating air pollution

While COVID-19 has only increased incineration

RAVENSR is the solution.

Every year **in Australia**



Australian **households recycle 51%** of their waste, which is high globally, but

67 million tonnes of total waste is generated per year, only **37% recycled**

Sales prices for recyclable materials have to as low as **$0/tonne,** increasing landfilling

130,000 tonnes of Australian plastic ends up **in waterways and oceans.**

and Victoria alone produces **39,000 tons of medical waste**

RAVENSR **is the solution.**

Society is **Demanding Renewable Energy**

National governments and international organizations are increasing pressure,

The New York Times

U.N. Adopts Ambitious Global Goals After Years of Negotiations

EU sees 'Green Deal' delays but keeps climate target plan: draft document

Caixin

New Draft Law Puts Clean Power at the Forefront of China's Energy Policy

And some companies have responded boldly.

Toward a low-emissions future
Repsol climate roadmap

REPSOL

DELTA

enagas

OGCI

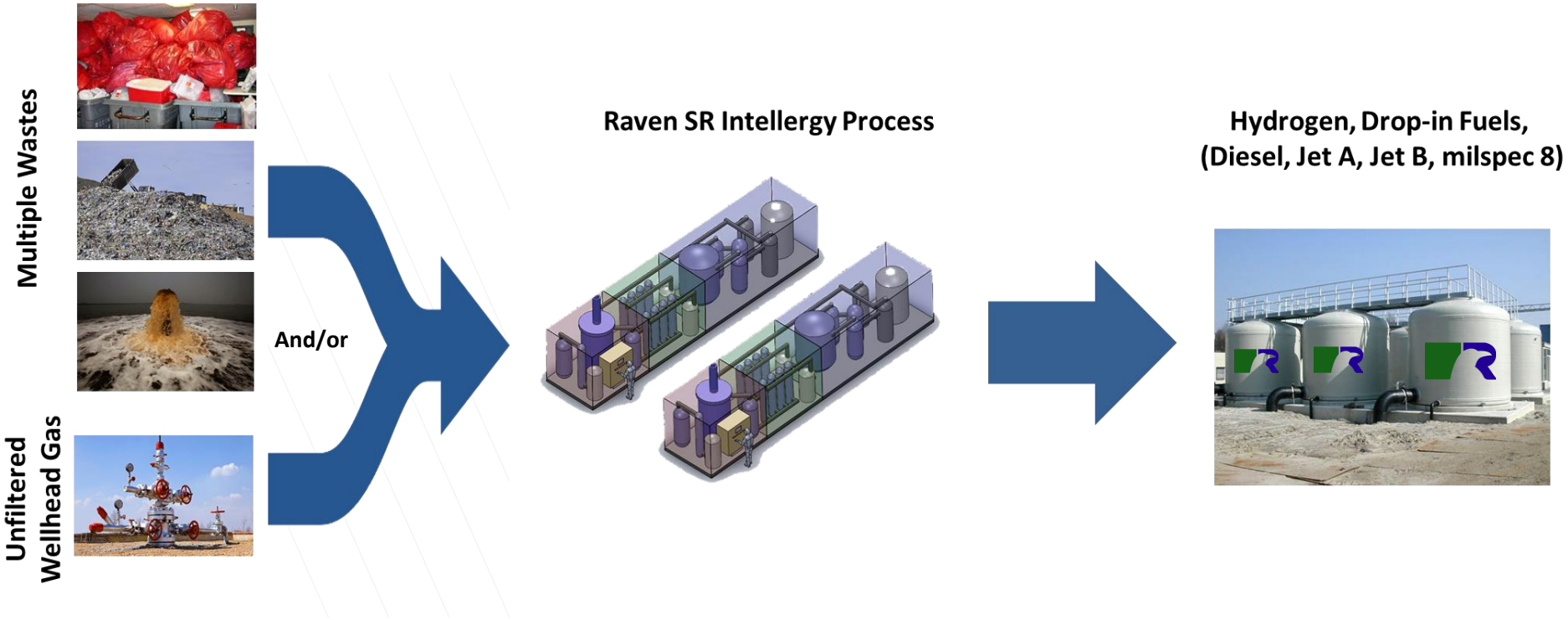
OIL AND GAS CLIMATE INITIATIVE

bp Chevron CNPC eni equinor ExxonMobil
Occidental PETROBRAS REPSOL TOTAL

RAVENSR is the solution.

We Turn **Trash** Into **Clean Fuels**

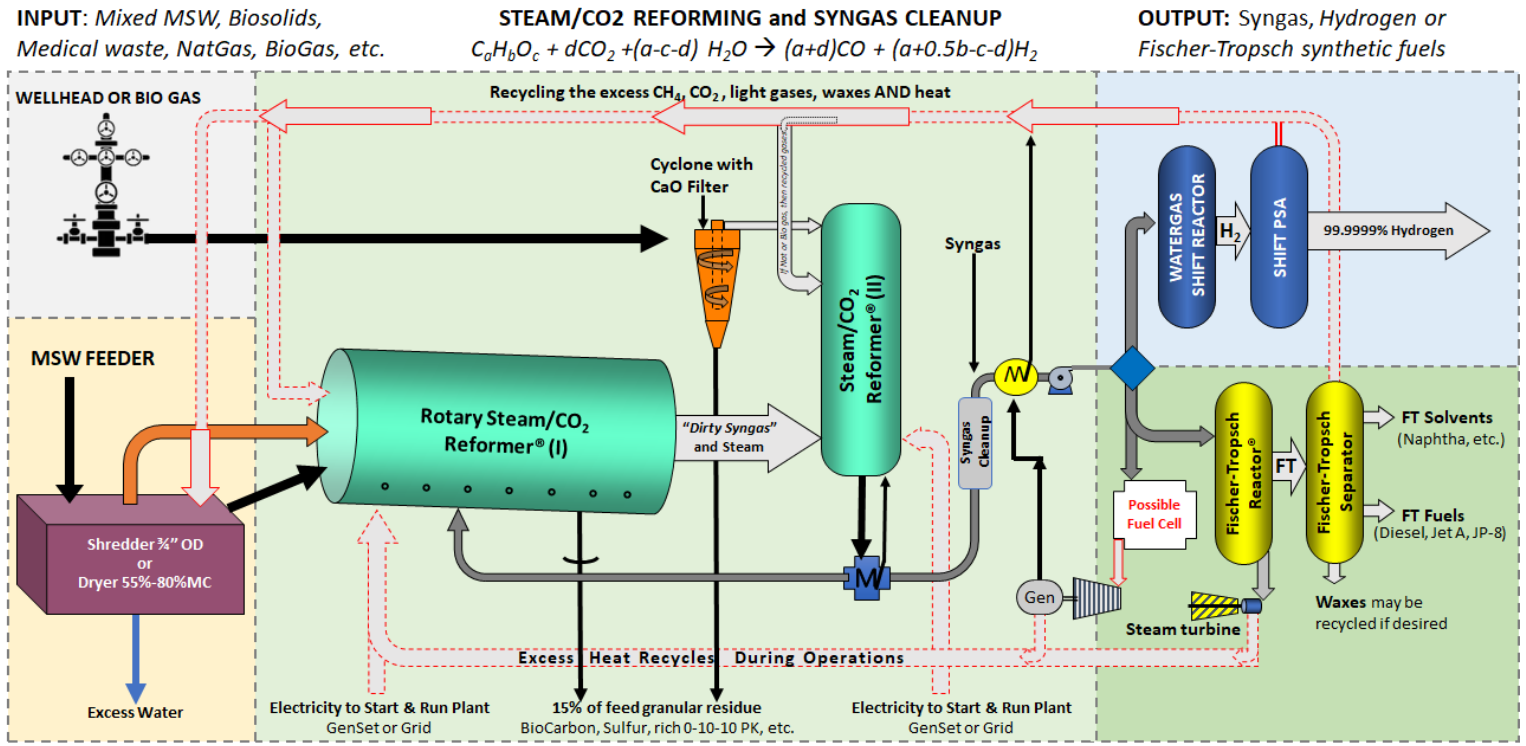
Our feedstock is waste - biomass, plastics, paper, medical waste, toxic waste – pretty much anything except metals and glass.



Our products are the cleanest fuel on the planet – hydrogen, or cleaner burning, synthetic Fischer-Tropsch fuels.

Using Our **Patented Technology**

Raven SR has 12 patents, including two basic chemistry patents, but the process is surprisingly simple.

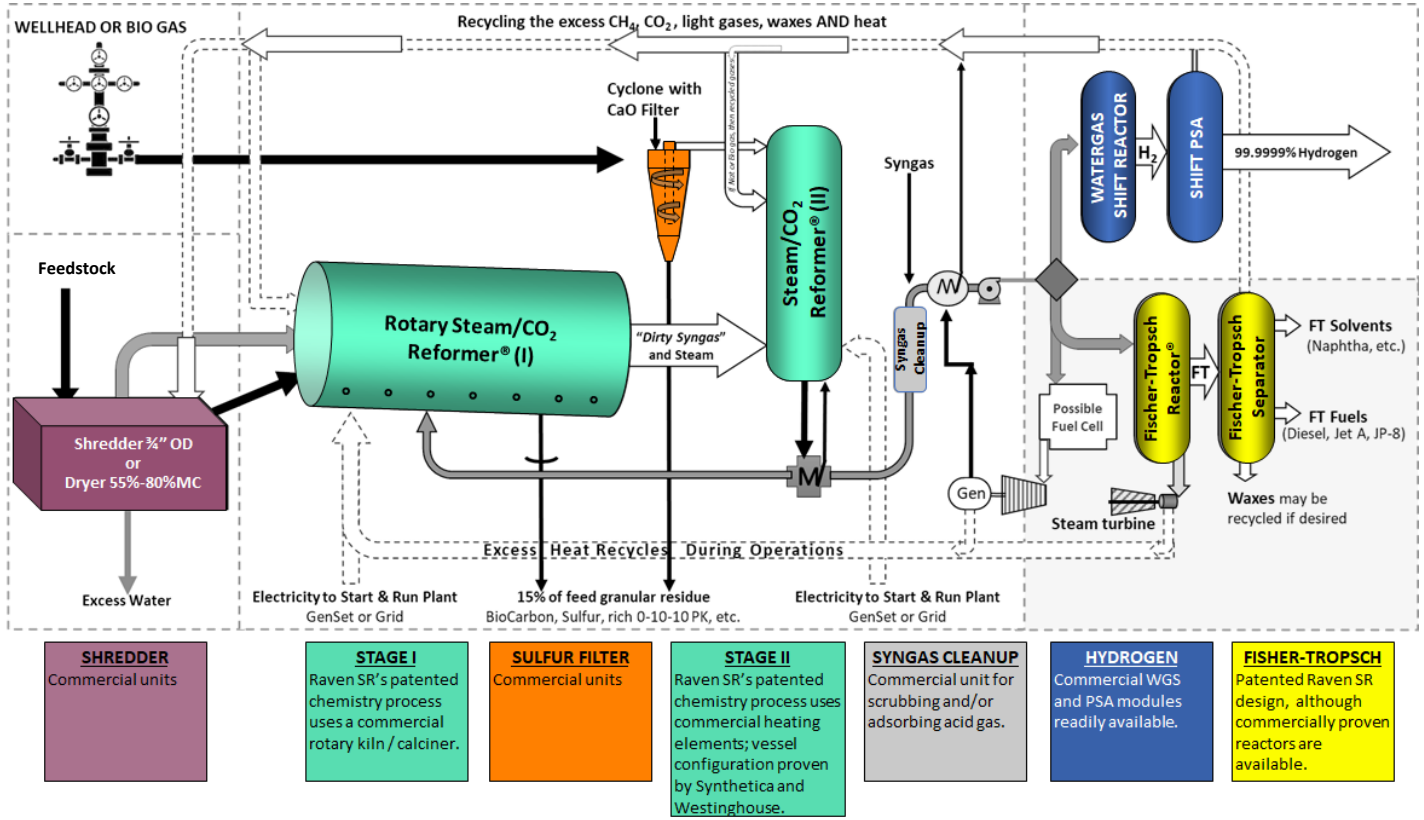


Patent Nos.: U.S. 8,858.900, U.S. 14/847,798, U.S. 14/995,713, U.S. 15/514,041, U.S. 62/776,203, U.S. 16/40,349, International Patent No. WO 2005/001977, European Patent No. 1,913,683, European Patent No. 04755504.0, Canadian Patent No. 2,530,496, Chinese Patent No. 99813930.0, U.S. Patent No. 7,556,736, U.S. Patent No. 6,187,465.

We heat the waste until it turns to syngas, then separate the hydrogen from the carbon, and either reform it into synthetic fuels, or extract the hydrogen and sequester the carbon.

Based on **Known and Proven Processes**

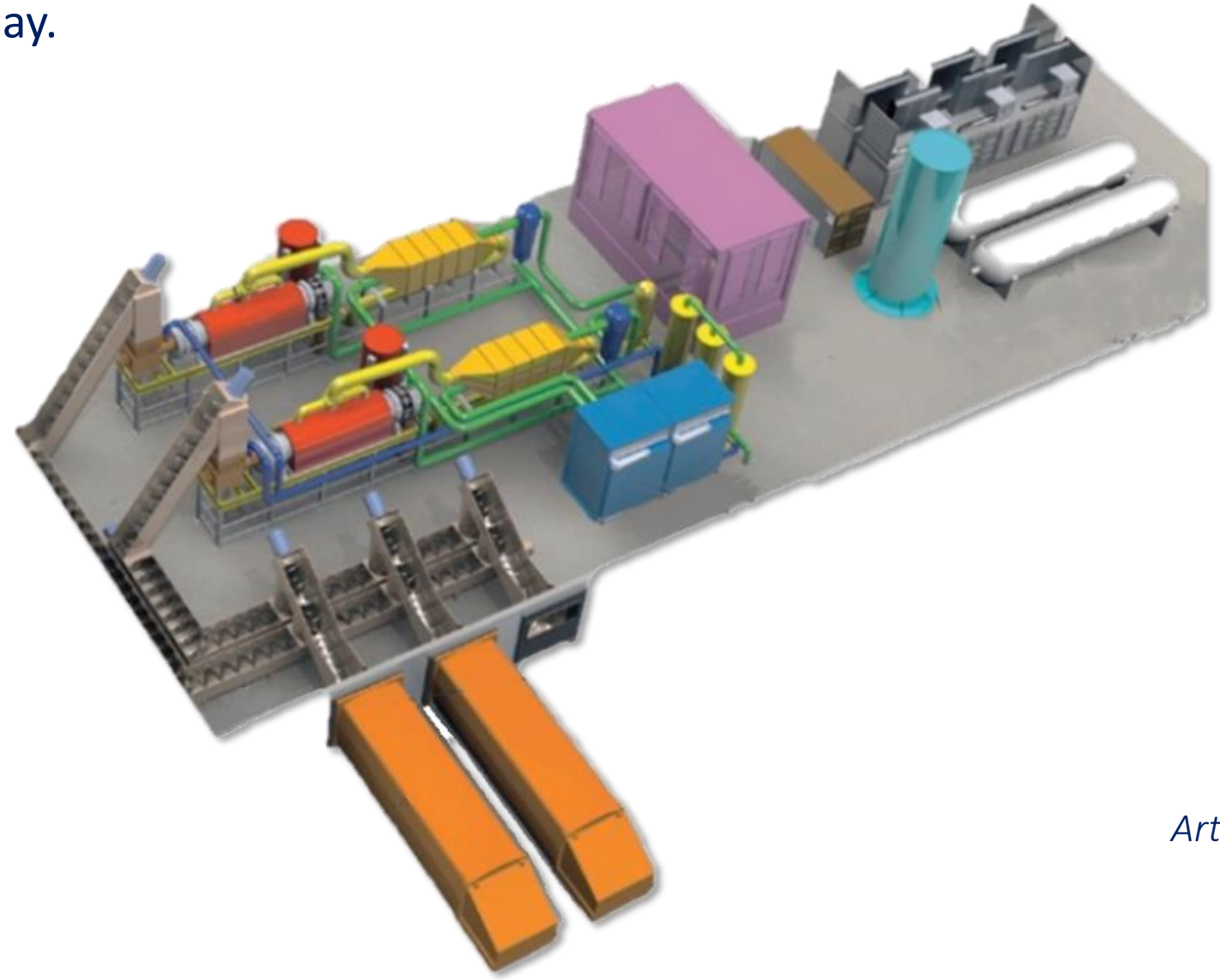
Much of the process is known and proven, or based on known and proven processes.



With the Raven SR "secret sauce" in the Rotary Steam/CO_2 reformers (green processes). We also have patented Fischer Tropsch technology (yellow) though we can use any FT system.

What It **Will Look Like**

Future 150 wet-ton/day Steam/CO_2 Reforming MSW to Hydrogen projected to produce 15,000 kgs/day.



Artist's conception

That Can Use A **Wide Range of Wastes**

The Raven SR system has been tested using the following waste streams:

1. Paint cans, partially full of paint of all types
2. Printed circuit boards
3. Industrial solvents of all types
4. Red shop rags
5. Kevlar cloth and parts
6. Aromatic chlorinated solvents with benzene
7. Epoxy waste
8. Plastics, including non-recyclables
9. NASA Astronaut waste, including feces
10. Medical waste of all types
11. Slurry Chelating Steam generator cleaning compounds with Cr^{+6}
12. Pleated Cartridge filters containing highly radioactive waste
13. Silicon wafer Fab solvents and chemicals
14. Creosote contaminated wood & soils
15. Biosolids
16. Animal carcasses and bedding waste
17. Laboratory waste
18. Australian Sheep Dip waste
19. Agricultural / green waste
20. Grape pomace

Rocks, metals and inerts are dropped out of the system.

We Are **Not Typical Gasification**

The critical difference is that Raven SR allows no oxygen into our system - there is no combustion or catalysts, which means:

- Higher efficiency – we don’t burn our feedstock for heat, we convert it to fuel
- Better operations – we don’t have tar build up or hotspot issues, reducing downtime
- Lower cost – we don’t need any expensive catalysts in our front end
- A cleaner process – lower emissions are better for GHG reductions as well as possible site locations
- Greater feedstock options – multiple feedstocks at once with a moisture content 30-55% reducing need of screening and drying

History: Intellergy to **Raven SR**

The waste disposal technology was developed by Intellergy in the 1980s, and at that time, it was more expensive than incineration.

Some systems were sold, including two for waste disposal in decommissioning nuclear power plants.

One 10 ton per day system was built in Canada, but never truly operated due to financial reasons of the owner.

The systems converted waste to syngas and burned the syngas turbines instead of converting it into fuel.

Because this was not a viable business model, when Raven SR acquired the patents, the technology process was improved and developed into today's system.

2 do per day system

20 ton per day operation

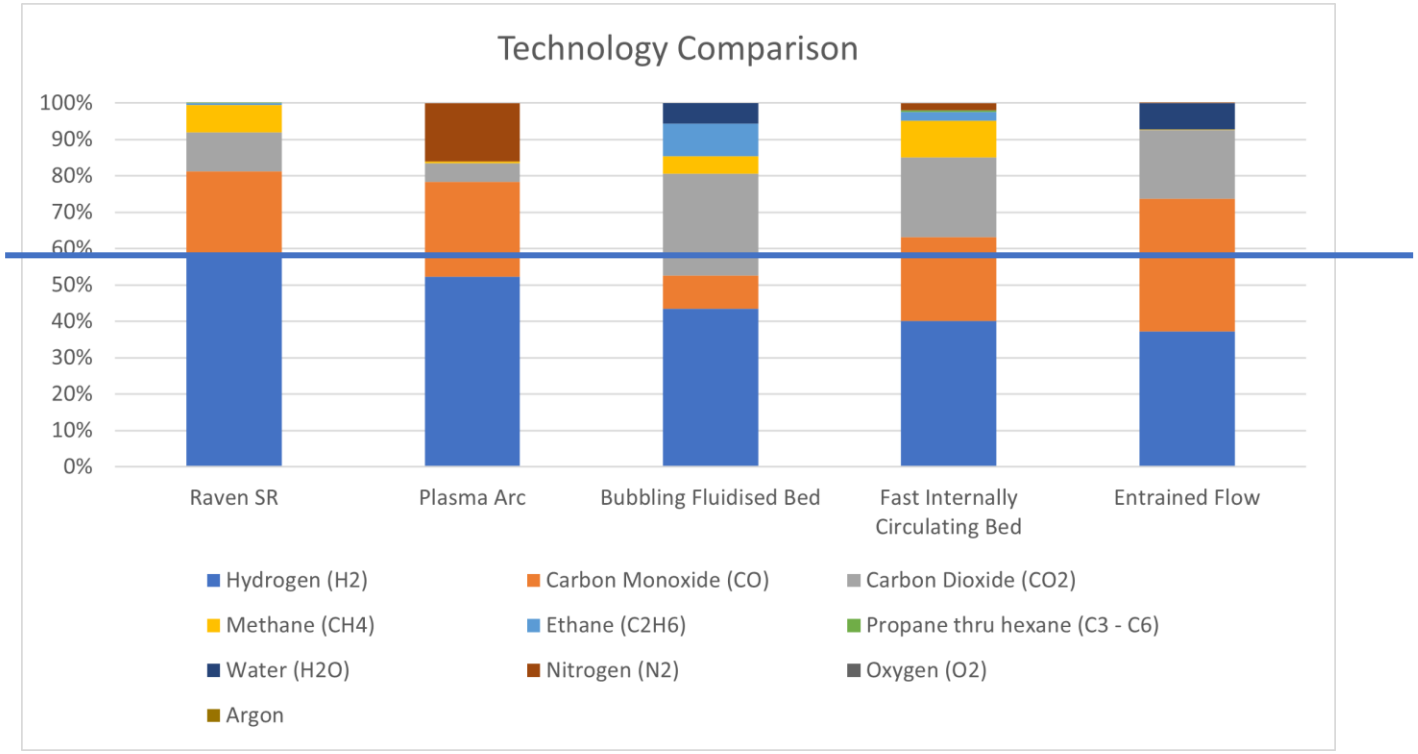
Track **Record**

Raven SR's scientific team has installed and run 2 ton per day half-systems. These were built as waste elimination systems, with resulting syngas burned in gensets. These help demonstrate Raven SR's scalability.

Project	Date	Description
STD0001	1982	In-house prototype, Lab Hood, 0.02 dtpd
STD1001	1985	In-house prototype, Drum Bunker, 0.1 dtpd
STD2001	1986	Trade show machine, Hercules, 1 DFE, 0.5 dtpd
STD2002	1987	Test bay machine, Richmond, 1 DFE, 1 dtpd
STD2003	1989	Commercial, UBE Industries, Japan, 1 DFE, 1 dtpd
STD2004	1989	Commercial, Ansaldo Industries, Italy, 1 DFE, 1 dtpd
STD2005	1990	Commercial, Palo Verde Nuclear Plant, Dual HSE, 1 dtpd
STD2006	1993	Commercial, Trojan Nuclear Pland, Canister Fed, 1 dtpd
STD2010	1991	Commercial, Westinghouse, 2 DFE + HSE, 2 dtpd
STD3001	2007	Commercial, Elementa Group, Ontario Canada, 10 dtpd

It's All In the **Syngas**

Raven SR's syngas has more hydrogen, and less GHG than other processes.



This process delivers more high-purity hydrogen and gives us close to the ideal (2.1:1) hydrogen to carbon monoxide ratio for synthetic fuel production.

That Creates A Consistent **Syngas Composition**

Raven SR's Syngas stays consistent regardless of what feedstock is used. The only thing that is feedstock dependent is the volume of syngas produced.

The typical range of the syngas composition:

- 55-63% Hydrogen
- 19-30% Carbon monoxide
- 2-10% Carbon Dioxide
- 5-8% Methane

STEAM/CO_2 GAS TEST RESULTS

H_2	Hydrogen	62.71 vol%
CO	Carbon Monoxide	18.57
CO_2	Carbon Dioxide	10.67
CH_4	Methane	7.58
C_2H_6	Ethane	0.48
C_3-C_6	Propane thru hexane	<0.01
C_6H_6	Benzene	<17 ppm
COS	Carbonyl Sulfide	4 ppm
CS_2	Carbon Disulfide	0.05 ppm
H_2S	Hydrogen Sulfide	< 5 ppm
$C_{10}H_8$	Naphthalene	2.6 ppb
$C_{10}H_7CH_3$	2-Methylnaphthalene	~0.6 ppb
$C_{12}H_8$	Acenaphthalene	~0.4 ppb
$C_{12}H_8O$	Dibenzofuran	0.36 ppb
Polychlorinated dibenzofurans + dioxins		0.0041 ppt TEQ

Which can produce **FT Fuels or Hydrogen**

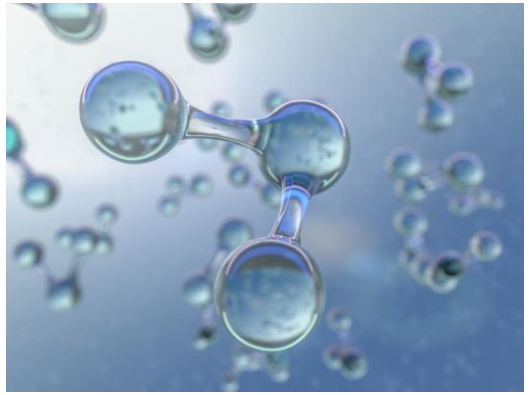
Daily output from a 25 dry-ton system can be:

Up to 5,000 gallons of synthetic fuels – diesel, Jet A or naphtha.

Raven SR systems can switch flexibly between FT fuels.

Cleaner FT fuels (left) vs traditional petroleum fuels

Up to 5,000 kgs of 99.9999% pure renewable gaseous H_2 (using MSW as a feedstock).



Comparable Project: **Plasma Gasification**

Project: California, Projected operational by Q1 2023.

Key technical features include:

- Plasma Gasification with Temperature > 5,000 °F
- 42,000 tons of sorted paper waste p.a.
- 3.8 MM kg hydrogen p.a.

Raven SR produces 10% more from the same input and Raven can process a far wider variety of feedstock.

Key Financing Points:

- $55MM project cost

Raven SR can produce 50% more hydrogen using the same CapEx.

Comparable Project: **Bubbling Fluidized Bed**

Project: Nevada, expected operational by 2021.

Key technical features include:

- 175,000 tons p.a. waste input
- 10,000,000 gallons Jet A output

Raven SR can produce 4.1x the fuel from the same input

Key Financing Points:

- $100M spent over 10 years to develop technology
- $280M project cost (originally $200M)

Raven SR can produce the same output for 30% of the CapEx

Comparable Project: **Microwave Plasma (MWP)**

Project: Multiple companies are creating projects converting Biogas or RNG to Syngas.

Key technical features include:

- Microwave excited plasma converts biogas (various combinations of CH_4, CO_2 and H_2O) into syngas.

Raven SR's technology is more dynamic and can produce hydrogen from biogas as well as MSW from landfills.

Key Finacial Points:

- Process requires ~35 kWh/kg H_2

Raven SR Uses only 16 kWh/kg H_2

Comparable Project: **Electrolysis**

Electrolysis (using solar generated electricity to break up water) is the favored method to make hydrogen,

But Raven SR is superior in many ways:

Metric	**Electrolysis**	**Raven SR**
Water Used/kg H2	9 liters	0 liters
Energy Used/kg H2	60 kWh	16 kWh
Carbon Sequestered/kg H2	0 kgs	0.7 kgs
Waste Eliminated/kg H2	0 kgs	4.7 kgs
Subsidies	Typically Yes	No
Cost/kg H2	$8-11	$2-3
CO2 Emitted/kg H2	0 kgs	7 kgs

Fukushima Hydrogen Energy Research Field Production Facility (18 ha, 2,500 kgs/day, US $189M)

Creating a Greener Green Hydrogen

Raven produces green hydrogen with additional green benefits of:

- Uses **less electricity** per kilogram of H_2 than other methods (*i.e. electrolysis, plasma gasification, microwave plasma, etc.*)

- Uses **less clean water** than electrolysis (*an increasingly limited resource*) and processes **wet-waste** without drying (*biogenic and non-biogenic at same time*),

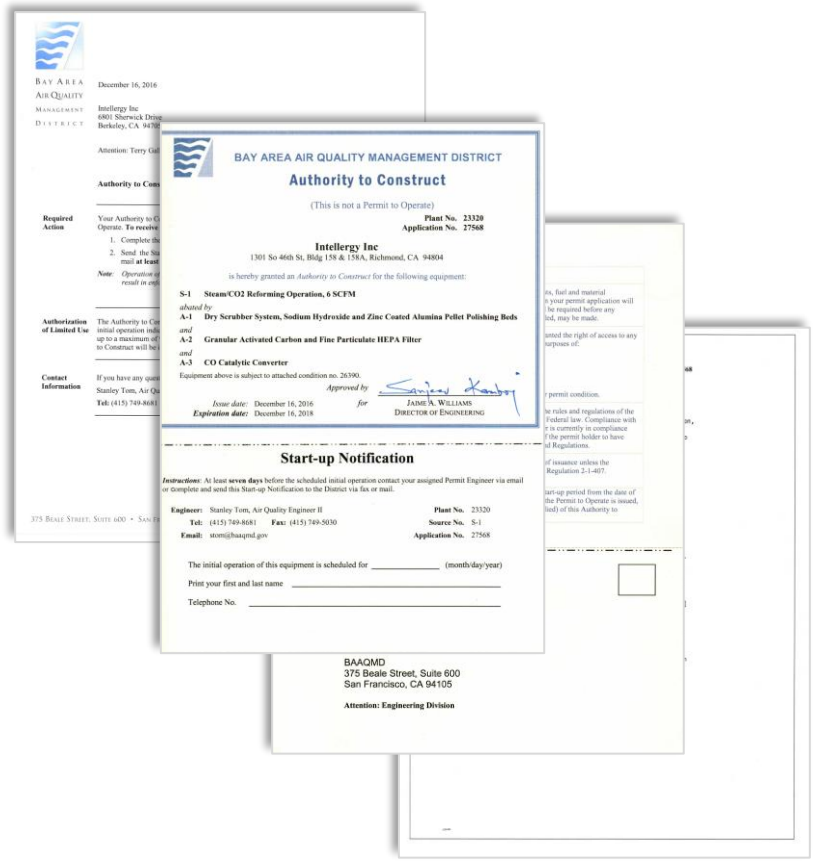
- **Fewer process emissions** since its non-combustion and **more avoided CO_2e emissions** by diverting waste from landfills and composting (*~3.3 kgs CO_2e per 1 kg of H_2*),

- Helps **divert waste** from landfills (*reducing the demand of landfill expansion*) to meet California's SB 1383's goal of reducing organic waste disposal by 75% from 2014 levels (*up to 27M tons of organic waste*) by 2025.

Environmental **Approval**

Raven SR's patented Steam/CO_2 technology is significantly cleaner than any competing system, principally because it is a non-combustion process.

- BAAQMD approved. The process has been approved by the rigorous Bay Area Air Quality Management District in Northern California.
- GHG reduction. A single 25 ton per day unit will reduce GHGs by 8,200 tons per year.
- Mixed input. Units can eliminate toxic waste, infected medical waste, and mixed waste from the environment.
- High credits. Because of its low carbon footprint, Raven SR can qualify for higher credits than competing systems.



Meeting California **Legislative Goals**

Converting Waste into Clean Fuels

SB-1771 California Climate Registry *SB-32 (AB-32) California Global Warming Solutions Act* *SB-375 Sustainable Transportation Planning*

SB-100 & 350 Renewable Energy Procurement *AB-617 Community Air Protection* *AB-1493 Automobile Emission Standards*

AB-1383 Short-Lived Climate Pollutant Reduction *SB-1383 Organic Waste Diversion* *AB-1826 Mandatory Recycling of Organic Waste*

AB-197 CARB Oversight and Reporting *AB-1007 Air quality* *AB-8 Alternative Fuels* *AB-32 Low Carbon Fuels Standard*

AB-341 Solid Waste Diversion *SB-662 Transportation Sector: Hydrogen* *SB-18 Green Hydrogen*

RAVENSR

Meeting California **Legislative Goals**

SB 1383 Organic Waste Diversion & AB-1826 Mandatory Recycling of Organic Waste

- A single 50 wet-ton per day system will divert up to 16,500 tons of organics per year.
- Modular design – easily deployed through out the state to match the ramp up of the organics' diversion goal.
- Co-location at landfills – Implementation would not change the current organics pickup/drop-off supply chain and allow for increased intake.

	Green Waste (MT/year)	Food Waste (MT/year)	Landfill Gas[1] (kgs/year)	Hydrogen (kgs/year)	Prelim CI[2] gCO2e/MJ	Avoided Emissions[3] (gCO2e/year)	Avoided Emissions (gCO2e/kg of H2)	Process Emissions[4] (kgs CO2e / kg H2)	Process Emissions (CO2e kgs/year)	Net Emissions[5] (gCO2e/kg of H2)	Bio-Carbon[6] (MT/year)
Case 1	7,718.0	7,718.0	-	1,190,000.0	27.7	4,002,158,326.3	3,363.2	9.544	11,357,236.4	6.18	1,312.1
Case 2	7,718.0	7,718.0	1,876,828.8	1,700,000.0	29.3	5,187,522,042.1	3,051.5	8.767	14,903,127.3	5.72	1,312.1
Case 3	7,718.0	7,718.0	3,764,919.0	2,108,000.0	31.5	6,372,885,757.9	3,023.2	8.713	18,367,418.2	5.69	1,312.1

1 *Landfill gas considered as 80% CH4 and 20% CO2 by mole*

2 *Reference CI 117.67*

3 *Avoided CH4 and N2O fugitive emissions from landfill diversion or composting alone*

4 *Emissions specific to tail gases from the water-gas-shift and pressure-swing-adsorption reactors*

5 *Process emissions less the eavoided emissions per kg*

6 *Bio-carbon (similar to bio-char) is around 15-20% of the dry-tons of solid waste processed; this additional carbon sequestration is not yet taken into consideration.*

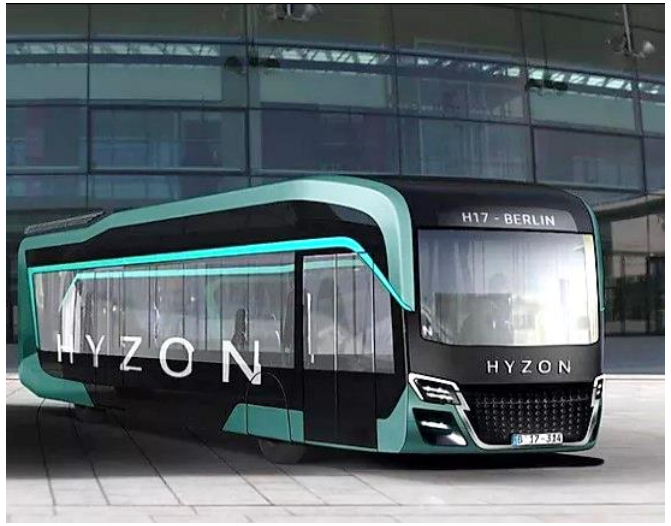
Raven & **HYZON Motors**

Raven SR and HYZON Motors have signed an MOU for a strategic alliance to develop a “local waste to local fuel for local mobility” projects.

Raven SR will provide renewable hydrogen to serve truck fleets under a single lease concept, including HYZON vehicles, maintenance and hydrogen fuel.

The ultimate goal will be to develop small, efficient hydrogen production and refueling units that can be installed anywhere there is waste, creating fuel on the spot, eliminating fuel transportation costs, and building a network of fuel for HYZON vehicles.

Initial collaboration will center around Raven One, to be based in San Jose, California.



Raven SR & **HYZON Zero Carbon Alliance**

HYZON ZERO CARBON ALLIANCE

The Hyzon Zero Carbon Alliance strengthens the supply chain of both product and service offerings for the global hydrogen mobility sector through the expertise of strong partners. The Alliance offers fuel, insurance and financing for local mobility powered by local fuels.

1

Garbage Truck Payload
(13.6t MSW per day) + Electricity

RAVENSR

30

Heavy-Duty Hydrogen Trucks Fueled[2]

Class 8 trucks with a TCO at around $1/mile

ARK ENERGY CORPORATION

AXA

BANK OF AMERICA

HIRINGA
The energy to change. Together.

MIG

NEOM نيوم

RAVENSR

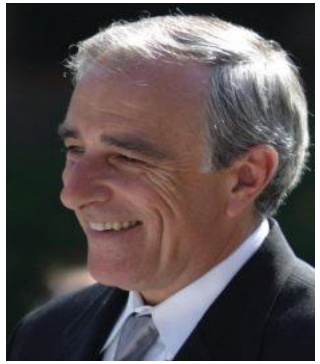
RECARBON, INC.

TOTAL

Raven **Management**

Matt Murdock, CEO. Serial entrepreneur, both in the U.S. and internationally, skilled in project delivery, negotiations, managing complex teams, problem solving and strategy. Quick grasp of complex issues and a focus on solutions.

Rick Noling, Strategic Business. MBA, MS in aerospace and mechanical engineering, 30+ years success in turnaround, management and IPO of software, hardware, and new technologies companies.



Matt Scanlon, CFO. Wharton MBA, spent 10 years in the Middle East with a private venture firm, developing projects in energy, telecoms, agribusiness and advised project company management teams and worked with startups and entrepreneurs.

Joseph Waidl, Engineer. 30 years experience in the renewable energy, chemical, nuclear power and semi-conductor industries. Knowledge of process equipment design, process simulations, pilot-plant operations, nuclear reactor systems design and service support.

Raven SR **Outside the Box**

Raven SR's technology has far reaching implications. The company has patents for a one ton per day unit, suitable for neighborhoods, as well as for a sea-bound version.

Raven SR has a patented "Eco-Whale" marine unit that could scoop waste from the sea and convert them ship-board to hydrogen or FT fuels.

Raven SR 1 ton systems could be installed at neighborhood levels, converting household waste into fuel.

Raven SR can help resolve flared gas issues by converting flared gas into fuel.


RAVENSR

RAVEN SR STEAM CO_2 REFORMING VS. GASIFICATION

Raven SR's steam CO_2 reformation process is often confused with gasification technologies, resulting in assumptions about scalability, efficiency, downtime, maintenance and economics that are incorrect and an under-appreciation of the extent to which Raven SR's process is a radical improvement over traditional gasification.

Gasification is very different chemically as well as thermodynamically from Steam/CO_2 Reforming. While both processes require heat to drive the endothermic chemistry, the source of that heat is significantly different with considerably different results. The essential difference is that gasification uses combustion, while Steam/CO_2 reforming does not.

For further clarification, combustion is defined as "*any process in which a substance combines with oxygen to produce heat and light*." [Oxford Dictionary of Chemistry] or "*Burning (rapid oxidation) of fuel, which releases energy in the form of heat and light, and also releases pollutants (such as sulfur dioxide, nitrogen oxides, and particulates).*" [Oxford Reference: A Dictionary of Environment and Conservation]

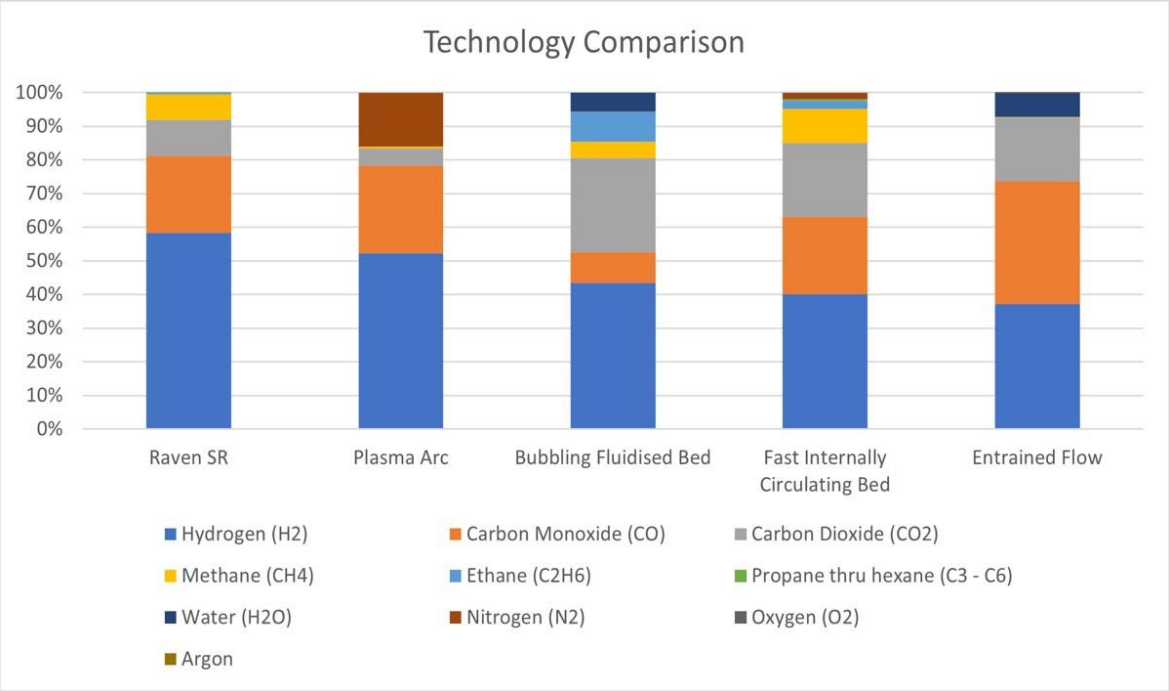
In gasification, combustion of part of the feedstock produces heat, which has several implications for efficiency, quality, process cleanliness and maintenance. First, combusting part of the feedstock makes CO_2, which dilutes the resultant syngas by reducing the amount of H_2 that is produced. That combustion also consumes part of the syngas further reducing the quantity H_2. This type of gasification is called "*Autothermal Gasification*," since the heat is supplied from inside the process and does not use heat from the outside. In addition to hot-spots or and buildup typical of gasifiers, the high temperatures will often melt glass and some metals, creating slag and makes disposal of the resultant ash a significant problem. In most cases, this combustion is driven by adding air, that further dilutes the H_2 by the presence of nitrogen. This combustion also generates various side reactions creating contamination of the syngas with particulate soot, oxides of nitrogen and sulfur and even makes dioxins and dibenzofuran, both of which are carcinogenic. Environmental and political stakeholders classify this autothermal gasification as incineration, which makes siting very challenging, if not impossible.

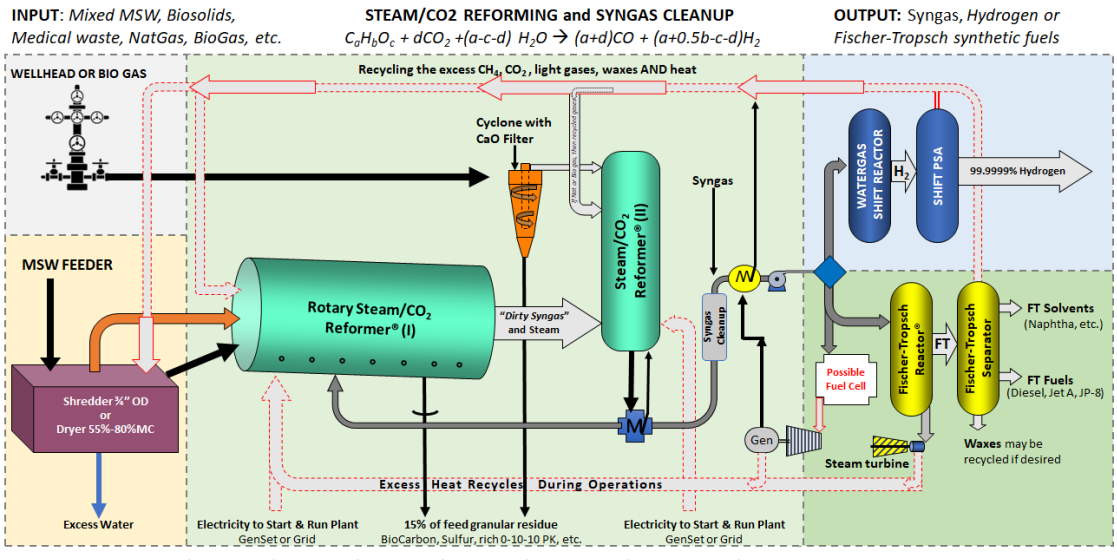
In some gasification processes, pure O_2 is added to increase yields. However, the practice of using pure O_2 is expensive and only justified with large scale plants where a liquid oxygen plant on site is justified. While using pure O_2 eliminates the N_2 dilution, it does nothing to eliminate the nasty by-products of combustion from dirtying the syngas which in turn harms catalysts in the Pressure-Swing-Adsorption unit and/or the Fischer-Tropsch reactors – reducing efficiency and increasing costs. Additionally, gasification requires moisture levels typically to be under 10% which requires expensive drying processes at the first stage of the process.

In "Steam/CO_2 Reforming," the term of our patented chemistry, not only is there no oxygen or air (*i.e. 78.09% nitrogen, 20.95% oxygen, 0.93% argon, 0.04% carbon dioxide, and small amounts of other gases*) added - it is actually evacuated from our process so that there is zero combustion inside our rotary reformer. For this reason, the EPA has determined that the Raven SR method is non-combustion process (*cf. 22 CCR § 66260.10 Definitions and 40 CFR § 260.10 Definitions*). We supply all the needed endothermic heat from sources outside of the reformer by recycling waste heat and/or electrical heat up to 1,200°F. We can also control the temperature gradient along the axis of the rotary reformer from 300°F at the front up to 1,800°F at the exit. This permits us to control the rotary reformer when there is water content or chemical makeup variation in the feedstock, such as in MSW. This careful temperature control prevents melting glass and metals and produces a biocarbon which is a salable product. As a non-combustion process, there is no ash and we get no slag, build up or hotspots in the equipment. We can also add small amounts of CO_2 to adjust the H_2/CO ratio in the process that is needed for FT fuel production. Steam/CO_2 reforming makes a much cleaner syngas with contaminates less than 1 ppm so

that the catalysts in the Pressure-Swing-Adsorption unit and or the Fischer-Tropsch reactors are not at risk from poisons and run longer and more efficiently. Additionally, high moisture content (~50%) is an advantage for steam/CO_2 processing and is near where most MSW is in a natural state. Thus, the Raven SR system avoids expensive drying processes. Finally, the process does not produce any of the siting issues associated with incineration/gasification projects.

The resulting syngas is rich in hydrogen (50-60%) without any catalysts or incineration, much higher than many competing technologies. This hydrogen-rich syngas can then be processed in a Water Gas Shift (WGS) and Pressure Swing Adsorption (PSA) resulting in high quantities of transportation grade hydrogen or into Fischer-Tropsch reactors for high quantities of synthetic fuels (see process diagram below).





Patent Nos.: U.S. 8,858.900, U.S. 14/847,798, U.S. 14/995,713, U.S. 15/514,041, U.S. 62/776,203, U.S. 16/40,349, International Patent No. WO 2005/001977, European Patent No. 1,913,683, European Patent No. 04755504.0, Canadian Patent No. 2,530,496, Chinese Patent No. 99813930.0, U.S. Patent No. 7,556,736, U.S. Patent No. 6,187,465.

The Chemistry

Typical Steam-Methane-Reformation: $CH_4 + H_2O$ (+ heat) $\rightarrow CO_2 + 3\ H_2$

- -

Typical Gasification: $C + O_2 \rightarrow CO_2$; $C + ½\ O_2 \rightarrow$ CO and $CO + H_2O \leftrightarrow CO_2 + H_2$

Gasification Gas Results

Hydrogen (H_2) = 25-30% vol Carbon monoxide (CO) = 30-60% vol Carbon dioxide (CO_2) = 5-15% vol

Water (H_2O) = 2-30% vol Methane (CH_4) = 0-5% vol Hydrogen sulfide (H2S) =0.2-1% vol

Nitrogen (N_2) = 0.5-4% vol Ammonia + hydrogen cyanide (NH_3 + HCN) = 0-0.3% vol

Carbonyl sulfide (COS) 0-0.1% vol Polychlorinated dibenzofurans + dioxins Ash/Slag/PM

- -

Raven SR's Steam / CO_2 Reformation: $C_aH_bO_c + d\ CO_2 + (a\text{-}c\text{-}d)\ H_2O \rightarrow (a+d)\ CO + (a+0.5b\text{-}c\text{-}d)\ H_2$

Minor reactions: $C + H_2O \rightarrow CO + H_2$ and $C + CO_2 \rightarrow 2\ CO$ + Heat and $H_2 + CO_2 \leftrightarrow H_2O + CO$ and $C + 2\ H_2 \rightarrow CH_4$

Steam / CO_2 Gas Results

Hydrogen (H_2) = 59-63% vol Carbon monoxide (CO) = 19-30% vol Carbon dioxide (CO_2) = 3-10% vol

Methane (CH_4) = 5-8% vol Ethane (C_2H_6) = 0.5% vol Higher HCs (propane thru hexane) = <0.01% vol

Sulfur Compounds <4 ppm Polychlorinated dibenzofurans + dioxins = 0.0041 ppt (ng/m^3) TEQ

The Raven SR patented Steam/CO_2 Reforming process is very different and a huge improvement over gasification, with better efficiency, fewer maintenance issues and better overall economics.

Dear Philadelphia Office of Sustainability,

My name is Luke Mills and I am a resident of West Philadelphia and a PGW customer. I am also a member of Sunrise Movement Philadelphia's Green New Deal For Housing Campaign. One of our group's major goals is to decarbonize and democratize utilities so that homes are powered and heated equitably without contributing to climate change and pollution. We are encouraged by the PGW Diversification Study and the fact that it acknowledges the importance of electrification. That being said, it is only a very small step forward. I am writing to advocate that this work does not end with this report. It is imperative that the findings of the study are acted upon and pushed further starting immediately. Electrification will be essential for Philadelphia to have a just transition to a zero carbon future so that we can improve air quality and health, protect jobs, and ensure all people can afford to heat their homes.

Thank you,
Luke Mills

Meenal Raval's written comments on the PGW Biz Diversification Study

I listened in on the May 11th Town Hall about the draft of PGW's Business Diversification Study, and have to say, I agree with pretty much every speaker, except the one representing the Chamber of Commerce. I would like to emphasize a few points that were not discussed adequately.

Firstly, there was no mention of energy conservation. The hierarchy of energy consumption is... conservation first, efficiency next, and then clean renewables. See here. Conservation means being smart and using less fuel.

One example of conservation for PGW is by identifying gas leaks, as in Boston. Slide 48 of the draft report, titled "What are other promising considerations?", says that there will be "Continued focus on leakage detection -- Increases safety, reduces costs and GHG emissions". This should not be an afterthought, but a priority. A study showed that 7% of leaks account for 50% of the lost gas. We are in the process of commissioning a gas leaks analysis for Philly, and invite PGW to join us in spearheading this.
There was much talk of affordability, especially around electrification. See, for example, slide 29.

Maybe if we shifted our perspective and questioned the need to keep all 1650 people on payroll. There must be data on aging out we could include in this report .The suggestion is not to layoff people, but to consciously decide to not replace them as they retire.

Also on affordability, I see that PGW billing is handled out of state. Why not bring it home?

Another way to save half a million... stop paying dues to the American Gas Association! If I remember right, it was the promise of a million in revenue that convinced the Gas Commission & Council to OK the Passyunk Energy Center. Conservation can apply to the budget as well.

On slide 68, an electric water heater was priced at $3225. This seems very high and is likely for a heat pump water heater.

Have you considered tankless electric water heaters? We have used these and are quite happy with them. The cost is a fraction of electric heat pump systems, with added benefit of creating space in a small basement. I will note that tankless systems require some user training to not wash the dishes when another person is in the shower!

Also, have you considered simply adding timers to standard electric water heaters? We've used this at other homes and were quite satisfied.

Lastly, our electric utility doesn't seem to be interested in altering the default service program to allow for more renewables. Perhaps if PGW were to become an electric distribution company, say via a ballot question, PGW could develop solar farms within and outside the City and offer emissions-free electricity as a default to their customers.

The climate crisis demands that we look at things very differently. I believe Lynn Robinson captured it well when she spoke that the town hall; that "PGW not diversifying is the underlying subtext of this study." We can do better. We must do better.

Sincerely, Meenal Raval
Philadelphia resident, living lightly in an all-electric rowhouse

Testimony for Gas Commission Town Hall
Mitch Chanin
May 11, 2021

My name is Mitch Chanin, and I'm a member of POWER and Philly Thrive, as well as other local organizations. I've lived in NE Philly for most of my life. Thanks for the opportunity to testify today.

The crises we face here in Philly are interconnected. The urgent threat of climate catastrophe, deep poverty, unaffordable energy bills, home disrepair, and widespread asthma are all related. To solve them, we need large scale investment to transform PGW and our wider energy system as well as our buildings.

The draft materials for the Diversification Study are a good--though very limited--first step toward figuring out how to do that. I'm encouraged to see the materials confirm that building electrification is essential, and that they begin exploring possibilities for networked geothermal systems. But much more is needed.

For example, the draft materials say little about options for repairing buildings and making them highly energy efficient. We'd like to see the completed report address those possibilities in more depth. A bold, comprehensive repair/retrofit program would improve residents' health, make our homes more comfortable and resilient, bring down energy bills, create jobs, and reduce displacement. It would also limit the cost of the new equipment and infrastructure that will be needed for heating and cooling buildings as we decarbonize.

I hope the study will kick off a fully participatory, community-based planning process over the coming months, so we can create the bold plans we need.

I urge the PGW and the City to undertake a pilot project that involves installing networked geothermal systems as well as home repairs and retrofits. At the same time, while we plan the future of PGW, I ask Gas Commissioners to take action to stop PGW from lobbying against policies that we'll need to achieve the goals that the study addresses. You'll hear more about that from colleagues this morning.

Thank you.

Testimony Regarding the Philadelphia Gas Works (PGW) Diversification Study
PECO
May 28, 2021

PECO is the Philadelphia-based electric distribution company serving Philadelphia, and the electric and natural gas distribution company serving Bucks, Chester, Delaware and Montgomery counties, as well as portions of York County (electric) and Lancaster County (natural gas). PECO provides service to more than 1.6 million electric customers and more than 532,000 natural gas customers across the region.

Within PECO and across the Exelon utilities, we are on a Path to Clean, building on emission reduction goals currently in place and transitioning to a cleaner future. The collective utilities across Exelon have committed to reducing operations-driven greenhouse gas emissions by at least 50 percent below 2015 levels by 2030. To do this, we'll modernize our natural gas infrastructure to minimize emissions and enhance safety, increase system energy efficiency, and invest in cleaner equipment and vehicles.

PECO commends the Office of Sustainability (OOS) and PGW on launching this important study of the future of natural gas distribution service in Philadelphia in the context of the City's climate commitments. We believe that climate change is real, and that we must work together to both reduce emissions and prepare for the impacts of more frequent and severe weather. The breadth of the climate challenge is great, and no sector in the economy is immune to change. Now is the time to pilot and test solutions that can substantially reduce emissions. We appreciate the City's commitment to working with highly respected national and local consultants to perform this analysis and develop options for future action. The Diversification Study draft materials issued in April provide a thoughtful examination of the challenges and opportunities facing the City, PGW and energy customers in Philadelphia.

Benefits of Natural Gas

PECO's suburban natural gas delivery system provides homes and businesses with a clean, safe, reliable, economic and efficient energy choice while recognizing the importance of reducing greenhouse gas emissions (GHGs) and ensuring affordability. Competing home heating resources result in substantially higher carbon dioxide (CO2) emissions per million British Thermal Units (BTUs) than natural gas, with fuel oil and propane having 37.8 percent and 18.8 percent higher emissions, respectively.[1] In the past 10 years, PECO customers have reduced emissions from these more polluting home heating fuels by converting to natural gas in more than 19,000 homes. The GHG emission reductions associated with these conversions are equal to planting 2.4 million trees, or not driving 250 million car miles. Natural gas is also an efficient fuel resource, as the direct use of natural gas in American homes and businesses achieves 91 percent delivered energy efficiency, and the average American home consumes 50 percent less natural gas than it did forty years ago.[2] These benefits are also delivered affordably, as the average PECO residential natural gas customer in the suburban counties saves $830 dollars annually compared with fuel oil and $935 annually compared to propane.[3]

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[1] Environment - U.S. Energy Information Administration (EIA) - U.S. Energy Information Administration (EIA)

[2] 2019-natural-gas-factsts-updated.pdf (aga.org)

[3] Short-Term Energy Outlook - U.S. Energy Information Administration (EIA), assumes purchase of 500 gallons annually of fuel oil or propane.

PECO's natural gas distribution system operates with the highest focus on safety, both for our employees and customers, with the company recently setting a system record of responding to every customer gas odor call within one hour for more than 500 consecutive days. Finally, the ability to store natural gas and the relatively low exposure of the gas distribution system to the elements provides additional resilience and reliability to our overall energy system.[4]

PECO is aggressively reducing emissions associated with leaks on its natural gas distribution system. Through the Company's Accelerated Gas Infrastructure Modernization Plan (AGIMP), PECO plans to replace all bare steel services on its gas delivery system by the end of 2022 and all bare steel mains by 2035. While continuing to accelerate the pace of main replacements, PECO must balance customer affordability impacts and workforce availability issues and recognizes that PGW faces similar challenges. PECO has been able to reduce its emissions associated with the natural gas distribution leaks by approximately 25 percent since 2015 and is on track to reduce these emissions by 70 percent by 2036. The Company continues to explore new processes and technologies to improve leak detection and reduce system emissions. PECO also will actively investigate opportunities to purchase Renewable Natural Gas (RNG) or Responsibly Sourced Natural Gas (RSG), with the goal of identifying opportunities that support the obligation to provide least cost, reliable supply for our customers.

Given the scale of the climate challenge and the breadth of uncertainty in the transition, PECO is exploring an array of GHG mitigation solutions. PECO has worked throughout the region to support projects that have achieved win-win GHG reductions, such as the installation of electric cranes at PhilaPort and the Kimberly-Clark combined heat-and-power (CHP) project in the City of Chester. The Company is partnering with the Philadelphia Industrial Development Corporation (PIDC) on the Navy Yard Energy Master Plan and Hilco's redevelopment project at the former Philadelphia Energy Solutions facility. PECO also places a high priority on supporting funding applications and offering technical support for innovative clean energy projects such as the Philadelphia Energy Authority's solar schools initiative, the School District of Philadelphia's electric school bus pilot and a range of City-sponsored energy efficiency projects. Through our parent company, Exelon, we are engaged in a number of research partnerships and efforts to advance a clean energy future, Department of Energy grants to explore the production and delivery of zero carbon hydrogen, the Exelon "2c2i" program to provide funding and technical assistance to promising start-up businesses developing climate solutions, and our commitment to the goal of electrifying 50% of Exelon's utility vehicle fleets by 2030.

The Climate Action Playbook appropriately recognizes that sequestration and removal of GHGs from the air will play a meaningful role in deep carbon reduction programs. Investments in green space preservation and tree planting, such as PECO's Green Region grants and participation in the Tree Line USA Arbor Day Foundation program, not only reduce emissions but also mitigate urban heat island effects and promote healthier lifestyles in our communities. As the final steps toward a net zero city are likely to be the most costly and technically challenging to implement, Philadelphia's plans should fully consider where natural gas remains the best option for meeting citizens' energy needs and pair this usage with offsets to achieve the most cost-effective solution.

Focusing on Affordability

One of the City of Philadelphia's widely recognized challenges is the prevalence of poverty. According to the PEW Charitable Trust's report on the state of Philadelphians living in poverty, nearly 400,000

[4] https://gasfoundation.org/2021/01/13/building-a-resilient-energy-future/.

Philadelphia residents – roughly 26 percent of the population – live below the poverty line and 14 percent are categorized as living in deep poverty.[5] Meeting citizens' energy needs affordably is a critical element of addressing the pervasive challenges and inequities the City faces. Energy is an essential service, and 75 percent of low-income households in the city are considered "energy burdened."[6] These same households face challenges with meeting other essential needs, including food, health care, transportation, education, and child and elder care. As the City moves forward with its carbon neutral goal and implementation of PGW diversification strategies, it is critical that it does so with a planned, integrated approach that places a priority on equity and cost-effectiveness.

Developing a Diverse Workforce from All Communities to Support a Clean Energy Future

Maintaining and operating what will likely be a more complex system in the future will also require investments in the local workforce so that Philadelphians from all communities can gain employment in the clean energy marketplace of the future. Electric and gas utilities have long provided opportunities for individuals from diverse backgrounds to gain employment in lifelong careers that pay family-sustaining wages. The clean energy future will require a workforce with skills in areas such as solar installation, advanced gas system management, deep building energy retrofits, smart grid operation, electric vehicle network deployment and demand management. These jobs will be locally based and will require a range of skills training programs.

To further support initiatives to move members of the Greater Philadelphia region from poverty to life-sustaining wages and careers, PECO Workforce Development leads and actively supports through funding and strategic collaborations, community organizations. PECO focuses its efforts on creating a healthier and more equitable economy where there is disproportionately high unemployment, low household incomes and wealth gaps. Partnerships with community organizations are the most effective way to transform communities with the most need. The community organizations that PECO supports provide internships, instructor-led energy-based curriculum, certifications, and job placement. The impact of these efforts is far-reaching -- hundreds of individuals have participated to date and benefitted from the nearly 20 strategic partnerships that have been formed.

Conclusion

Addressing Climate Change and Clean Energy is one of the greatest challenges of our time. As the Diversification Study notes, achieving the City's goal of a net zero emissions future by 2050 is an enormous task that will have implications for every Philadelphian. This will be a multi-decade journey that will require flexibility, technology development and testing, customer engagement, strategic planning and careful examination of costs and benefits.

PECO commends the City, the Office of Sustainability, and PGW for initiating this Diversification Study and looks forward to engaging with all stakeholders on this effort in the years and decades to come.

[5] The State of Philadelphians Living in Poverty 2019 | The Pew Charitable Trusts (pewtrusts.org)
[6] Affordable Residential | Philadelphia Energy Authority (philaenergy.org)

PGW Business Diversification Study Comments

Allsion Saft

In order to meet the city's climate goals, PGW must transition away from being a fossil fuel company. Public health, safety, and equity are appropriate guiding principles of the diversification study. Anything less will not adequately address the climate crisis.

I offer the following suggestions on the draft report:

Under the hybrid electrification model, the report envisions customers adopting heat pumps paired with a gas furnace to meet "peak heat" demands during the coldest periods of winter. Heat pump technology has advanced so quickly, and with the recent announcement from Biden's administration that they are investing in technology to further improve heat pumps, there is no need for a backup gas furnace.

The analysis appropriately recognizes that relying exclusively on decarbonized gas is risky, poses unsustainable and long-term bill impacts to PGW customers, and does not improve air quality.

I understand that the analysis found that exclusively relying on electrification can reduce energy bills for households that electrify, but increase energy bills for customers remaining on the gas system, which can pose equity challenges unless mitigated. I ask that the report consultants analyze options for mitigating potentially high energy bills for non-participating customers.

I support that the list of diversification options on p.45 of the report are "under consideration" (especially community solar, microgrids, installation and maintenance of heat pumps, and on-bill financing). I recommend modeling how much revenue PGW could make from the other diversification options suggested in the report, including weatherization and energy efficiency services, community solar operations, and geothermal micro-districts, to see if these options could fill the revenue gaps needed for the electrification and hybrid scenarios. While I understand that PGW is already involved with liquefied natural gas facilities, this option, along with compressed natural gas facilities, conflicts with the criteria of protecting public health, safety, and addressing air pollution and climate change.

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Sincerely,
allison saft

PGW Business Diversification Study Comments

Brian Moore

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PGW Business Diversification Study Testimony

Chirag Patel

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PGW Business Diversification Study Testimony

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PGW Business Diversification Study Testimony

David Gibson

I am the staff director for Peace, Justice, Sustainability NOW. An on line group in several states including Pennsylvania associated with National Peace Action.. On behalf of our members and allies on Pennsylvania I concur with this letter

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PGW Business Diversification Study Comments

Denise Costello

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PGW Business Diversification Study Comments

Diana Hulboy

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PGW Business Diversification Study Comments

Diane Fuchs

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PGW Business Diversification Study Comments

Donna Cosgrove

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Sincerely,
donna cosgrove

PGW Business Diversification Study Testimony

Duncan Wright

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All of the above steps will help us towards a common goal of a clean and just economy for everyone.

Sincerely, Duncan Wright

PGW Business Diversification Study Comments

Emma Sabin

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PGW Business Diversification Study Comments

Eric Langenmayr

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PGW Business Diversification Study Comments

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PGW Business Diversification Study Testimony

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PGW Business Diversification Study Testimony

Eugene Gualtieri

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PGW Business Diversification Study Testimony

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Geneva Butz

PGW Business Diversification Study Comments

Janet Filante

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PGW Business Diversification Study Comments

Jason Sandman

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PGW Business Diversification Study Comments

Jason Volpe

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PGW Business Diversification Study Comments

Jessica Bellwoar

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PGW Business Diversification Study Comments

Jessica Krow

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PGW Business Diversification Study Comments

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PGW Business Diversification Study Comments

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PGW Business Diversification Study Testimony

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TESTIMONY OF KEITH HOLMES, PRESIDENT
GAS WORKS EMPLOYEES UNION LOCAL 686,
UTILITY WORKERS UNION OF AMERICA

PGW BUSINESS DIVERSIFICATION STUDY

Thank you for the opportunity to provide testimony on behalf of 1150 unionized employees of the Philadelphia Gas Works who are members of Local 686. While the Union recognizes the dangers from climate change and is an advocate of reasonable steps to reduce emissions while protecting PGW's workforce and Philadelphia's low income citizens, we believe that most of the alternatives set forth in E3's Diversification Study ignore stakeholders' critical priorities of "safeguarding low income households" and "retaining PGW's workforce and creating new opportunities for jobs and economic growth." The strategies that E3 seems to advocate either concede that a retention of PGW's 1600 workers is largely impossible, and/or provide no analysis on how a service transition can occur while retaining these good Union jobs. E3's alternatives set forth in the Study also appear to recognize such service transitions would be unaffordable to the City's poorest residents, but appear nonetheless to ignore these concerns, making the nation's poorest City even poorer. I will address the Union's concerns about each of these strategies below.

Protecting Quality Union Jobs in Philadelphia is Paramount

PGW's workforce has been supplying safe and reliable natural gas to residents of Philadelphia for 185 years. Our members reside in the City, and PGW has long been a vehicle to provide good paying stable jobs to residents of the City's poorest neighborhoods. Our service and safety record are outstanding, and Philadelphians know us and rely on us to provide this essential service. Most of UWUA members have made this their only career, staying until

retirement while honing the unique skill of providing natural gas to consumers. There can be no dispute that if the City were to somehow eliminate natural gas as a source of energy, all of these good jobs would be lost and could not be replaced with a viable alternative. My members would lose the economic stability these jobs have provided, would lose their health care, and would fall back into poverty, compounding Philadelphia's already fragile economy.

There is no denying that the full Electrification Strategy and Hybrid Electrification Strategy are both alternatives that would decimate the PGW workforce and send valuable employees back into poverty. The study matter-of-factly acknowledges this loss of jobs and provides no strategy for retaining PGW's workforce and the wage levels, health care and retirement benefits that these jobs provide because no such alternative exists. Simply stated, these good Union jobs will be lost under any electrification alternative. Similarly, the Geo Micro District Strategy would also destroy Union jobs, as PGW would have to abandon parts of its current distribution system.

Unless and until the City can craft a strategy where thousands of workers are not suddenly unemployed and without healthcare, one of the stakeholders' most critical goals will not have been met, and its reputation as a partner of organized labor will be tarnished.

The Electrification and Geo Micro District Strategies Will Penalize the City's Poorest Residents

Philadelphia has the highest poverty rate of any major U.S. city and almost 1/3 of PGW customers are considered low income. The Electrification and Geo Micro District Strategies would single-handedly guarantee that Philadelphia's poorer residents cannot keep warm in Winter or place hot meals on their tables. They will necessarily leave poorer customers behind.

As the Study acknowledges, the Electrification Strategies have a high price tag for consumers. Under these alternatives, 450,000 PGW customers would need to replace natural gas heating equipment with fuel heat pumps and electric appliances that cost more than gas appliances, and that they simply cannot afford. These families will also not be able to afford the cost of electric heat during the Winter – the average cost of monthly electric energy is nearly double that of natural gas. Their energy costs will skyrocket with the increased demand for electricity. As the Study notes, full electrification requires "building retrofits, potential electric peak load impacts, may result in stranded assets and future gas force reductions." The Hybrid Electrification Strategy is no easier on Philadelphia's poor, as we believe rates will increase three or four times over existing rates because natural gas will only be used on the coldest days, thereby pushing poorer customers to incur the additional costs of converting to full electrification. A Yale Environment 360 Study recently noted:

> But even if operating a heat pump is likely cheaper over the long run that firing a furnish with biogas, the up-front costs of buying and installing one, including upgrading wiring and circuit breakers to handle heavier loads, remains high relative to a conventional gas heater. Those costs are still way beyond what many Philadelphians can afford.[1]

The study also emphasized that:

> As more affluent customers abandon gas to install heat pumps and other clean energy upgrades with higher up-front costs, many advocates for a "just transition" worry that lower income ratepayers will be left to fit the bill for maintaining PGW's aging gas infrastructure. *Id*. Page 4.

The Geo Micro District Strategy is no kinder to the City's poorer residents. In that

[1] Yale Environmental 360 *Cities Confront Climate Challenge: How to Move from Gas to Electricity*. Jonathan Mingle April 20, 2021, Page 6.

alternative, all customers connected to a micro district must replace their current space heating equipment along with their natural gas appliances in their homes, as the natural gas mains on the street will be abandoned, and the cost will be significant.

These three Strategies would indeed result in an "unjust transition," as good Union jobs would be lost, and an even greater financial burden would be placed on Philadelphia's poorest residents. Obviously then, it is clear that these three Strategies fail two fundamental tests set out by Stakeholders – safeguarding the good jobs that PGW provides to its unionized workforce and ensuring that the poor are not placed at risk from a forced conversion.

Good Jobs and the Existing Infrastructure Can Be Maintained While Steps are Taken to Reduce Emissions

It is easily forgotten that natural gas is a relatively clean fuel providing much lower emissions than coal or petroleum products for virtually all air pollutants, including nitrogen sulfur oxides and carbon dioxide. While we cannot finally endorse the Study's "Decarbonized Gas Strategy" at this time, it does appear to be the only strategy that meets all of their professed goals – reducing harmful emissions, protecting the workforce, and protecting the poor. Other gas utilities are already pursuing these goals and are reducing emissions by injecting biogas, hydrogen, or synthetic natural gas into their gas system. These Renewable Natural Gas (RNG) sources would reduce the impact of GHG emissions while maintaining the existing infrastructure. This strategy is at least worthy of further consideration to determine whether it is a viable alternative.

The Union also has long supported an enhanced role for PGW in educating customers regarding weatherization and energy efficient services, and we have long been an advocate of

establishing and/or including the sale of LNG and CNG to regional customers. Of course, the Union also advocates a continued and intense focus on leakage detection to reduce costs and GHG emissions, as the study notes.

The Union intends to remain a partner in determining whether a just transition can occur, so long as a criteria stakeholder goal is met – to "maintain a financially sound utility that continues to maintain safety and reliability and sustain good Union jobs in Philadelphia."

Respectfully submitted,

KEITH HOLMES, PRESIDENT
GAS WORKS EMPLOYEES UNION LOCAL 686,
UTILITY WORKERS UNION OF AMERICA

TESTIMONY OF KEITH HOLMES, PRESIDENT
GAS WORKS EMPLOYEES UNION LOCAL 686,
UTILITY WORKERS UNION OF AMERICA

PGW BUSINESS DIVERSIFICATION STUDY

Thank you for the opportunity to provide testimony on behalf of 1150 unionized employees of the Philadelphia Gas Works who are members of Local 686. While the Union recognizes the dangers from climate change and is an advocate of reasonable steps to reduce emissions while protecting PGW's workforce and Philadelphia's low income citizens, we believe that most of the alternatives set forth in E3's Diversification Study ignore stakeholders' critical priorities of "safeguarding low income households" and "retaining PGW's workforce and creating new opportunities for jobs and economic growth." The strategies that E3 seems to advocate either concede that a retention of PGW's 1600 workers is largely impossible, and/or provide no analysis on how a service transition can occur while retaining these good Union jobs. E3's alternatives set forth in the Study also appear to recognize such service transitions would be unaffordable to the City's poorest residents, but appear nonetheless to ignore these concerns, making the nation's poorest City even poorer. I will address the Union's concerns about each of these strategies below.

Protecting Quality Union Jobs in Philadelphia is Paramount

PGW's workforce has been supplying safe and reliable natural gas to residents of Philadelphia for 185 years. Our members reside in the City, and PGW has long been a vehicle to provide good paying stable jobs to residents of the City's poorest neighborhoods. Our service and safety record are outstanding, and Philadelphians know us and rely on us to provide this essential service. Most of UWUA members have made this their only career, staying until

retirement while honing the unique skill of providing natural gas to consumers. There can be no dispute that if the City were to somehow eliminate natural gas as a source of energy, all of these good jobs would be lost and could not be replaced with a viable alternative. My members would lose the economic stability these jobs have provided, would lose their health care, and would fall back into poverty, compounding Philadelphia's already fragile economy.

There is no denying that the full Electrification Strategy and Hybrid Electrification Strategy are both alternatives that would decimate the PGW workforce and send valuable employees back into poverty. The study matter-of-factly acknowledges this loss of jobs and provides no strategy for retaining PGW's workforce and the wage levels, health care and retirement benefits that these jobs provide because no such alternative exists. Simply stated, these good Union jobs will be lost under any electrification alternative. Similarly, the Geo Micro District Strategy would also destroy Union jobs, as PGW would have to abandon parts of its current distribution system.

Unless and until the City can craft a strategy where thousands of workers are not suddenly unemployed and without healthcare, one of the stakeholders' most critical goals will not have been met, and its reputation as a partner of organized labor will be tarnished.

The Electrification and Geo Micro District Strategies Will Penalize the City's Poorest Residents

Philadelphia has the highest poverty rate of any major U.S. city and almost 1/3 of PGW customers are considered low income. The Electrification and Geo Micro District Strategies would single-handedly guarantee that Philadelphia's poorer residents cannot keep warm in Winter or place hot meals on their tables. They will necessarily leave poorer customers behind.

As the Study acknowledges, the Electrification Strategies have a high price tag for consumers. Under these alternatives, 450,000 PGW customers would need to replace natural gas heating equipment with fuel heat pumps and electric appliances that cost more than gas appliances, and that they simply cannot afford. These families will also not be able to afford the cost of electric heat during the Winter – the average cost of monthly electric energy is nearly double that of natural gas. Their energy costs will skyrocket with the increased demand for electricity. As the Study notes, full electrification requires "building retrofits, potential electric peak load impacts, may result in stranded assets and future gas force reductions." The Hybrid Electrification Strategy is no easier on Philadelphia's poor, as we believe rates will increase three or four times over existing rates because natural gas will only be used on the coldest days, thereby pushing poorer customers to incur the additional costs of converting to full electrification.

A Yale Environment 360 Study recently noted:

> But even if operating a heat pump is likely cheaper over the long run that firing a furnish with biogas, the up-front costs of buying and installing one, including upgrading wiring and circuit breakers to handle heavier loads, remains high relative to a conventional gas heater. Those costs are still way beyond what many Philadelphians can afford.[1]

The study also emphasized that:

> As more affluent customers abandon gas to install heat pumps and other clean energy upgrades with higher up-front costs, many advocates for a "just transition" worry that lower income ratepayers will be left to fit the bill for maintaining PGW's aging gas infrastructure. *Id*. Page 4.

The Geo Micro District Strategy is no kinder to the City's poorer residents. In that

[1] Yale Environmental 360 *Cities Confront Climate Challenge: How to Move from Gas to Electricity*. Jonathan Mingle April 20, 2021, Page 6.

alternative, all customers connected to a micro district must replace their current space heating equipment along with their natural gas appliances in their homes, as the natural gas mains on the street will be abandoned, and the cost will be significant.

These three Strategies would indeed result in an "unjust transition," as good Union jobs would be lost, and an even greater financial burden would be placed on Philadelphia's poorest residents. Obviously then, it is clear that these three Strategies fail two fundamental tests set out by Stakeholders – safeguarding the good jobs that PGW provides to its unionized workforce and ensuring that the poor are not placed at risk from a forced conversion.

Good Jobs and the Existing Infrastructure Can Be Maintained While Steps are Taken to Reduce Emissions

It is easily forgotten that natural gas is a relatively clean fuel providing much lower emissions than coal or petroleum products for virtually all air pollutants, including nitrogen sulfur oxides and carbon dioxide. While we cannot finally endorse the Study's "Decarbonized Gas Strategy" at this time, it does appear to be the only strategy that meets all of their professed goals – reducing harmful emissions, protecting the workforce, and protecting the poor. Other gas utilities are already pursuing these goals and are reducing emissions by injecting biogas, hydrogen, or synthetic natural gas into their gas system. These Renewable Natural Gas (RNG) sources would reduce the impact of GHG emissions while maintaining the existing infrastructure. This strategy is at least worthy of further consideration to determine whether it is a viable alternative.

The Union also has long supported an enhanced role for PGW in educating customers regarding weatherization and energy efficient services, and we have long been an advocate of

establishing and/or including the sale of LNG and CNG to regional customers. Of course, the Union also advocates a continued and intense focus on leakage detection to reduce costs and GHG emissions, as the study notes.

The Union intends to remain a partner in determining whether a just transition can occur, so long as a criteria stakeholder goal is met – to "maintain a financially sound utility that continues to maintain safety and reliability and sustain good Union jobs in Philadelphia."

Respectfully submitted,

KEITH HOLMES, PRESIDENT
GAS WORKS EMPLOYEES UNION LOCAL 686,
UTILITY WORKERS UNION OF AMERICA

PGW Business Diversification Study Comments

Kirk Wangensteen

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The analysis appropriately recognizes that relying exclusively on decarbonized gas is risky, poses unsustainable and long-term bill impacts to PGW customers, and does not improve air quality.

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PGW Business Diversification Study Comments

Lorraine Gimblett

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Sincerely,
Lorraine Gimblett

Testimony for Philadelphia Gas Commission Town Hall
Lynn Robinson M.Ed.
May 11th 2021

Good morning and thank your for the opportunity to speak about the Office of Sustainability's PGW Diversification Study. My name is Lynn Robinson, director of Neighbors Against the Gas Plants, a member of several environmental and human rights organizations, and a retired Philadelphia Public School teacher.

I'm disappointed that the Office of Sustainability (OOS) allowed industry consultants to participate in the writing of this Business Diversification Study for PGW, but the OOS does deserve credit for the way it solicited significant public input, and 2 tangible slides in the diversification study prove it. Networked geothermal energy (ground source heat pumps) was considered as an option on slides 34 and 35. However, a later slide, #44, about customer decisions determining the future, leaves geothermal out of its chart.

All of the economic predictions about various electrification models in the study assume that customer "participants" in electrification would be randomly scattered throughout the city, and that each one would pay individually for installation of their new electric infrastructure. The study calls gas customers "non participants," and assumes that only they would be PGW customers. Gas mains would still need to be maintained all over the city to serve these PGW customers. Due to the extra expense of individual financing of electrification, all low-income people and the smallest businesses would remain as PGW customers, and their bills would go up, as PGW sells less fracked gas to the wealthier "participants." This scenario for PGW implies no business diversification away from selling gas.

The consultants recommend bolstering revenue for PGW's gas-only business by investing in selling fracked gas (LNG and CNG) through 2050, to whomever across the globe is buying. However, selling LNG and CNG is not a long-term profitable option, even for plastics, or fertilizer. By 2050, climate change will have driven those markets to dry up, either due to intelligence of leadership, or to disappearing of swaths of human populations.

Slides 32 and 47 also lack common sense. They promote "Hybrid Electrification" as the most equitable outcome between participants and non-participants. I believe that the writers are fully aware that a hybrid model is unrealistic. How many urban homeowners will opt to purchase and crowd two heating systems into one home, while still living alongside gas leaks and gas main repairs on their streets?

Here is another "funny" prediction. By 2050, decarbonized gas would cost more for customers than fracked gas, as if advances in technology do not reduce pricing. Maybe this assumes that government in 2050 will still heavily subsidize fossil fuel extraction. The "bottom line" is that burning decarbonized gas is only a temporary solution, as the city transitions away from any burning fuels, because burning hydrocarbons is highly destructive to the climate.

One ominous prediction on slide 34 might interest Chairman Green. 50% debt financing should actually be no problem, if loans come from a Philadelphia Public Bank.

The draft includes some transparency on slides 31 and 32. Economic predictions are made for no PGW diversification in electrification and for hybrid electrification models. These slides clearly reveal the subtext for this study, which is that PGW and its customers are economically better off if PGW does not diversify beyond fracked gas.

As an educator, I give the PGW Business Diversification Study Draft an "F" for content, and a "C" for presentation. The presentation graphics are easy to read, but since no supporting evidence is provided for any of the economic predictions or recommendations, the economic conclusions are unsubstantiated and incomplete. Industry marketing is blatantly obvious in the study's conclusions and in the justifications for those conclusions in previous slides.

Right now, what our city most needs in terms of energy efficiency are two things.

1. A huge and rapid home repair and retrofit program serving low-income homeowners, and for public schools. Such a program would also make those structures healthy to breathe in. But what concerns me is that Philadelphia Energy Authority's "Built to Last" program is defunded from the city budget, probably to please powerful real estate developers, who are lapping up cheap acquisitions and displacing low-income homeowners. Will the city's currently elected be willing or able to allow PGW or the PEA to do a truly effective "Built to Last" program?

2. The city needs a networked geothermal pilot project, if by September or October 2021, the conclusions from the current Boston pilot project are not enough to rely on.

In conclusion, our city does not need to stall for time until the Biden presidency is overturned, or until Tuesday, November 5th, 2024, when a member of the Trump family is elected to turn the fossil fuel extraction industry spigot back on full blast. We, through PGW, need to embrace the opportunity to address climate change now, while we still can.

PGW Business Diversification Study Comments

M Stephens

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Marcus Ferreira

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PGW Business Diversification Study Comments

Marielle Lerner

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PGW Business Diversification Study Comments

Mary Ferrigno

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PGW Business Diversification Study Comments

Meredith Stone

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PGW Business Diversification Study Testimony

Patricia Roberts

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PGW Business Diversification Study Comments

Paul Riermaier

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PGW Business Diversification Study Testimony

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PGW Business Diversification Study Comments

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PGW Business Diversification Study Comments

Sheila Erlbaum

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PGW Business Diversification Study Testimony

Sheldon Isaac

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PGW Business Diversification Study Comments

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PGW Business Diversification Study Comments

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PGW Diversification Study Testimony

Walter Tsou

Thank you for commissioning the Diversification study. I think it brought together a lot of interesting possibilities and challenges. Here are some additional thoughts as I read through the slides. The new International Energy Agency report has basically stated we need to stop all new gas development. https://www.bloomberg.com/news/articles/2021-05-18/the-world-s-top-energy-agency-reckons-with-net-zero-emissions?sref=xrGaC0DP

1. Philadelphia sits on the confluence of two rivers and no mention was made of water source heat pumps. Is it possible to create a community water installation that would feed into a heat pump for those who live near the rivers? The Baxter water plant or the city wastewater treatment plant already could be a test of the concept where a water source heat pump could air condition and heat the water plant and maybe neighboring structures.

2. A survey of homes that already have ducts and have gas heat could be done.. Blocks of similarly constructed homes with ducts are ideal for heat pump conversions. A surveyor should see if a geothermal micro grid could be established in a nearby park and use it to feed the heat to homes. Gas lines are closed in blocks that been "converted" to electricity.

3. Repurpose Philly rec centers and park areas, vacant lots to be locations of geothermal microgrids with the intention of restoring the park after construction. Locations of open space can be found at NaturePHL.org.

4. License the technology of Dandelion Energy. www.dandelionenergy.com to do individual homes in Philly for residential and businesses.

5. Convert row house roof tops into solar panels roofs installed by PGW and amortized over 25 year life span of panels. This would put PGW in competition with many solar installers so it may be more for commercial or industrial properties.

6. I would argue that the additional revenue that PGW needs in order to keep customer bills reasonable will be the federal investment needed to convert to a fossil fuel free future. Compared to the cost of inaction, it is a reasonable federal investment.

PGW Business Diversification Study Comments

Will Fraser

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PGW Business Diversification Study Comments

William Edelman

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Under the hybrid electrification model, the report envisions customers adopting heat pumps paired with a gas furnace to meet "peak heat" demands during the coldest periods of winter. Heat pump technology has advanced so quickly, and with the recent announcement from Biden's administration that they are investing in technology to further improve heat pumps, there is no need for a backup gas furnace.

The analysis appropriately recognizes that relying exclusively on decarbonized gas is risky, poses unsustainable and long-term bill impacts to PGW customers, and does not improve air quality.

I understand that the analysis found that exclusively relying on electrification can reduce energy bills for households that electrify, but increase energy bills for customers remaining on the gas system, which can pose equity challenges unless mitigated. I ask that the report consultants analyze options for mitigating potentially high energy bills for non-participating customers.

I support that the list of diversification options on p.45 of the report are "under consideration" (especially community solar, microgrids, installation and maintenance of heat pumps, and on-bill financing). I recommend modeling how much revenue PGW could make from the other diversification options suggested in the report, including weatherization and energy efficiency services, community solar operations, and geothermal micro-districts, to see if these options could fill the revenue gaps needed for the electrification and hybrid scenarios. While I understand that PGW is already involved with liquefied natural gas facilities, this option, along with compressed natural gas facilities, conflicts with the criteria of protecting public health, safety, and addressing air pollution and climate change.

The report states that the costs of hybrid electrification (with geothermal micro-districts as a promising option) are highly uncertain and dependent on local characteristics, such as geology and building type. I recommend that the report consultants do a deeper analysis of what these costs would be locally so that the public has a more accurate understanding of the costs and benefits of this option. After this analysis is completed, and if the results show that this technology is appropriate for the Philadelphia context, the Office of Sustainability should consider using geothermal micro-districts as a pilot project to test out this concept.

Sincerely,
William Edelman

PGW Business Diversification Study Comments

William Holloway

Hey guys, you're likely getting a bunch of form letters about how important the environment is, and the future of the planet. I think those are valid concerns, but more immediately relevant to you, I think, is that the proliferation of solar and wind power in particular present an immense business opportunity for PGW. Those are growing sectors, and their growth will only accelerate.

At some point, people will start realizing that they can get off the grid by buying solar panels or a small turbine for themselves and completely decouple from utilities.

PGW can either be in the vanguard of this transition, or risk being left behind. You can pretend it won't happen within the next 20 years, but I urge you to remember how quickly the horse and buggy was replaced by the automobile. This progression is going to happen exponentially, not linearly, and you'll be left with your pants down if you don't start making serious moves right now.

So for the sake of PGW, if not the sake of the planet, begin making real progress towards pulling out of fossil fuels. I totally get that that's hard for a gas company to do, but if you don't you risk being left behind completely in the coming decades and becoming a defunct relic of an earlier age.

Sincerely,
William Holloway

Philadelphia Gas Commission
1515 Arch St # 9A
Philadelphia, PA 19102

May 25, 2021

Dear Councilman Green, Councilman Jones, Ms. Rebecca Rhynhart, Ms. Jocelyn Hill, and Mr. Royal E. Brown and Ms. Christine Knapp,

We submit the following comments regarding the future of Philadelphia Gas Works. These comments are submitted by the Just Community Energy Transition Project (JCET). JCET is a project rooted in Philadelphia that partners with community-based grassroots organizations to facilitate participatory policymaking and community-driven strategies towards a climate and racially-just society, primarily through the lens of the energy economy and its transition. JCET works in Philadelphia, Pennsylvania, and with communities in the Gulf South.

Over the years JCET has collaborated on multiple projects around energy democracy - a perspective that believes that working people, low-income communities, and communities of color, and their allies should be in control of energy resources and decision-making. It is a view that the solutions to our climate crisis requires that we have a decentralized energy system, one characterized by social and community-based control and ownership of energy resources, a shared resource developed in harmony with the Earth ecosystems.

This perspective views a just transition from a fossil-fuel economy to a new renewable energy economy must be grounded in economic and social justice -for workers and the community.

One critical component to achieving energy democracy is for public control. Given that PGW is a public utility, we are in a unique position as the City of Philadelphia to seize and advance energy democracy that will benefit residents, workers, and the city's economic future. We offer three critical points of intervention moving forward.

First, we must ensure that PGW's decisions follow the lead of the community, in particular those most impacted. As a public utility, PGW should be doing whatever is best for the municipality and those living in it - i.e. the residents it serves. The majority of the voices in the municipality are calling for a shift to renewable energy and conservation practices. The city itself voted for a resolution opposing state legislation that would preempt municipalities from adopting policies advancing building electrification. Unfortunately, this stands in direct contrast to how PGW has used its profits. Rather than focusing on community interests, PGW has used profits to lobby state legislation to continue extractive energy practices that continue to harm the planet and its customers the worst.

The Commissioners should, as Bishop Dwayne Royster called for, "require PGW to provide a comprehensive and public accounting of its lobbying activities relating to Senator Yaw's dangerous preemption bill and to building electrification generally, and PGW must be directed in no uncertain terms to cease such activities."

We as constituents deserve transparency and participatory spaces to hold the municipally owned entity accountable. That should be the foremost motivation and goal of the government and the basis of its oathto stand in representation of the people's will.

Second, we must ensure that any and all decisions do not replicate top-down, racist, and exploitative processes and practices. Instead PGW must move forward with intentional community-labor strategies and participatory processes. We cannot continue top down approaches to economic transition and allow industry to decide how to best exploit labor, community and government. Those three entities need to explore ways to work together and empower one another to ensure a fair and just transition. We need a new social contract that centers on those most marginalized by the system so that the transition yields a new economic structure that works for everyone, not just industry. That new social contract needs to be a partnership between labor, community and government, all of which in some capacity are grounded in people power and are held accountable to the denizens of the municipality.

JCET has joined many of the city's residents and community organizations respectfully in written comments and letters respectfully calling for a participatory process among residents and workers in shaping the future of PGW. There has been some work by the Office of Sustainability to advance equity and inclusion in conversations around energy burdens, which we are deeply grateful for. However, this is not enough. From the deeply untransparent processes in selecting new leadership this past winter to a technical diversification study that failed to have any legitimate or adequate engagement with community residents and leaders - we continue to have top-down solutions that do not put the residents and workers first. As a public utility, we expect better. We deserve better. We ask that the City and PGW Gas Commission convene a truly participatory and authentic community and worker planning process to ensure that decisions in PGWs future do not leave workers and the most marginalized residents behind, but rather build a future together.

Third, we must reject false solutions of LNG, RNG, or other extractive solutions that just kick the can down the road. Instead we must transition to renewable solutions to re-envision PGW as a heating and cooling services utility that continues to keep energy in public governance, maintains a strong and healthy workforce, and ensures that no resident is burdened with financial or health costs because of the energy they need. PGW should have the best interests of the City's residents in mind, and therefore it should transition away from gas and into heating and cooling services, employing a model that prioritizes low income communities first. As the Biden Administration begins to advance infrastructure plans - PGW should be at the forefront for federal investment by building out strategies for building decarbonization, leading the way in advancing equitable electrification and healthy home repairs and services, and integrating new innovative technologies that can serve residents. One particular model that must be explored was shared by Rabbi Julie Greenberg of POWER in the public comments earlier this month. Rabbi Julie stated, "networked geothermal sponsored by PGW is [one of] the best way to protect the institution of PGW, protecting the workforce by focusing on energy infrastructure, housing efficiency and heat as a service rather than collapsing in a death spiral as people who can afford to switch to electrification do so, while those who are energy burdened remain in the sinking ship of PGW." A just transition plan structured around equity and justice, i.e. serving those most marginalized first, is the best path forward for the people and the business.

Respectfully,

Anthony Giancatarino
JCET Director
agiancatarino@gmail.com

GREEN BUILDING UNITED

Green Building United
Written Comments on Draft PGW Diversification Study
May 27, 2021

Thank you to the City of Philadelphia's Office of Sustainability, Philadelphia Gas Works, and to the Philadelphia Gas Commission including Chairman Green for the opportunity to provide comments on the draft version of the PGW Diversification Study and for the work to date on this critical, complex challenge.

Green Building United is a mission-based member organization of industry professionals including architects, engineers, contractors, developers, building owners and managers, and more. Our members play a critical role in the built environment, including decision making around equipment in new and existing buildings and homes.

Given this expertise, we are submitting these detailed written comments in response to what is included in the PGW Diversification Study draft materials. We hope that our feedback can complement the research done to date to ensure the best possible accuracy in modeling assumptions of this study to further vet high electrification and heat-as-a-service options as viable pathways. We follow this direct feedback with questions and comments on what was not yet included or specified in the draft materials but is necessary to fully understand this study and next-step options.

Electrification

We know that all-electric new homes are comparable, even cheaper, in terms of upfront and long-term utility costs as compared to their mixed fuel counterparts. We know that electrification in existing homes is more affordable when paired with energy efficiency and weatherization measures. We know that electrification improves indoor air quality, which affects health. And, through this study, we know that decarbonized natural gas is not a viable, cost-effective alternative. **With electrification as a potential path forward for PGW, we need to fully vet the technical and financial feasibility of scaling electrification in existing homes, especially those in need of repair, through a pilot program. This is a critical need to ensure that low-income Philadelphians are not left behind in a transition.**

This study also makes clear that "consumer decisions on how to heat their homes are largely outside of PGW's control." So how do consumers make decisions on what to install in their homes? The vast majority, nearly 90%, of home HVAC replacements are happening on an emergency basis. The decision that consumers are making in a moment of need is locked in for the 15 to 20 year long lifespan of the equipment.

To support electrification as a viable option, we need to ensure that all points in the process are equipped to make a supportive decision. Consumers need assurance that electrification meets their affordability, comfort, and health needs. Contractors need familiarity and experience with equipment installation and high-impact efficiency measures that pair best with electrification. Grant, loan, and rebate program implementers need evidence of electrification improving cost, comfort, and indoor air quality. This applies to not only home heating but also to all of the other gas appliances in a home including stoves, clothes dryers, and water heaters. If the transition is not truly all-electric, gas lines to each home would need to be maintained.

A robust existing homes electrification pilot as the next phase of this process can help answer these critical questions. An existing homes electrification pilot can also help PGW assess the viability of some of the diversification options – namely heat as a service – that were briefly presented in this draft.

Hybrid Electrification

For the heat pump and hybrid scenarios, we have significant concerns with the cost estimates provided, which range in rigor and credibility from detailed federal government survey data to the contractor lead generation website HomeAdvisor. While precision may be difficult to achieve, accurate cost ranges are possible to establish, and important considering that they are extrapolated in long-term cost models.

We would like to see more detail on the air source heat pump cost assumptions on slide 68. In particular, we would like to understand why the hybrid scenario, which includes both a heat pump and furnace equipment, is assumed to cost $3,000 less than a heat pump on its own.

We would also like to know what is included in the price point for a heat pump and how the heat pump tonnage was established, as it is almost twice the size of what we would expect for a typical-sized Philadelphia rowhouse.

Geothermal MicroDistricts

We understand that this was a late addition based on stakeholder input and could not be fully explored but would like to understand how the process will proceed in evaluating the viability of this and other nascent technology options.

In particular, we are interested in a combination scenario with the deployment of Geothermal MicroDistricts, where appropriate, alongside air source heat pumps and standalone ground source heat pumps. It appears that MicroDistricts were only considered alongside the hybrid electrification scenario on slide 40.

A scope ought to include details on how costs of MicroDistricts could be allocated (e.g. costs borne by users only or spread across customer base) as well as the potential for MicroDistricts to maintain PGW's existing gas workers as its other lines of business shift away from maintaining the current system.

General Comments and Questions

Are the cost estimates for participants and non-participants only limited to residential customers? That appears to be the case given the modeled options for decarbonized end uses are restricted to home heating. How, if at all, were commercial and industrial customers considered in this study? How does the inclusion or exclusion of commercial and industrial customers in this study impact the potential rates for nonparticipants under the electrification scenario?

How were system costs calculated through 2050 under the various end use decarbonization scenarios? The electrification revenue chart, for example, suggests that diversification needs to make up roughly $0.5 billion in revenue. Does that assume maintenance of the entire existing system for nonparticipants? What are the workforce projections during this time frame? Do the costs take into account naturally occurring retirements and relocation? Are there strategies for the deployment of electrification that could reduce these system costs?

We would like to review details on the assumptions for building shell upgrades mentioned for new and existing buildings on slide 67, and offer to provide comparable cost information from built projects in this region.

In response to slide 69, distributed renewable generation is scaling much faster than expected, with the International Energy Agency revising its forecast to 40% of U.S. electricity generation by 2050. Grid interactive building technologies are also scaling rapidly, which will also expedite the transition away from gas based on economics.

Finally, we would like to have the opportunity to review the full details and provide feedback on the proposed diversification strategies, as that is the main goal of the study. It is difficult to provide comprehensive feedback on the appropriate path forward without a sense of the viability of the proposed alternative revenue generation options. We also hope that the diversification options will include a characterization of the current workforce (i.e. administrative, management, gas workers) as well as an assessment of which new business lines provide viable retraining pathways and for whom.

What's more, we would like to see a continuation of this public input process after the final report is complete including but not limited to opportunities to review and provide feedback on the forthcoming PGW pilot project.

Thank you for your consideration and we look forward to the final draft.

POWER: An Interfaith Movement

powerinterfaith.org

May 28, 2021

Via Email

Christine Knapp
Director, Office of Sustainability
City of Philadelphia
One Parkway Building
1515 Arch St., 13th Floor
Philadelphia, PA 19102
christine.knapp@phila.gov

Re: Philadelphia Gas Works Business Diversification Study

Dear Christine,

On behalf of POWER, I am happy to submit these comments about the draft materials for the PGW Business Diversification study. We look forward to further conversation about the study, and we look forward to working with the City on plans to transform PGW and buildings across the city.

Thanks very much,

Rabbi Julie Greenberg

Director of Climate Justice and Jobs
215-843-9592 / jgreenberg@powerphiladelphia.org

COMMENTS ON THE DRAFT MATERIALS FOR THE PGW BUSINESS DIVERSIFICATION STUDY

POWER Interfaith

May 28, 2021

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I. Executive Summary

POWER Interfaith ("POWER") appreciates the opportunity to provide these written comments ("Comments") on the draft materials ("Draft Materials") shared on April 30, 2021 by the City of Philadelphia (the "City") in connection with the City's Business Diversification Study for Philadelphia Gas Works ("PGW").[1] These Comments complement and expand on testimony offered by POWER members at the Town Hall meeting about the Business Diversification Study convened by the Philadelphia Gas Commission on May 11, 2021.[2]

The purpose of these Comments is to provide feedback on the Draft Materials and to support the City in accomplishing a just transition for PGW to a fully decarbonized business model. These Comments first address cross-cutting issues. To start, while the City promised to provide a full draft of the Business Diversification Study for public comment,[3] the Draft Materials provided by the City comprise only a set of PowerPoint slides describing the study. In order to provide the public with a meaningful opportunity for participation, the City must hold a hearing on a full draft of the Business Diversification Study at which the public can submit comments on the draft. Next, the Draft Materials fail to provide specific information on opportunities for savings on energy and bills from energy efficiency, repairs and retrofits. It is also unclear the extent to which cost projections factor in such energy efficiency opportunities, which the full draft study must clarify, and if such opportunities are not factored in, to incorporate them.

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[1] City of Philadelphia, *Draft Materials and Town Hall Transcript for PGW Business Diversification Study Now Available*, City of Philadelphia (Apr. 30, 2021), https://perma.cc/DE4B-E7M9; City of Philadelphia, *Draft Materials* (Apr. 2021), https://perma.cc/TA8Y-6SYN.
[2] Virtual Town Hall Tr. (May 11, 2021) ("May 11 Tr."), https://www.phila.gov/media/20210520113906/VirtualTownHall_PDFTran-5-11-21.pdf.
[3] City of Philadelphia, *PGW Business Diversification Study Kicks Off* (Sept. 2, 2020), https://perma.cc/3HXV-WRRZ.

Another cross-cutting issue is that the Draft Materials assume, under all decarbonization scenarios, that PGW maintains its entire gas distribution network at its current size, even under a high electrification scenario in which almost all residents are not using it. Keeping the full gas network in place regardless of use would impose a very high cost burden on ratepayers, but the Draft Materials do not explain why portions of the gas network cannot be strategically decommissioned as they become unnecessary. Such a strategic decommissioning process would greatly alleviate the cost burden on Philadelphians and would reduce the revenue needs of PGW substantially, opening up more flexibility for new business models. The full draft study needs to drop the unreasonable assumption that under all decarbonization scenarios the gas network must stay the same size, and model the possibilities that open up as a result.

Additionally, the Draft Materials appear to assume that under all decarbonization scenarios, the City remains in the fossil fuel business through 2050, through PGW selling liquefied natural gas and compressed natural gas to regional customers even after it stops distributing natural gas in the City. This is completely unacceptable, and it would be a moral scandal for the City to still be involved in the fossil fuel business in 2050. The Business Diversification Study needs to make it expressly clear that PGW will fully exit all fossil fuel business lines, and model pathways for doing so.

Furthermore, the Business Diversification Study must analyze options to advance the four critical values of (1) affordability, (2) decarbonization, (3) fair labor, and (4) health and safety in an integrated fashion, and not simply pose false choices between them. POWER sees community-informed solutions that integrate these four goals as a necessary response to the disastrous juncture of climate crisis and extreme inequality in our city. A cross-cutting problem in all the decarbonization scenarios in the Draft Materials is a failure to model potential public

policy interventions and business model changes that could support integrated progress on all four of these values. The full draft study must correct these omissions.

Finally, the four scenario-specific analyses in the Draft Materials also need improvement. First, the high decarbonized gas scenario fails to address supply and cost constraints that throw into serious question the feasibility of replacing any significant proportion of current gas demand with decarbonized gases. Next, this scenario also fails to advance the essential value of health and safety in any meaningful fashion, leaving residents stuck dealing with indoor air pollution problems from continued reliance on gas combustion for heating and cooking. Finally, this scenario fails to ensure equitable access to electrification for all, and creates the risk of a "death spiral" in which those with privilege electrify and those left behind face health impacts and rising infrastructure costs.

Second, the high electrification scenario suffers from distorted affordability and revenue modeling through a failure to incorporate both cost reductions possible through decommissioning unnecessary gas infrastructure and new revenue streams from business opportunities consistent with high electrification. Similarly, the high electrification scenario fails to model options for the public policy interventions needed to ensure equitable access to electrification and instead simply assumes electrification could only occur in an unplanned fashion.

Third, the hybrid electrification-decarbonized gas scenario fails to address supply, cost, and health issues for decarbonized gases, and also fails explain why the gas network cannot be reduced in size even as most heating demand is met by electrification. Finally, the fourth scenario, involving a hybrid of electrification, decarbonized gas, and networked geothermal, fails to explain why decarbonized gas should be part of the scenario and fails to substantiate its

projections for the proportion of demand that networked geothermal could meet. In order to help fill that information gap, the City should pursue a networked geothermal pilot program, which would provide an important learning opportunity about a potential new revenue source and could help provide and maintain union jobs.

As next steps, the City should incorporate these Comments into a full draft of the Business Diversification Study, and publish that draft for public comment. Failing to allow for public comment on a full draft of the study, as promised, will not generate the insights and forge the trust needed to navigate a just transition for PGW. Upon completion of the study, the City must promptly convene hearings on changes to PGW's business model to be implemented in 2022 to incorporate the study's findings. This is time-sensitive. PGW will next be able to apply for a rate increase on January 1, 2022, and it must not be allowed to raise rates on residents again without a real plan for decarbonization.

Finally, the City must order PGW to stop working behind the scenes to preempt the City's ability to implement the Business Diversification Study. As discussed further below, it is concerning to note reports of PGW's activities in support of the bill by Senator Gene Yaw that seeks to preempt municipalities from adopting policies to transition away from natural gas. PGW is also a major funder of—and active participant in—trade associations that fight to preempt municipalities around the country from taking control of their energy future. It would not be reasonable for any municipally-owned utility to work to hamstring and limit the municipality that owns it, and the City must not tolerate this behavior. PGW must be ordered to immediately terminate any form of funding, lobbying, or advocacy for municipal preemption or against any policy tool the City may need to implement the Business Diversification Study. Next, PGW must be ordered to produce a full and public report on any such activities. Having cleared the air in

such a fashion, PGW must then re-engage with the City and with the public in a true spirit of partnership and collaborate on the shared project of decarbonization consistent with the City's policy.

II. Background

POWER is a racial and economic justice organizing force in the Commonwealth of Pennsylvania, helping people put faith and values into strategic action to win concrete change in the public sphere. POWER organizes in southeastern Pennsylvania and in coalitions across the state for racial and economic justice on a livable planet by shifting the moral and policy universe towards possibilities that support the common good. POWER's Climate Justice and Jobs team draws people from both marginalized and privileged neighborhoods into the public struggle over land and energy, considering key land and energy issues as contested space in this world. POWER fights against dirty fossil fuel expansion and for green economy solutions. In our integrated strategy, we center racial and economic equity issues as an essential part of every single building block of policy.

POWER strongly supports a just transition to a 100% clean energy future for PGW, consistent with the City's commitments and the urgency of the climate crisis. On September 26, 2019, the City of Philadelphia passed Resolution No. 190728, which determined that "the City of Philadelphia shall take measures to achieve a fair and equitable transition to the use of 100% clean renewable energy for electricity in municipal operations by 2030, for electricity City-wide by 2035, and for all energy (including heat and transportation) city-wide by 2050 or sooner."[4]

[4] City of Philadelphia, Resolution No. 190728 at 3 (Sept. 26, 2019), https://phila.legistar.com/LegislationDetail.aspx?From=RSS&ID=4142523&GUID=BA06CC3B-7B43-4743-A07E-515A145C4A2A.

As Resolution No. 190728 specified, the "clean renewable energy" that shall be used for all purposes in the City, including heat, "includes energy derive[d] from solar, wind, and geothermal; but does not include natural gas."[5] Additionally, on January 15, 2021, Mayor Jim Kenney announced that the City is committed to achieving "net-zero greenhouse gas emissions in the buildings, energy, transportation, and waste sectors" by 2050.[6]

These policy commitments reflect the need for action on climate change, particularly to protect environmental justice communities. As the Pennsylvania Department of Environmental Protection's Environmental Justice Office Director Allison Acevedo recently noted, "Pennsylvanians who have lived in communities with almost a century of disinvestment now also face disproportionate risk from climate change impacts… State and local leaders must work proactively and intentionally with communities and other partners to reduce the significant risks of climate change and cultivate resources, health supports, and other development in communities that disproportionately confront these critical climate issues."[7]

III. Technical Issues with the Draft Materials

A. Cross-Cutting Issues

1. The City Promised to Provide a Full Draft of the Business Diversification Study for Public Comment, But Has Provided Only a Set of PowerPoint Slides Describing the Study

One overarching technical issue is that the Draft Materials do not disclose much of the calculations, modeling, or assumptions used to form the basis of the preliminary conclusions in

[5] *Id.* at 2.
[6] City of Philadelphia, *City Commits to Carbon Neutrality by 2050, Releases Climate Action Playbook and Hires First Chief Resilience Officer*, City of Philadelphia (Jan. 15, 2021), https://perma.cc/Q2S6-WCC4.
[7] Press Release, Governor Tom Wolf, *Gov. Wolf 2021 Climate Impacts Report Projects Pennsylvania Will Be 5.9° F Warmer by Midcentury, Targets Areas to Reduce Risk* (May 5, 2021) ("Governor Wolf Press Release"), https://perma.cc/9864-6PR5.

the Draft Materials. The City previously committed to providing a full draft of the study for public comment, stating that "[l]ike the City's process for receiving feedback on regulations, drafts of the outline and study will be available for public review and comment."[8] As the City stated, this step would "be taken to ensure that residents' voices are reflected in the study."[9]

However, the Draft Materials, which take the form of a set of PowerPoint slides about the study, do not meet this standard and do not provide the public with access to the information needed to evaluate the conclusions contained in the Draft Materials. By failing to share a full draft Business Diversification Study for the public to comment upon, the City has significantly deprived the public of the ability to provide technical comments on the Business Diversification Study. Indeed, under the City's present approach, the public can only comment on a set of PowerPoint slides about the study, but not on a draft of the study itself. Given the important issues at stake in the transformation of PGW, this is inadequate.

This gap should be rectified, as discussed further below, by further opportunities for public participation, including commenting on the full Business Diversification Study. Nevertheless, even based on the limited contents of the Draft Materials, a number of further comments are warranted, and are offered here in the hopes that they will be useful in the completion of the study.

2. The Draft Materials Fail to Provide Information on Energy Efficiency, Repair, and Retrofit Opportunities

An additional cross-cutting issue is that the Draft Materials do not provide any specific information on the energy and financial savings possible through aggressive deployment of energy efficiency, including home repairs and retrofits. On Slide 14, the Draft Materials

[8] City of Philadelphia, *PGW Business Diversification Study Kicks Off* (Sept. 2, 2020), https://perma.cc/3HXV-WRRZ.
[9] *Id.*

generally acknowledge that energy efficiency must be a part of any decarbonization scenario.[10] However, the Draft Materials contain no quantitative information on how much the public could save in terms of energy use and bills through energy efficiency.

In evaluating the revenue and cost impacts of different decarbonization options, the Draft Materials expressly assume that bills will stay stable.[11] The Draft Materials provide no detail on what this assumption means or how it was derived. However, it appears to mean assuming that aggressive energy efficiency measures will not take place, because such measures would substantially reduce customer bills. At the same time, Slide 67 recognizes that "[b]uilding shell upgrades reduce demand for space heating."[12] The Business Diversification Study, to provide useful guidance for the future, must clarify how these assumptions interact, and provide specific information quantifying what energy and bill savings are possible from energy efficiency.

Another reason it is important for the Business Diversification Study to model the potential savings from energy efficiency is because it would help map out the business opportunities available for PGW in providing energy efficiency services. As reflected on Slide 24, the business diversification option with the highest level of stakeholder support is for PGW to play "a more active role in energy efficiency and weatherization of homes."[13] While the Draft Materials fail to adequately analyze the role of energy efficiency, including home repairs and retrofits, in a just transition for PGW, the Business Diversification Study must correct this deficiency.

[10] Draft Materials at Slide 14.
[11] *Id.* at Slide 33 ("operating costs do not include building shell upgrades"); Slide 37 ("assuming PGW customer bill stability"); Slide 38 ("assuming PGW customer bill stability"); Slide 39 ("assuming PGW customer bill stability"); Slide 40 (assuming "stable customer bills").
[12] *Id.* at Slide 67.
[13] *Id.* at Slide 24.

3. The Draft Materials Unreasonably Assume that PGW's Infrastructure Cannot Be Reduced in Size, Inflating Cost Projections and Systematically Skewing the Analysis Towards the Use of Decarbonized Gas

A basic principle of decarbonizing a gas utility is that as gas demand falls, gas infrastructure needs to be reduced in size to avoid saddling ratepayers with unnecessary costs.[14] It may take some time to do so, but instead of modeling this process, the Draft Materials instead unreasonably assume that even if gas demand falls substantially (or even drops to near zero), PGW must indefinitely continue to charge the public for the cost of maintaining its entire gas network at its current size. This approach is both extremely expensive and extremely wasteful, and makes little sense.

No gas utility would ever decarbonize in this way, so assuming that this will occur is not helpful. Instead, what is needed is modeling of how, during the period from now until 2050, a declining cost curve driven by strategic decommissioning of gas infrastructure interacts with new revenue sources coming online from diversified business lines. Assuming that even in decarbonization scenarios with little gas use, the public will pay crushing costs to maintain unnecessary levels of gas infrastructure until 2050, is not practical, realistic, or useful.

As Mike Henchen, director of the building decarbonization program at the energy thinktank RMI, recently commented in an interview about PGW, "What you want to avoid is the situation where you have to maintain and spend money on the whole system, even while you sell less gas."[15] Instead, as Henchen notes, the City could examine a segment of PGW's gas network, "work to support every building served by [a pipe] to convert to a carbon-free alternative to gas, and then decommission an actual pipe in the ground… Close the valve."[16]

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[14] Jonathan Mingle, *Cities Confront Climate Challenge: How to Move from Gas to Electricity?* (Apr. 20, 2021), https://e360.yale.edu/features/cities-confront-climate-challenge-how-to-move-from-gas-to-electricity.
[15] *Id*.
[16] *Id.*

Such an effort could draw from the innovative work of Councilmember Derek Green and the Philadelphia Energy Authority on the Built to Last program. The Built to Last Program provides for coordinated, interagency work to restore safe, healthy, and affordable homes to low-income residents through a variety of interventions, including energy efficiency, repairs, retrofits, and electrification.[17] A similar initiative focused on equitable electrification in the context of PGW's decarbonization could provide for a key leadership and implementation role for PGW. Such an initiative could ensure that low-income residents have equitable access to the long-term cost savings and health benefits available from electrification that is integrated with energy efficiency, home repairs, and retrofits.

Finally, assuming that PGW's gas network cannot be reduced in size systematically skews the decarbonization scenario analysis towards making decarbonized gas look artificially more attractive because it uses that network. Propping up decarbonized gas in this manner is effectively a massive subsidy extracted from PGW ratepayers. It obscures the true public savings that may be available through the reduced infrastructure costs and reduced customer bills from the strategic decommissioning of unnecessary portions of PGW's network. As discussed further below with regard to the specific decarbonization scenarios discussed in the Draft Materials, this analytic flaw must be corrected in the Business Diversification Study.

4. Decarbonizing PGW Must Include Exiting All Fossil Fuel Business Lines, Including Those Involving Gas Transportation, Liquefied Natural Gas, and Compressed Natural Gas

For PGW to meaningfully decarbonize, PGW must develop a business plan to exit all of its fossil fuel business lines, not just stop distributing natural gas. As Slide 36 notes, in addition

[17] Alon Abramson, *Built to Last: An Initiative to Restore Safe, Healthy, and Affordable Homes*, Philadelphia Energy Authority (Aug. 2020) ("Built to Last Overview"), https://philaenergy.org/wp-content/uploads/2020/08/8-2020-PEA-Built-to-Last-Overview.pdf.

to revenues from gas customers, PGW also derives substantial revenues from "other business lines," including gas transportation services and liquefied natural gas ("LNG") facilities.[18] However, under all of the decarbonization scenarios evaluated, the Draft Materials appear to assume that these "other" fossil fuel business lines will continue until 2050.[19] The Draft Materials even propose that PGW develop an expanded business line involving "[t]he operations and sales of Liquefied Natural Gas (LNG) or Compressed Natural Gas (CNG) to regional customers."[20]

Given the urgent need for a just transition to full decarbonization, it is not acceptable for the City to continue actively fueling climate change in such a fashion. As the Pennsylvania Department of Environmental Protection has recognized, climate change will hit environmental justice communities, including many of POWER's members, the hardest.[21] For the City to still be actively participating in the fossil fuel business by 2050, as the Draft Materials appear to assume, would be a moral scandal. The Business Diversification Study must address this problem by confirming the City's intention to exit all of its fossil fuel business lines by 2050 (or sooner) and charting a path to do so.

5. <u>The Business Diversification Study Must Evaluate How to Advance the Four Critical Values of Affordability, Decarbonization, Fair Labor, and Health and Safety in an Integrated Fashion</u>

Finally, the Business Diversification Study must analyze options to advance the four critical values of (1) affordability, (2) decarbonization, (3) fair labor, and (4) health and safety in an integrated fashion, and not simply pose false choices between them. POWER sees community-informed solutions that integrate these four goals as a necessary response to the

[18] Draft Materials at Slide 36.
[19] *Id.* at Slides 37–40.
[20] *Id.* at Slide 45.
[21] Governor Wolf Press Release.

disastrous juncture of climate crisis and extreme inequality in our city. A recurring problem in all the decarbonization scenarios is a failure to model potential public policy interventions and business model changes that could support integrated progress on all these values.

Instead, the scenarios in the Draft Materials simply assume that when PGW's traditional primary revenue source, distribution of natural gas goes away, no revenue source other than distribution of decarbonized gas could replace it, and the revenue gap mean that bills have to spike, causing affordability problems. In particular, potential public policy interventions and business model changes that could complement and support the high electrification scenario are left unanalyzed. Finally, a just transition for PGW is also an opportunity to improve residents' health, safety, comfort, and economic well-being while also creating lots of good jobs. Ambitious efficiency retrofits could also make Philadelphia's buildings more resilient**,** allowing them to remain at a comfortable (and healthy) temperature much longer in the event of a power outage. These broader social co-benefits should also be acknowledged and factored into scenario analysis, which should also include projections on job creation through energy efficiency, repairs, retrofits, and electrification. These omissions represent not only a failure of analysis, but a failure of imagination. The full Business Diversification Study must rectify this problem.

B. High Decarbonized Gas Scenario

With respect to decarbonizing PGW's gas distribution business, the Draft Materials state that the Business Diversification Study will evaluate four full decarbonization scenarios, namely, scenarios relying on (1) high levels of decarbonized gas; (2) high levels of electrification; (3) a

hybrid of electrification and decarbonized gas; and (4) a hybrid of electrification, decarbonized gas, and networked geothermal.[22]

1. Cost, Production, and Supply Constraints

The Draft Materials note that decarbonized gases, including biomethane, hydrogen, and synthetic natural gas, are highly expensive and that a high decarbonized gas scenario is undesirable because it "poses unsustainable bill impacts[.]"[23] However, the Draft Materials do not adequately acknowledge the additional challenge of whether a sufficient supply of decarbonized gas would be available to meet a high proportion of PGW's full system needs at any feasible price.

The gas industry's own analyses show that there is projected to be only enough supply of biomethane and synthetic natural gas to meet a fraction of current gas demand. As a study by the American Gas Foundation demonstrated, even if production of biomethane and synthetic natural gas was fully ramped up, it could only supply between about 5.3% and (under the most optimistic possible conditions) 12% of current demand.[24] Reaching that 12% proportion would, the study projects, require until 2040 to build out production facilities, if such buildout occurs at all.[25] These production limitations create a serious supply bottleneck, at least at a level of pricing that would be reasonable to include in production modeling.

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[22] Draft Materials at Slide 29.
[23] *Id.* at Slide 47.
[24] American Gas Foundation, *Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment*, at 2 (Dec. 2019), https://perma.cc/8JM4-CWC4 ("AGF Study"). The AGF Study estimates total resource potential for both biomethane and synthetic natural gas in 2040 to be between 1,660 tBtu (low scenario) and 3,780 tBtu (high scenario). According to the U.S. Energy Information Administration ("U.S. EIA"), total U.S. gas consumption in 2019 equals 31,099 tBtu. U.S. EIA, *Natural Gas Explained*, https://perma.cc/QPU8-4Q9G. Biomethane and synthetic natural gas together there have a resource potential that ranges from 5.34% (1,660 tBtu / 31,099 tBtu) to 12.15% (3,780 tBtu / 31,099 tBtu).
[25] AGF Study at 2.

Hydrogen faces similar constraints. Critically, the ability of natural gas infrastructure to safely carry hydrogen is limited. The California Energy Commission has estimated that a natural gas distribution system can only safely tolerate a mix of up to 7% of hydrogen by volume before expensive safety upgrades would be needed.[26] The Draft Materials state that they assume a blend of 7% of hydrogen by volume.[27]

Given the supply limitations described above, this leaves a substantial gap. But Draft Materials claim that in a high decarbonized gas scenario, all decarbonized gas needs other than those met by biomethane and hydrogen would come from synthetic natural gas, a technology that the Draft Materials note is "not yet commercialized."[28] The Draft Materials do not state when sufficient supplies of synthetic natural gas, at a feasible cost, will become available, if they ever do. As noted above, the most optimistic scenario envisaged by the American Gas Foundation projects that both biomethane and synthetic natural gas, combined, could only supply up to 12% of current gas demand, assuming production facilities for those gases are ramped up to their maximum.

Since the Draft Materials do not establish if or when, in light of projected production limitations, a sufficiently large supply of synthetic natural gas will ever become available at a feasible cost to make a high decarbonized gas scenario workable, the high decarbonized gas scenario should be discarded as speculative and unsupported. However, if the City intends to contend that a high decarbonized gas scenario is appropriate to include on a list of potential PGW futures, the City should show how and why it reasonably believes that such a large supply of decarbonized gas could be procured at a feasible cost.

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[26] California Energy Commission, The Challenge of Retail Gas in California's Low-Carbon Future, at 24 (Apr. 2020), https://ww2.energy.ca.gov/2019publications/CEC-500-2019-055/CEC-500-2019-055-F.pdf.
[27] Draft Materials at Slide 63.
[28] *Id.*

2. Indoor Air Quality Issues

The Draft Materials' discussion of the high decarbonized gas scenario also contains no plan for how to address the serious indoor air quality problems posed by reliance on the combustion of decarbonized gases. As Slide 29 recognizes, using decarbonized gas for customer end-uses faces all the same indoor quality problems as using natural gas.[29] As Dr. Walter Tsou of Physicians for Social Responsibility testified on May 11, "there are significant health impacts of burning gas indoors," particularly to "young children whose lungs are still developing and will breathe in twice the indoor air relative to the size of their lungs compared to adults."[30]

Cooking with a natural gas combustion stove emits air pollutants that cause asthma, wheezing, and "decreased respiratory function."[31] One meta-analysis found that children living in a home that uses gas for cooking have a 42% higher risk of having asthma.[32] Additionally, these public health impacts are inequitably distributed, as residents of low-income homes are hit the hardest, because low-income homes tend to be smaller and have kitchen stoves that are less well ventilated.[33]

In contrast, a recent study by the Commonwealth of Massachusetts found that broad electrification efforts can have substantial public health benefits. That study found that complete electrification of heating in Massachusetts would have public health benefits of (1) annually

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[29] *Id.* at Slide 29.
[30] May 11 Tr. at 63:9–24.
[31] Jenifer M. Logue et al, *Pollutant Exposures from Natural Gas Cooking Burners: A SimulationBased Assessment for Southern California*, at 4 (June 2014), https://www.osti.gov/servlets/purl/1163745/; Julie Chao, *Pollution in the Home: Kitchens Can Produce Hazardous Levels of Indoor Pollutants* (July 23, 2013), https://newscenter.lbl.gov/2013/07/23/kitchens-can-produce-hazardous-levels-of-indoor-pollutants/.
[32] Weiwei Lin et al, *Meta-analysis of the effects of indoor nitrogen dioxide and gas cooking on asthma and wheeze in children*, 42 Int'l J. of Epidemiology 6 (2013), https://academic.oup.com/ije/article/42/6/1724/737113#12981970.
[33] Steven Mufson, *The battle over climate change is boiling over on the home front*, Washington Post (Feb. 23, 2021) ("Washington Post Article"), https://www.washingtonpost.com/climate-environment/2021/02/23/climate-change-natural-gas/.

avoiding 200 deaths from cardiovascular and respiratory illness; (2) annually avoiding 12,400 days of work absences; and (3) annually saving $2.2 billion in healthcare costs.[34] The final Business Diversification Study should contain a similar evaluation of the public health benefits of electrification and the public health costs of relying on natural gas or decarbonized gas.

The Draft Materials assign a "yellow" middle rating to the high decarbonized gas scenario, because it brings "no significant change" to the indoor air quality problems caused by natural gas.[35] However, the public, as clearly shown in survey results, has rated action on indoor air quality among its top priorities for the Business Diversification Study.[36] Failing to take any action on air quality should, properly, be assigned a "red" lowest rating on air quality. The harmful status quo is not acceptable, and Business Diversification Study should not suggest otherwise.

3. Failure to Ensure Equitable Access to Electrification

A further problem with the high decarbonized gas scenario is that it unrealistically assumes that more privileged customers will not begin to electrify on their own in the face of rising gas costs, particularly from the more expensive varieties of decarbonized gas which the scenario assumes will be put into use. This will create an inequitable dynamic in which those who do not have access to the private capital needed to electrify are "left behind" on the gas network with indoor air quality problems and the rising infrastructure costs that are sometimes referred to as a "death spiral." Such an unplanned electrification process would be unjust and inequitable.

[34] Commonwealth of Massachusetts, *Massachusetts 2050 Decarbonization Roadmap*, at 43 (Dec. 2020) ("MA Decarbonization Roadmap"), https://www.mass.gov/doc/ma-2050-decarbonization-roadmap/download.
[35] Draft Materials at Slide 29.
[36] *Id.* at Slide 26.

In contrast, a high electrification pathway that is supported by public policy interventions and business model changes ensuring equitable access to electrification avoids these problems. There is no question that the privileged will have access to electrification. The only question is whether the City is willing to do the analysis and take the steps to ensure that electrification is accessible to all. How such an equitable approach to a high electrification scenario could be modeled is discussed further below.

C. High Electrification Scenario

Given that decarbonized gas, under even the most optimistic possible conditions, could likely only ever supply a small proportion of current gas demand,[37] the Business Diversification Study needs to take a more serious and detailed look at the high electrification scenario. The hybrid electrification/decarbonized gas scenario is discussed further below, but even under that scenario, given the limitations on decarbonized gas supply, the City would effectively be facing a high electrification scenario, which will require many of the same policy approaches and business model adjustments needed for that scenario.

An additional reason why the high electrification scenario should be studied in more detail is that electrification has overwhelming stakeholder support. As the Draft Materials show, electrification has over 70% support, substantially higher than any other energy direction, including a hybrid electrification-decarbonized approach (about 50% support) and a decarbonized gas approach (about 40% support).[38]

1. <u>Incomplete Affordability Analysis</u>

[37] *See supra* Part III.B.1.
[38] *Id.* at Slide 23. The Draft Materials do not provide any quantitative data from survey, but present survey results in a bar chart on Slide 23 with the specific percentages for scenarios left unlabeled, necessitating the above estimates.

The Draft Materials assign a yellow-coded middle rating to high electrification's impact on affordability, but fail to support this conclusion.[39] Notably, the Draft Materials indicate that they are assuming the current size and cost of PGW's current infrastructure will only increase out to 2050.[40] However, the Draft Materials do not explain why it is reasonable to assume that if the City decides to pursue a high electrification decarbonization pathway, PGW would also simultaneously need to indefinitely maintain a gas distribution system at 100% of its current size.

In order to be relevant and useful, any study of a high electrification scenario must model and factor in the cost savings possible through shrinking PGW's gas distribution infrastructure as it is replaced by electrification. Simply put, it is unreasonable to expect ratepayers to continue to pay for infrastructure that is not needed or used.

If under the high electrification scenario, ratepayers are not unreasonably saddled with continuing to pay to maintain PGW's entire current gas infrastructure for the next 30 years, the evidence shows that high electrification is a highly cost-effective way for residents to power their heating needs. As Slide 33 shows, over the long term, residents who electrify save money compared to continuing to use gas.[41]

This is consistent with findings by the Commonwealth of Massachusetts, which recently published a report detailing its roadmap to achieve net zero emissions by 2050.[42] As the report concluded, "[e]lectricity is the least-cost means of supplying zero-carbon energy, and in many cases, electrification also increases energy efficiency."[43]

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[39] *Id.* at Slide 31.
[40] *Id.* ("Electrification causes a shift of fixed gas system costs to customers who are not able to electrify[.]"). *See also*, *id.* at Slide 36, showing PGW's gas system costs increasing steadily out to 2050.
[41] Draft Materials at Slide 33.
[42] MA Decarbonization Roadmap at 4.
[43] Commonwealth of Massachusetts, *Energy Pathways to Deep Decarbonization: A Technical Report of the 2050 Decarbonization Roadmap Study*, at 1 ("MA Pathways to Deep Decarbonization Technical Report") (Dec. 2020), https://www.mass.gov/doc/energy-pathways-for-deep-decarbonization-report/download.

As the Massachusetts report also concluded, "[a]cross a wide range of potential futures, electrification of end uses, particularly space heating through the use of electric heat pumps, was found to be the most economically advantageous and cost-effective decarbonization strategy for widespread deployment across the Commonwealth's building sector, especially for residences and homes[.]"[44]

Finally, it is also important to note, for the purposes of affordability analysis, that electric heat pumps offer an additional benefit beyond what a gas furnace can provide: they offer affordable, highly-efficient cooling as well.[45] Particularly as temperatures rise, extending the access of low-income residents to affordable cooling services, who might otherwise rely on inefficient window or portable air conditioning units, or go without, has important financial and public health benefits that must be factored into an affordability analysis.[46]

Another critical omission is any modeling of adjustments to PGW's business model in assessing the affordability impacts of the high electrification scenario. The only slide in the Draft Materials that provides any discussion of the affordability impacts of high electrification is Slide 31, which contains an express admission that the analysis does not factor in any "diversifying strategies for PGW."[47] Yet in any imaginable scenario in which the City decided to pursue the high electrification option, PGW's business model would need to be completely transformed.

The Draft Materials do not contain any modeling of options for that business model transformation, but it is essential that the Business Diversification Study does. The public

[44] MA Decarbonization Roadmap at 45.
[45] Commonwealth of Massachusetts, *Building Sector Report: A Technical Report of the Massachusetts Decarbonization Roadmap Study*, at 19 (Dec. 2020) ("MA Building Sector Decarbonization Technical Report"), https://www.mass.gov/doc/building-sector-technical-report/download.
[46] MA Pathways to Deep Decarbonization Technical Report at 45 ("For example, switching to an air-source heat pump provides space cooling benefits, with measurable public health benefits, likely directed to underserved communities, in the face of a warming climate.")
[47] Draft Materials at Slide 31.

deserves and needs a real study of the high electrification scenario that includes careful attention to and modeling of the business model options that can realize that vision in a just and equitable way.

The omission of business diversification strategies from the affordability assessment also appears to produce misleading conclusions about affordability in the Draft Materials. Slide 29, which contains a master chart of the ratings for all four evaluated scenarios, contains no disclaimer informing readers that the affordability ratings exclude the potential positive effects of business diversification strategies. It is only upon careful review of Slide 31, which discusses the affordability rating for the high electrification scenario, that it is disclosed that the rating ignores the affordability benefits of business diversification strategies. As noted above, what is really needed is actual modeling of such strategies. However, since the affordability ratings reflected in the master chart on Slide 29 do not include potential benefits of business model adjustments, at a minimum, this must be communicated to the reader with a prominent disclaimer.

Furthermore, the affordability evaluation of the high electrification scenario also appears to completely exclude the role of public policy interventions in protecting low-income ratepayers. However, it is not realistic to assume that if the City pursues the high electrification pathway, it would take zero action to protect low-income ratepayers. A more useful approach for the Business Diversification Study would be to model the effects of different policy interventions the City could deploy, to help identify the most effective ones. As noted above, the Philadelphia Energy Authority's Built to Last program represents a promising paradigm.[48]

Additionally, Slide 64, which presents an "Energy Cost Comparison," is also misleading.[49] Although the headline of the slide announces that it addresses "rate affordability,"

[48] Built to Last Overview.
[49] Draft Materials at Slide 64.

the slide actually only contains information about the projected per-unit cost of electricity and gas over time.[50] As the slide notes, the chart does not include as part of the "Energy Cost" for gas the monthly fixed charges that must be paid for gas service.[51] As the slide also notes, the per-unit cost of energy is not a particularly relevant criterion for customers, because highly efficient electric heat pumps use many fewer units of energy than gas heating systems.[52]

On the contrary, residents concerned with "rate affordability" need to know the monthly total cost of different energy options, not the per-unit cost of energy supply for a fictional world in which all home heating system types consume an identical number of units of energy and in which gas customers pay no fixed monthly charges. Accordingly, this chart should be removed and replaced with a chart of average monthly total energy cost projections, which includes consideration of per-unit energy costs but also properly considers average energy consumption as well as the monthly fixed charges that residents would have to pay for gas service.

2. Incomplete Revenue Analysis

On Slide 38, the Draft Materials discuss revenue impacts from electrification.[53] Electrification is assigned the lowest "red" ranking on revenue impacts.[54] The slide notes that "new revenue sources and business models" will be needed to cover PGW's system costs.[55] However, like the discussion of affordability, the treatment of revenue impacts suffers from the same two flaws: (1) it unreasonably assumes that under a high electrification scenario, PGW will continue to pay enormous sums to maintain a gas distribution system of identical size out to 2050 even while nearly all its customers electrify, and (2) it unreasonably fails to examine whether or

[50] *Id.*
[51] *Id.*
[52] *Id.*
[53] *Id.* at Slide 38.
[54] *Id.*
[55] *Id*.

not new business models could meet PGW's revenue needs, particularly where PGW's infrastructure cost fall as the size of its gas distribution system is reduced over time.

It does not take much analysis to determine that if PGW changes none of its costs, removes its traditional revenue source, and adds no new revenue sources, it will experience negative revenue impacts. But these assumptions are not realistic, as no gas utility decarbonization process would ever unfold in such a fashion. What is needed instead is real business modeling of (1) potential infrastructure cost reductions and (2) potential revenue streams available from different business diversification strategies. The Draft Materials failed to perform these tasks. The Business Diversification Study can, and must, do better.

As Slide 38 itself recognizes, there are numerous potential business diversification options consistent with high electrification that could produce additional revenue for PGW, including heat as a service, weatherization and energy efficiency services, strategic electrification, utility-led financing options, and networked geothermal.[56] All of these options, as well as other options discussed elsewhere in the Draft Materials, such as developing community solar projects,[57] must be modeled in order to understand what the revenue impacts (and opportunities) of a high electrification scenario would be. Concluding that a high electrification future will have large revenue impacts on PGW depends on ignoring the potential revenue generation from the many diversification strategies consistent with high electrification. This is not appropriate for a Business Diversification Study, which should be centrally focused on assessing the possible revenue from different diversification options, in order to support an informed choice between those options.

[56] *Id*.
[57] *Id*.

Accordingly, since the Draft Materials contain no information on whether or not, under a high electrification scenario, potential cost reductions paired with new additional revenue streams could meet PGW's revenue needs, the "red" lowest rating for high electrification in the revenue impacts area should be removed, because it is unsupported. That rating should be filled in based on actual business modeling once completed.

D. Hybrid of Electrification and Decarbonized Gas Scenario

The Draft Materials' discussion of the hybrid electrification-decarbonized gas scenario also suffers from the same twin flaws of assuming all of PGW's infrastructure costs stay the same and that PGW gains no new revenue sources from business diversification opportunities.[58] Having discussed those flaws at length above, these Comments will not dwell on them further here.

1. Missing Proportionality Analysis

One problem particular to this hybrid scenario is that the Draft Materials do not make clear the modeling assumptions supporting the projected amount of demand that would be met with decarbonized gas. Slide 63 suggests that the hybrid scenario analysis assumes that 25% of annual heating demand will be met by decarbonized gases, primarily biomethane.[59] The basis for determining this percentage is unclear, and should be further explained in the Business Diversification Study.

However, given the serious cost and supply constraints on decarbonized gas, especially biomethane, there are serious questions about whether meeting such a 25% proportion of demand would be feasible.[60] It should be further explained how and why it is reasonable to assume that

[58] Draft Materials at Slide 32.
[59] *Id.* at Slide 63.
[60] *See supra* Part III.B.1.

those constraints will be overcome. If they are not, a hybrid electrification-decarbonized gas scenario may very well end up very similar to the high electrification scenario, requiring many of the same infrastructure cost reductions and business model adaptations. The Business Diversification Study, to be useful, must grapple with these issues.

2. Redundancy Issues

The Draft Materials also indicate that the hybrid electrification-decarbonized gas scenario under review assumes that residents that have installed electrified heating and cooking solutions will also keep their gas furnace and will use decarbonized gas for heat "during the coldest periods of winter."[61] The Draft Materials state that heat pumps "are sensitive to outside temperature" and thus a gas furnace is needed "as a backup source of heat."[62]

However, the Draft Materials provide no technical basis for their claim that heat pumps cannot work in cold temperatures. In contrast, the Commonwealth of Massachusetts recently studied options for achieving full decarbonization by 2050, and concluded that heat pumps are an extremely efficient and effective way to meet the heating (and cooling and dehumidification) needs of Massachusetts residents:

> As systems that can provide heating, cooling, and dehumidification, electric heat pumps provide a single-equipment solution for meeting the entire typical range of building space conditioning needs. And they can do so extremely efficiently: by extracting and moving ambient heat, rather than producing it through combustion, currently-available heat pumps can deliver two to six times the amount of energy that they consume year-round, including during periods of bitter cold winter weather. This high level of energy efficiency drives the cost-effectiveness of heat pump technology, particularly as an affordable solution for widespread deployment.[63]

[61] Draft Materials at Slide 17.
[62] *Id.*
[63] MA Decarbonization Roadmap at 45.

As the Commonwealth of Massachusetts has confirmed, heat pumps have been "proven to work as a building's only heating source."[64]

It is worth noting that Massachusetts, located to the north of Pennsylvania in a colder climate zone, typically experiences colder winters than Pennsylvania. It is unclear why heat pumps, which work very well in Massachusetts winters, could not work equally well in Philadelphia winters.

It is also notable that the Draft Materials do not describe, under the high electrification scenario, any problem at all with residents fully relying on electrified heat. As such, it is also unclear why the Draft Materials assume that only when residents electrify under the hybrid scenario (but not under the high electrification scenario) do those residents also need to keep their gas appliances and periodically use them.

In general, it is unclear why, technologically, heat pumps could not serve as a building's sole heat source. It is possible that in certain buildings, installation of a heat pump sized properly to meet a building's full heating needs may be very expensive or impossible, and if that is the case, the modeling should adopt a reasonable estimate of the number of such buildings and factor that in.

However, the Draft Materials' apparent assumption that all heat pumps installed in all buildings under a hybrid scenario need to have "backup" from gas heat for when the weather gets cold in unsupported. If that assumption is dropped, the study must supply an alternative reason why the entire current gas network must be maintained under the hybrid scenario, at great cost to ratepayers.

[64] MA Building Sector Decarbonization Technical Report at 19.

Finally, it should be noted that if nearly all Philadelphians switch to heat pumps for heating, this may require additional some investment in the electric distribution grid to support the increased winter electric demand. Yet the amount of the added investment needed may turn out to be relatively small. The distribution grid is already built out to handle heavy summer electric demand, with peaks driven by air conditioning. Additionally, "peak management" technologies such as energy efficiency, demand response, and energy storage can help reduce the costs of adapting the grid. Further, as residents transition off gas, the gas network can be gradually decommissioned, providing savings on gas infrastructure costs. All of these factors should be considered as part of an "apples to apples" comparison of the costs of a high electrification scenario to other scenarios. However, it is difficult to imagine how any necessary electric distribution grid investments would come close to or exceed the infrastructure costs of maintaining a full-sized gas distribution network indefinitely.

E. Hybrid of Electrification, Decarbonized Gas, and Networked Geothermal Scenario

The final scenario assessed in the Draft Materials is a hybrid that combines electrification, decarbonized gas, and networked geothermal. Like the other scenario assessments, it should be noted that this one too suffers from a failure to assess the possibility of shrinking PGW's total system size and a failure to model the amount of revenue potentially available to PGW from business diversification strategies. Since these matters are addressed above, they will not be addressed again here.

The primary problem specific to this assessment is its lack of detail. The Draft Materials provide little information about how networked geothermal might work as part of PGW's future, and note that "[a]dditional research on this concept is required."[65] Although Slide 34 indicates a

[65] Draft Materials at Slide 34.

high-level estimate of residents that could be served by networked geothermal, no basis is provided for that estimate, which likely understate the potential of networked geothermal.[66] Further research is indeed required, which is part of why a networked geothermal pilot, as discussed further below, is important.

One framing issue that should be corrected is that networked geothermal is discussed only as part of a hybrid with both electrification and decarbonized gas. However, there is no basis to conclude that networked geothermal should only be studied as part of a scenario also including decarbonized gas. Networked geothermal systems do not use gas for any function, but instead use electricity to move water through pipes underground. As such, networked geothermal systems are fully consistent with a high electrification future, and if PGW were to engage in the installation and maintenance of networked geothermal systems, this added revenue opportunity could be an ideal component of a business diversification strategy supporting a high electrification scenario. Unless it is shown that there is some need or gap that only decarbonized gas can fill, it should not be assumed that networked geothermal can only be studied alongside decarbonized gas.

Finally, as a technical note, the Draft Materials mischaracterize the functioning of networked geothermal technology (which the Draft Materials refer to as "Geothermal MicroDistricts").[67] Slide 3 states that networked geothermal systems carry "piped hot water" between multiple buildings.[68] This is inaccurate. In fact, networked geothermal systems can carry water of varying temperatures, which is important because this means they can provide not just heating, but also cooling services, like air source heat pumps.

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[66] *Id.*
[67] *Id.* at 3.
[68] *Id.*

This has design and engineering implications, because the most efficient design of a networked geothermal system is to link buildings with different heating and cooling needs, such as residences, offices, and businesses, in order to be able to store heat shed from cooling one location and transfer it later to another location to provide heating.[69] As the nonprofit HEET explains, "[i]magine a supermarket with its fridges humming all the way through the winter. It's going to be rejecting heat into that shared loop of water, making the water hotter. That heat can then be used by the homes down the street."[70]

Finally, it should be noted that infrastructure costs for networked geothermal could be recouped over very long time-frames. Drilling the necessary boreholes will require a considerable upfront expense, but those boreholes will last many decades and require little maintenance. Additionally, the City should explore options for incorporating water mains and sewage pipes into networked geothermal systems, a task for which PGW could partner with the Philadelphia Water Department.[71] If some heat pumps within the system transfer heat into and out of water mains or sewage pipes, that could reduce the need to drill boreholes. Fewer boreholes would mean a lower capital cost for the system.[72]

IV. The City Should Pursue a Networked Geothermal Pilot Program

A. Developing a New Revenue Source

The City has committed, as part of its plan to take action to decarbonize PGW, to pursue a pilot program informed by the findings of the Business Diversification Study.[73] Networked

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[69] HEET Written Testimony, at 6–7 (May 11, 2021) ("HEET Testimony"), https://www.dropbox.com/s/2vc5y27dezs7l3d/HEET%20Written%20Testimony%2005-11-21.pdf?dl=0.
[70] *Id.* at 6.
[71] Lilli Ambort & John Farrell, *Water Main Geothermal: Could Existing Water Pipes Replace Dirty Energy Utilities?*, at 7–9, Institute for Local Self-Reliance (Oct. 2020), https://ilsr.org/report-water-main-geothermal/.
[72] *Id*.
[73] City of Philadelphia, *PGW Business Diversification Study Kicks Off* (Sept. 2, 2020), https://perma.cc/3HXV-WRRZ.

geothermal technology is an ideal candidate for such a pilot, due to a number of key characteristics. First, networked geothermal represents a potential new decarbonized revenue source for PGW. As the Draft Materials indicate, a key challenge for PGW in decarbonizing is setting up new revenue streams to replace its traditional revenue source, distributing gas. Networked geothermal is a promising candidate. A networked geothermal system can repurpose existing gas distribution lines and rights of way to instead carry water that can be used to provide heating and cooling using geothermal energy. PGW could pilot a "heat and cooling as a service" business model by repurposing portions of its infrastructure to provide networked geothermal heating and cooling to residents and businesses. This would allow such repurposed infrastructure to not simply be a cost center, but a tool to generate revenue in a decarbonized future.

B. Providing and Maintaining Union Jobs

Second, networked geothermal provides an opportunity to provide and maintain union jobs for PGW workers. Much of the labor required to install and maintain a networked geothermal system draws on skills similar to those needed for working with gas pipes, which PGW's union workforce has. A networked geothermal pilot would be a "shovels in the ground" project that could put such skilled union labor to work building a sustainable future for PGW.

C. A Learning Opportunity

Networked geothermal pilots are underway or under consideration in a number of jurisdictions, including Massachusetts[74] and New York,[75] all of which provide opportunities that the City could learn from in designing its own pilot. Moreover, the nonprofit HEET convenes a

[74] Justin Gerdes, *Massachusetts Pilot Project Offers Gas Utilities a Possible Path to Survival*, Greentech Media (Aug. 6, 2020) https://www.greentechmedia.com/articles/read/can-gas-companies-evolve-to-protect-the-climate-and-save-their-workers.
[75] Samantha Gilman, *New York, Massachusetts Utilities Investigate Potential New Business Model: Community-Scale Geothermal*, Electric Power Research Institute (Jan. 26, 2021), https://energycentral.com/o/EPRI/new-york-massachusetts-utilities-investigate-potential-new-business-model.

consortium on networked geothermal deployment, including representatives from jurisdictions implementing pilots, that the City could participate in and learn from.[76]

While there is abundant information available on best practices from the above sources, a networked geothermal pilot in PGW's service territory would provide an essential learning opportunity for how such best practices could be applied here. While networked geothermal may provide a "win-win-win" combination of decarbonizing, generating revenue, and providing union jobs, it will take experimentation to test out its prospects and to assess opportunities to scale. A properly designed and resourced networked geothermal pilot program could provide that opportunity.

V. Further Public Participation is Essential to the Just Transition of PGW

A. The City Must Provide a Full Draft of the Study for Public Comment

Further public participation is essential to the just transition of PGW to a fully decarbonized future. To start, the public must have an opportunity to provide feedback and comments on a full draft of the Business Diversification Study. As noted above, the City promised this opportunity. In the City's own words, the City committed to the following: "Issue drafts of the outline and study: Like the City's process for receiving feedback on regulations, drafts of the outline and study will be available for public review and comment."[77]

With all of the information missing from the Draft Materials, not providing a full draft of the Business Diversification Study is effectively locking the public out of participating in its creation. Providing a set of PowerPoint slides describing the study is not an adequate substitute for providing a full draft of the study as promised.

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[76] HEET, HEET Community Charrettes, https://heet.org/2021/03/01/heet-community-charrettes/.
[77] City of Philadelphia, *PGW Business Diversification Study Kicks Off* (Sept. 2, 2020), https://perma.cc/3HXV-WRRZ.

A solution to this problem would be to schedule a hearing at which members of the public can submit oral and written comments on a full draft of the Business Diversification Study. Then, the City can consider those comments, respond to them, and create a final draft of the Business Diversification Study. Given the complex challenges involved in decarbonizing PGW, providing incomplete information to the public for comment will not generate the insights and forge the trust needed to navigate this process. Instead, a just transition needs transparency and a full and open engagement with public comment.

Another important step is to make publicly available all of the written comments the City receives on the Draft Materials. This ensures that members of the public can learn from the written comments of others, which improves everyone's ability to participate in the discourse about PGW's future. Similar to the process used in environmental impact review, the City should include as appendices to the final study a transcript of oral comments, a compendium of written comments, and a chart indicating how the City has responded to each oral and written comment. Given the stakes of PGW's transformation, it is important that the City show that it is treating comments from the public seriously in such a fashion.

B. The City Must Hold Hearings to Determine Changes to PGW's Business Model in Light of the Study's Findings

It is also important that public participation continues after the finalization of the Business Diversification Study. For all of the work that has and will go into the study to have meaning, it must be translated into action, and the public must have a role in formulating that action. As the Draft Materials indicate, the option for PGW's future with the highest level of stakeholders "very opposed," and the lowest level of stakeholder support, is "[c]ontinuing current business model."[78]

[78] Draft Materials at Slide 24.

As such, after the Business Diversification Study is concluded, the City should promptly convene hearings on how PGW's business model will be adjusted in 2022 in light of the findings of the Business Diversification Study. These hearings need to address several key topics. As a starting point, they should address changes to PGW's business plan to include implementation of a business diversification pilot. But just as importantly, PGW's business plan must be changed to begin the process of aligning with the City's policy of full decarbonization by 2050 at the latest. That date may seem far off, but PGW is currently in the process of building out hundreds of millions of dollars in gas infrastructure investments with a useful life of far past 2050. To reduce stranded asset risks and ensure ratepayer dollars are prudently invested, PGW must begin thinking about how to realign and redesign its business now.

This process is time-sensitive. PGW will next be able to file for a rate increase on January 1, 2022.[79] PGW should not be allowed to raise rates on residents again without having a plan in place to ensure that ratepayer dollars will be invested prudently and consistent with City policy, and not poured into more gas infrastructure likely to become stranded assets in a decarbonized future. Moreover, there are steps that can and should be taken immediately, such as banning gas connections in new construction and eliminating incentives for new gas appliances, that reduce stranded asset risks and prevent the costs of decarbonization from growing.

As such, the City must take swift action to initiate a participatory public process for transforming PGW's business plan to be consistent with a decarbonized future. This process should start with hearings on changes to PGW's business plan to be implemented in 2022, but the process must be ongoing.

[79] Pennsylvania Public Utility Commission, Order and Op. at 22 (Nov. 19, 2020), https://www.puc.pa.gov/pcdocs/1684745.docx.

VI. The City Should Order PGW to Stop Working Behind the Scenes to Preempt the City from Implementing the Business Diversification Study

Finally, it is also essential to a just transition that PGW engage with the City and the public with transparency and a spirit of partnership. However, it appears that PGW has, instead, worked behind the scenes to preempt the City's ability to implement the Business Diversification Study.[80] It is concerning to note reports that PGW has attempted to persuade parties to testify in favor of a Senate bill by Senator Gene Yaw that seeks to preempt municipalities from adopting policies to transition off of natural gas, known as Senate Bill 275.[81] PGW has also refused to release, pursuant to a Pennsylvania Right to Know Request, records regarding discussions it had involving "strategy used to develop or achieve the successful adoption of Senate Bill 275."[82]

PGW is also an active member and major contributor to the Energy Association of Pennsylvania ("EAP"), which has strongly supported passing Senator Yaw's municipal preemption bill. Terrance J. Fitzpatrick, President of the EAP, testified in favor of the Yaw municipal preemption bill, and listed in his testimony PGW as among the EAP members supporting passage of the bill.[83]

PGW is, moreover, an active member and major contributor to the American Gas Association ("AGA"),[84] which has invested heavily in attempting to pass similar municipal

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[80] Susan Phillips, *As Philadelphia works to tackle climate change, a question emerges: Is PGW on board?*, WHYY (May 28, 2021) https://whyy.org/articles/as-philadelphia-works-to-tackle-climate-change-a-question-emerges-is-pgw-on-board/; Andrew Maykuth, *Can Philadelphia's gas utility survive in a climate where fossil fuels are shunned?*, Philadelphia Inquirer (May 11, 2021) ("Inquirer Article") https://www.inquirer.com/business/philadelphia- gas-works-climate-study-decarbonization-20210511.html; Jeremy Deaton, *Philly Wants to Wean Off Gas. The City-Owned Gas Utility Is Refusing to Go Along*, Nexus Media News (Mar. 22, 2021) ("Nexus News Article"), https://nexusmedianews.com/philadelphia-gas-utility-climate-change/.

[81] Inquirer Article.

[82] PGW, *Exhibits to Brief of PGW in Opposition to Appeal of Charles Spatz*, at 2 (Apr. 29, 2021), https://www.documentcloud.org/documents/20791392-pgw-exhibits-to-brief-of-pgw-in-opposition-to-appeal-of-charles-spatz#document/p2/a2037128.

[83] Terrance J. Fitzpatrick, *Comments – Joint Public Hearing to Discuss Senate Bill 275(Energy Choice)*, EAP (May 11, 2021), https://perma.cc/5WB9-CMFM.

[84] American Gas Association, Invoice for Philadelphia Gas Works (Sept. 28, 2018), https://www.documentcloud.org/documents/20787119-pgw-dues.

preemption bills around the country and which actively develops playbooks of strategies to fight municipalities that try to transition off of natural gas.[85] As the Washington Post recently reported, while many cities and towns are considering requiring new buildings to be electrified, "the American Gas Association...and its members are campaigning in statehouses across the country to prohibit the new local ordinances."[86]

In contrast, City Council passed a resolution calling upon the General Assembly to reject the Yaw municipal preemption bill, which City Council found "would restrict municipalities from addressing climate change through legislating energy and heating infrastructure requirements."[87] City Council further found that taking away such tools from municipalities would interfere with their ability to "protect the most vulnerable ratepayers" and to "proactively explore ways to clean, green, and investing in our infrastructure, including for heating and cooking[.]"[88]

As explained by Charlie Spatz, a researcher at the Climate Investigations Center, "When you pay your gas bill in Philadelphia, Philadelphia Gas Works is taking that money and spending it on dues for groups like the American Public Gas Association and the American Gas Association, which are then doing things to fight against electrification. The gas utility is pretty at odds with the actual policies of the Mayor's Office and the City Council."[89]

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[85] Washington Post Article; Jeff Brady & Dan Charles, *As Cities Grapple with Climate Change, Gas Utilities Fight To Stay In Business*, NPR (Feb. 22, 2021), https://www.npr.org/2021/02/22/967439914/as-cities-grapple-with-climate-change-gas-utilities-fight-to-stay-in-business; https://www.nrdc.org/experts/alejandra-mejia/gas-interests-threaten-local-authority-6-states.
[86] Washington Post Article.
[87] City of Philadelphia, Resolution No. 210374 at 1 (Apr. 29, 2021), https://phila.legistar.com/LegislationDetail.aspx?ID=4920953&GUID=3E36B49B-3D34-4221-B99F-90B79B4FAC45&Options=&Search=.
[88] *Id.*
[89] Nexus News Article.

It is not appropriate for PGW, as a publicly owned utility, to use the public's resources to launch a "preemptive strike" against the Business Diversification Study through supporting Senator Yaw's municipal preemption bill or through funding the municipal preemption and anti-electrification advocacy of the AGA. It would not be reasonable for any municipally-owned utility to work to hamstring and limit the municipality that owns it, and the City must not tolerate this behavior.

To begin to repair these harms, PGW must be ordered to immediately terminate any form of funding, lobbying, or advocacy for municipal preemption or against any policy tool the City may need to implement the Business Diversification Study, including electrification. Next, PGW must be ordered to produce a full and public report on any such funding, lobbying or advocacy activities. As Justice Louis Brandeis famously observed, sunlight is the best disinfectant.[90] Having cleared the air in such a fashion, PGW must then re-engage with the City and with the public in a true spirit of partnership and collaborate on the shared project of decarbonization consistent with the City's policy.

VII. Conclusion

As Resolution No. 190728 notes, "[t]he City of Philadelphia must continue to take the lead in advancing proactive climate change solutions."[91] The City of Philadelphia has the opportunity to be a national leader in modeling best practices for decarbonizing a municipally-owned gas utility. It should take the opportunity to do it right. POWER respectfully requests that

[90] Louis Brandeis, *Other People's Money*, Ch. 5 (Dec. 1913), http://louisville.edu/law/library/special-collections/the-louis-d.-brandeis-collection/other-peoples-money-chapter-v.
[91] City of Philadelphia, Resolution No. 190728 at 1 (Sept. 26, 2019), https://phila.legistar.com/LegislationDetail.aspx?From=RSS&ID=4142523&GUID=BA06CC3B-7B43-4743-A07E-515A145C4A2A.

the City address the issues described above, and looks forward to reviewing a draft Business Diversification Study that takes these Comments into account.

May 28, 2021

Respectfully submitted,

/s/

Bishop Dwayne Royster
Executive Director
POWER Interfaith

POWER Climate Justice and Jobs Team

May 28, 2021

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Comments on PGW Diversification Study Draft Materials (April 2021)

Submitted via email to sustainability@phila.gov

Dear Ms. Knapp:

On behalf of The Sierra Club and our more than 2500 members in Philadelphia, many of whom are PGW customers, please accept the following comments on the PGW Diversification Study Draft Materials. Overall we find the results presented in April to be useful in providing some realistic guardrails for the discussion about how and how fast PGW needs to change its operations. *Section I* of these comments focuses on points we find particularly compelling and should provide the basis for near-term policy changes to accelerate electrification of buildings.

That said, the format of the draft as a slide deck rather than a full report causes us to have many unanswered questions about assumptions and the depth of the alternatives analysis. *Section II* elaborates on some of these key questions. We urge the City to address these questions in a draft form subject to additional public comment before any binding decisions are made.

Finally, *Section III* provides recommendations for two pilot programs. We believe both suggestions are compatible with a wide range of scenarios, and will help determine feasible business diversification pathways. Therefore, we urge the City to begin work on both pilots before finalizing any long term business plan for PGW, so that they can inform that plan.

Section I -- Key Findings the Report and Their Implications

Electrification results in significant greenhouse gas (GHG) reduction today

The analysis on Slide 19 unequivocally demonstrates that even with today's grid mix, heating electrification results in significant GHG reduction, and that gap will only increase over time.

Beginning the long and complex process of electrification immediately is a no-regrets, commonsense pathway to meeting the city's 2050 decarbonization commitment. It does not require further grid decarbonization as a prerequisite.

Substitution of decarbonized gas without dramatically reducing demand for gas is unaffordable, perpetuates health risks, and fails to meet the study's decarbonization goal.

Slide 33 clearly demonstrates that simply switching from fossil gas to renewable or decarbonized gas is not an economically feasible solution. Even in the optimistic gas price scenario, the cost to participants is roughly 2.5 times higher than in the electrification scenario, and 50% higher than in the hybrid scenario. There is plenty of reason to believe that the optimistic price scenario is unlikely, as Slide 63 points out that the "synthetic natural gas" (SNG) resources on which the decarbonized gas scenario relies for roughly 70% of its supply are "not yet commercialized." In contrast, air source heat pumps (ASHPs) are not only commercially available now, they are already cost effective for new construction and major renovations in cold climates, and the technology continues to improve.[1,2] It is irresponsibly risky to base policy decisions on the hope that an alternative solution will be developed when a viable (and superior) alternative currently exists.

Heat pumps are superior because SNG suffers from the same health, safety and emissions drawbacks as fossil gas.[3] First, it is flammable and explosive, causing increased building fire hazards,[4] and requiring constant vigilance and expense to prevent future disasters like the explosion in South Philadelphia in December 2018.[5]

Second, combustion creates indoor and outdoor air pollution that is detrimental to health. A recent study from the Harvard TH Chan School of Public Health[6] found that in 2017 the cost of negative health impacts of burning gas in buildings in PA was over $4.2 billion, and resulted in hundreds of premature deaths. A UCLA study found that gas stoves and ovens lead to indoor air pollution levels that would exceed state and federal standards for acute outdoor air pollution

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[1] Billimoria, Sherri, Mike Henchen, Leia Guccione, and Leah Louis-Prescott. The Economics of Electrifying Buildings: How Electric Space and Water Heating Supports Decarbonization of Residential Buildings. Rocky Mountain Institute, 2018, http://www.rmi.org/insights/reports/economics-electrifying-buildings/

[2] Massachusetts 2050 Decarbonization Roadmap, p45. Available at: https://www.mass.gov/doc/ma-2050-decarbonization-roadmap/download

[3] For an in depth discussion of these issues, see: S Saadat, M Vespa, & M Kresowik, 2020, Rhetoric vs. Reality: The Myth of "Renewable Natural Gas" for Building Decarbonization, available at: https://earthjustice.org/sites/default/files/feature/2020/report-decarb/Report_Building-Decarbonization-2020.pdf

[4] National Fire Protection Association, 2018, National Gas and Propane Fires, explosions, and Leaks Estimates and Incident Descriptions.

[5] https://www.inquirer.com/news/south-philly-explosion-fire-cause-gas-main-leak-crack-20200116.html

[6] Buonocore, JJ et al, 2021, A decade of the U.S. energy mix transitioning away from coal: historical reconstruction of the reductions in the public health burden of energy. Environ. Res. Lett. 16 (2021) 054030, available at https://iopscience.iop.org/article/10.1088/1748-9326/abe74c/pdf.

in 90% of homes after just one hour of use.[7] As a consequence, children who grow up in a home with a gas stove are 42% more likely to develop asthma than those who don't.[8]

Most importantly given the objectives of this study, SNG is still primarily methane, which has 86 times the global warming potential of carbon dioxide (CO2) over 20 years.[9] It is just as prone to leaks at all stages from production to delivery as fossil gas. A recent study in the journal Science estimated that methane leaks amount to 2.3% of gross production, and the impact of these leaks on climate over a 20-year time horizon is comparable to that of all the CO2 resulting from methane combustion.[10] **Therefore, even if combustion of SNG is truly carbon neutral, the actual global warming impact of the system as a whole would only be reduced by 50%.** This is clearly not compatible with a net-zero greenhouse gas emissions (GHG) goal.

The renewable natural gas (RNG) scenario clearly will not work. All feasible pathways require massive electrification to get to net-zero emissions. The only question is whether the electrification is complete or not. In any case, we need to begin ambitious electrification programs now.

The high electrification scenario is the least-cost option through 2050

According to Slide 33, it is the only option in which participants save money compared to the BAU scenario. In fact, all other scenarios result in significantly higher costs to PGW customers. The cost to non-participants by 2050 as presented is alarming, but can be significantly mitigated if electrification is coupled with strategic decommissioning of large sections of the gas distribution network. This also requires that PGW immediately ceases investments in replacing its pipeline network (with the exception of fixing safety hazards and large leaks), because there will not be enough time to fully recover the cost of the investment as customers leave the system. Non-participants in this scenario represent only 5% of the customer base. We must prioritize electrification of low-income customers first, in order to ensure that they are not saddled with higher gas prices as the customer base for gas declines, and discuss this further in Section III.

Electrify all new construction for housing affordability

Slide 48 states that "(e)lectrification in newly constructed homes is much cheaper than ***retrofitting existing homes***" [emphasis added], which is intuitive. While not explicitly stated in

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[7] https://ucla.app.box.com/s/xyzt8jc1ixnetiv0269qe704wu0ihif7
[8] https://pubmed.ncbi.nlm.nih.gov/23962958/
[9] Myhre, G., D. Shindell, F.-M. Bréon, W. Collins, J. Fuglestvedt, J. Huang, D. Koch, J.-F. Lamarque, D. Lee, B. Mendoza,T. Nakajima, A. Robock, G. Stephens, T. Takemura and H. Zhang, 2013: Anthropogenic and Natural Radiative Forcing. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Table 8.7. Available at: https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf
[10] Ramon A. Alvarez et al., Assessment of Methane Emissions from the U.S. Oil and Gas Supply Chain, 361 Science 186, 186–188 (July 13, 2018), https://science.sciencemag.org/content/361/6398/186.

the draft, it is also cheaper to build and maintain all electric new homes than new homes which rely on both electricity and gas, as the cost of external and internal pipelines, connections, and meters can be avoided entirely. The cost of supplying gas to a new home increases the cost of the house by over $6400 on average[11] compared to electric-only housing, and most electrical appliances are cheaper than their gas counterparts.[12] Housing affordability is one more reason no new gas connections should be permitted in PGW territory effective immediately.

Major changes to PGW's business model are unavoidable

In all scenarios, PGW needs to find alternative revenue sources, or reduce their budgetary needs (slide 41). Unfortunately, we see no indication in the slide deck that this second option was considered, which is a significant oversight. Furthermore, slide 36 illustrates a seriously flawed assumption that PGW continues to receive (and rely upon) gas-related revenues from sources other than customers, including Gas Transportation Services and Liquified Natural Gas. Neither of these examples is compatible with net-zero GHG emissions - as discussed above, even if methane combustion is carbon neutral, inevitable leaks of intentionally produced methane are not.

Section II -- Major Outstanding Questions and Study Needs

Additional study details must be made available for public comment

The 70-slide presentation was shared in late April and the public was given less than 30 days to provide written comments, and each individual was afforded only two minutes for verbal comments. In addition to the limited amount of time provided for review, the format leaves reviewers guessing on many of the assumptions underlying the analysis. The four scenarios presented represent but a few possible futures, and there is very little sensitivity analysis presented.

We urge the City to release a full draft report for public review and comment, followed by City Council hearings for additional feedback. Because of the complexity of the issue, we expect that additional studies will be undertaken to examine the success of pilot programs, and the impacts of changing technology, policy, and economic factors. The evolution of PGW as a business is not a decision that can be made once and put on autopilot. This draft is but the first phase in a long and iterative process, and all phases must include robust public input opportunities and be followed by meaningful implementation steps.

Why does the revenue requirement not decline in the "High Electrification Scenario"?

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[11] www.synapse-energy.com/sites/default/files/Decarbonization-Heating-CA-Buildings-17-092-1.pdf
[12] Navigant Consulting for the California Building Industry Association, August 2018, Impacts of Residential Appliance Electrification, available at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=224761

The High Electrification Scenario appears to assume that the entire gas distribution network remains in place and in service, which is redundant and wasteful, and essentially translates into a more aggressive hybrid scenario. This would only be necessary if PGW (or any other entity) played no role whatsoever in assisting or coordinating the electrification of its customers, resulting in a random geographic distribution of remaining gas customers, and requiring the same pipeline grid to serve them. This redundancy is completely unnecessary, as the vast majority of buildings along the network would have no access to or need for it.

It would be much more cost effective to divide the gas distribution network into sectors, actively coordinate the complete electrification of each sector, and then decommission the pipes in that sector (or possibly replace them with networked geothermal pipes, if conditions warrant). Sectors which leak more methane or have older pipes that present elevated safety concerns should be prioritized. This strategic downsizing of the system would significantly reduce the revenue requirement by 2050.

A critical early step in this approach would be a street by street detection, quantification, and mapping of fugitive methane over the entire gas utility network in Philadelphia. This would serve both to prioritize areas with large numbers of small leaks for priority decommissioning, and catch dangerous large leaks for emergency repair.

The hybrid electrification scenario as described seems arbitrary and suboptimal, but a more limited, targeted, and temporary role for decarbonized gas could make sense

The “hybrid electrification scenario” presents just one possibility for how decarbonized gas could continue to play a more limited role in a largely electrified city, and we believe other options would be better for both customers and the climate.

The premise of this scenario appears to be that nearly all customers (except a small number of non-participants by 2050) fully electrify clothes dryers, cooking, and water heating, but instead of switching to all electric heat pumps, they purchase hybrid systems that operate on decarbonized gas when the temperature drops below an undefined threshold. Slide 63 states that in this scenario, “Hybrid systems are used to meet “peak heat” demands on cold days, accounting for around 25% of annual space heating demand.” The derivation of the 25% figure is not explained.

The intent of the scenario seems to be to reduce strain on the electric grid during cold weather peaks.[13] However, in so doing, it commits to the perpetual maintenance of a complete gas distribution system ***for the sole purpose*** of meeting cold weather peaks. If this were to become the dominant mode of gas use by 2050 across the northeast, might we run into an even bigger peak demand distribution problem for gas than for electricity, requiring significant upgrades to gas transmission and especially gas storage to maintain reliability? We think it is highly likely

[13] Slide 18 lists “mitigates electric grid impacts” as a potential benefit of the hybrid electrification option, and slide 17 states that “ASHPs are sensitive to outside temperature”. We see no reference to any analysis that cold weather grid problems are actually projected in the electrification scenario.

that the total cost of electric grid reliability upgrades, including storage integration,[14] required for a fully electrified scenario would be lower than the cost of maintaining a parallel gas system that delivers no value for nine months of each year. This is the relevant analysis from the utility customer perspective, but it appears absent from this study.

Furthermore, this scenario depends on customers actually wanting hybrid heating systems that require them to be tethered to and paying for the gas network when they rarely use it. But why would they do this, when slide 33 so clearly projects that they will be paying double the annual heating bill than if they had fully electrified? In reality, those with the financial means will close the gas valve entirely, creating a feedback loop of rising gas rates and more customer flight. The "hybrid scenario" will begin to look more like the "high electrification" scenario based solely on price signals and availability of better alternatives.

While we see no permanent future for decarbonized gas in most buildings, we do see two possible roles:

1. Certain niche applications may be identified for which electrification would be especially expensive, or would result in disproportionately large demand spikes that cause reliability concerns. We imagine these could include some industrial processes, and buildings with exceptionally high ventilation needs or for which weatherization is impractical; and
2. In a transitional role in areas where local electric grid upgrades are planned in the future to accommodate electrification, but have not yet occurred.

Identify programs and policies to ensure electrification access for ALL low-income customers

The Philadelphia Energy Authority's Built to Last (BTL) program[15] is a promising start for addressing this issue, but sustainable funding sources must be identified to move the program beyond the pilot stage and implement it at scale, and to assist customers who rent their homes as BTL is focused on low-income homeowners. As such, possible models for provision of heat as a service by PGW should be piloted (see Section III) until a workable model is identified and scaled up. This needs to be a priority in either the high electrification or hybrid scenario, because in both cases non-participant costs are significantly higher than both participant costs and the status quo.

Under what circumstances is networked geothermal cost-effective to apply relative to air-source heat pumps, and how should costs be allocated?

[14] As transportation electrifies, electric utilities will have strong incentives to enlist electric vehicle owners to both charge during off-peak times and feed electricity to the grid during high demand hours, which will counter demand peaks from building electrification, and create a distributed storage network by default. Consider Ford's recent announcement that its new F150 Lightning is designed to be able to power the average house for the duration of a 3-day outage, which will likely become common among EVs: https://media.ford.com/content/fordmedia/fna/us/en/news/2021/05/19/all-electric-ford-f-150-lightning.html

[15] https://philaenergy.org/wp-content/uploads/2020/08/8-2020-PEA-Built-to-Last-Overview.pdf

The Geothermal MicroDistricts (GMD) scenario is an attractive option, but is projected to only cover about 25% of the customer base in slide 34. It is not clear what assumptions form the basis of this projection, and under what circumstances access to the system could be cost-effectively increased. We strongly agree with the footnote on this slide that additional research is needed.

The question is asked whether the costs of financing and maintaining the system should be borne by the users only, or by the entire customer base. A third option would split the difference. Recognizing that the GMDs offer some system-wide benefits of reducing peak electricity demand, reducing the need for expensive decarbonized gas, and providing an option for retaining at least some pipeline workers permanently, all customers could reasonably be expected to pay for these benefits, while direct users of the system could pay a premium to account for the fact that they are receiving the additional direct benefit from lower energy consumption as a result of GMD operating efficiency. Furthermore, the decision of where to install GMDs is not up to the individual customer, but is a collective planning decision. Therefore, at least partial socialization of costs seems fair.

What role will attrition and employee turnover play in changes to PGW's workforce?

We support the goal of maintaining an equal or greater number of jobs at PGW at comparable wages. However, it is both unrealistic and unnecessary to assume that all, or even most, of the current 1600 jobs will require the same skill sets in 2050 that they require today. We also recognize that it is not a simple transition for a late career skilled worker to retrain for a different job. But the evolution of the required skill sets, and the shift in the relative number of people required to do each type of job will happen over multiple decades, as retrofits are made building by building and block by block.

PGW should conduct a study of its workforce to match the anticipated retirement and resignation rates for each job category with the anticipated changes in the number of workers required in that job category, and adjust hiring accordingly. If properly planned, it may be possible that the entire 30-year business evolution can be done without a single related layoff, even in a fully electrified scenario, but only if the planning starts now.

What changes must be made to PGW's ongoing line replacement projects?

PGW is engaging in a cast iron main replacement program that will cost $183 million over the next six years, and the total project will cover 18 miles of lines according to PGW's 2020 Comprehensive Annual Financial Report at page 3.[16] In light of this ongoing diversification study, especially its finding that simply replacing fossil methane with decarbonized methane is economically unworkable, even short term replacement programs like this must be re-evaluated as to their fiscal prudence because the infrastructure being installed now may be taken out of service long before the end of its useful life.

[16] https://www.pgworks.com/uploads/pdfs/2020_Comprehensive_Annual_Financial_Report.pdf

We strongly recommend a suspension of the line replacement program until this diversification study provides some clarity as to how the gas distribution network will change over time. The result should include a plan for strategic decommissioning of network sectors. The line replacement program must then be revised to avoid spending tens of millions of ratepayer dollars on projects that will become stranded assets. Taking this action may have the benefit of reducing PGW's debt and could create budgetary flexibility for pilot program implementation.

How much will efficiency and conservation reduce the demand for thermal energy?

Slide 33 contains a footnote that reveals a fundamental shortcoming of this study that must be rectified: "For optimal comparison with BAU, operating costs do not include building shell upgrades." A more informative approach would have been to assume a program to realize all cost-effective building weatherization is achieved citywide by 2050 as the baseline for comparing the alternatives. This would be useful for multiple reasons:

1. Building efficiency is generally the least cost option for customers to control utility costs;
2. The task of achieving net-zero emissions will be significantly more time consuming and expensive, regardless of the scenario pursued, without first having reduced energy demand as much as possible; and
3. Building shell upgrades will significantly reduce demand for heating energy (gas or otherwise), which will create additional challenges for PGW to meet its revenue requirement even if no electrification were actively pursued.

By excluding building shell upgrades from the study, the BAU scenario is essentially a climate inaction scenario, which is counter to adopted city policy and should not even be considered a possibility. Instead of ignoring this fundamental decarbonization tool, the study should analyze how best to minimize the demand of buildings for heating by 2050, as well as ways that PGW can *adapt its business model to monetize the building shell upgrades themselves*.

Section III -- Recommended Pilot Programs

The Sierra Club recommends two different pilot programs be initiated as soon as possible in order to begin to answer some of the questions raised above.

One pilot would test the feasibility of networked geothermal systems. The concept is very promising in terms of energy efficiency, the retention of skilled pipeline workers, and alternative revenues for PGW. The nature of these systems requires utility coordination of many stakeholders; they cannot be initiated by any single willing party. This makes them an ideal candidate for a PGW-led pilot. That said, networked geothermal is unlikely to be the optimal solution everywhere. It is also a new concept with a limited real-world track record, so the learning curve on the first project may mean the pilot takes years to complete.

Therefore, additional pilots to assist low income customers to electrify should be undertaken immediately as well. It is clear that the high electrification scenario offers the lowest cost to

participants by a wide margin. We share the concern about the potentially extreme costs to the last non-participants in this scenario, who could be mostly low-income because those with financial means to retrofit will respond quicker to avoid rising gas prices. Upgrading and electrifying low-income customers **first** has to be the goal, and the PEA's Built to Last Program offers a promising solution, with its holistic approach to coordinated home rehabilitation, weatherization, and electrification.

PGW should partner with BTL during its two-year pilot to determine how it can provide heating and cooling services while reducing capital outlay for customers. For example, this could include performing building envelope upgrades, as well as installing, leasing, and maintaining heat pumps.[17] Strategic targeting of whole neighborhoods for retrofits, allowing for decommissioning of sections of the gas system, could also be a goal of a pilot. Comparable programs for rental properties should also be developed to ensure all customers can participate and whole neighborhoods can be electrified.

Conclusion

We appreciate the opportunity to comment on this first phase of a long, complicated, but necessary project. We stress the importance of immediately beginning implementation of no-regrets strategies and pilots focused on electrification, while continuing to develop a robust long-term decarbonization strategy with enhanced and consistent opportunities for public and stakeholder input.

Respectfully Submitted,

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[17] These fall under the umbrella of a "Heat as a Service" business, of which there are a variety of different models as described here: https://www.delta-ee.com/delta-ee-blog/defining-heat-as-a-service.html. While we support the intent of replacing potentially prohibitive capital outlays with manageable ongoing service fees, this business model must still be subject to regulatory oversight in order to ensure that predatory practices are not used against low income customers, and do not increase the risk of indebtedness or service termination.

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May 28, 2021
Philadelphia Office of Sustainability
1515 Arch St.
Philadelphia, PA 19102
Re: PGW Diversification Study written comments, RMI

On behalf of RMI, we respectfully submit these comments regarding PGW's draft Diversification Study.

About RMI

RMI is an independent, non-partisan, non-profit organization whose mission is to transform the global energy system to secure a clean, prosperous, zero-carbon future for all. Our initiatives include researching the business models, policies, technologies, and financing mechanisms necessary to decarbonize the buildings and power sectors and advance an equitable clean energy transition.

RMI has supported utilities and governments around the world to develop integrated resource plans by providing analytical support, project management, and advisory input. RMI believes strongly in the importance of analytically rigorous, participatory, and properly overseen energy plans that consider all available options to achieve decarbonization and constituent benefit.

Introduction

In April 2021, the City of Philadelphia released draft findings of its Philadelphia Gas Works Diversification Study and stakeholder process. Philadelphia Gas Works (PGW) – the largest municipal gas utility in the country and an employer of 1,600 workers – currently relies on a business model of supplying fossil gas to buildings that is incompatible with the city's climate target of carbon neutrality by 2050. Charting a path forward for the utility bears significant equity and cost implications for employees, customers, and Philadelphians at large.

The Study presented detailed analysis of the climate, gas usage, PGW revenue, and bill impacts over time for three scenarios: Decarbonized Gas, Full Electrification, or Hybrid Electrification. Based on stakeholder input, study authors also looked at a specific electrification opportunity: GeoThermal MicroDistricts.

Following a review of the findings, RMI has identified four themes of feedback for the draft report:

- Emphasize the likely and significant reduction in gas demand by 2050, across scenarios;
- Discuss equity challenges of Hybrid Electrification;
- Assess potential for new revenue streams and planned transition to improve a shift to electrification;
- Highlight immediate, no-regrets actions to support PGW's transition.

1. The Study should emphasize PGW is likely to see an 80% or greater decline in delivered gas volume to Buildings by 2050

The Summary Findings of the Study characterize the three scenarios based on feasibility. The Decarbonized Gas scenario and Full Electrification scenario are described similarly: "exclusive reliance" on either solution presents challenges, with differing complications. The Hybrid Electrification scenario is positioned as a middle ground and presented as a feasible decarbonization path.

The analysis does not support this framing. First, the Decarbonized Gas scenario presents outsized risks. There are significant unknowns with supply, scalability, and cost of RNG; annual customer energy bills are projected to be 250-600% higher than the Electrification scenario by 2050;[1] air pollution and health impacts from decarbonized gas would continue or worsen relative to today, despite clear stakeholder goals of improving air quality and resident health.[2] To make matters worse, PGW would still face a 2050 revenue shortfall of at least $800 million (under the most optimistic RNG cost assumptions).[3]

Second, while Hybrid Electrification is an intermediate scenario, it is not best understood as a 'middle ground.' All decarbonization scenarios except the Decarbonized Gas scenario project significant reductions in delivered gas to buildings. In the Hybrid Electrification scenario, PGW's delivered gas volumes in 2050 would be 80% lower than 2019 levels.[4] In the Full Electrification scenario, PGW would reduce gas throughput even more, to nearly 95% from 2019 levels.[5]

The Study's Summary Findings should clearly frame the challenge ahead: PGW is confronting an 80-95% reduction in delivered gas to Buildings by 2050 – a major deviation from PGW's current business model. The utility will have costly infrastructure to maintain and significantly reduced gas usage and revenue to match those costs. Higher rates are unlikely to make up the large shortfall, given affordability considerations. With this backdrop, solutions that modestly increase long-term gas demand will not guarantee PGW's viability. They may harm PGW's long-term financial health by forestalling creative solutions to reduce gas system costs and diversify revenue streams.

2. The Study should discuss equity challenges of Hybrid Electrification

In the Summary Findings, Hybrid Electrification is positioned as a path for more equitable outcomes compared to the Electrification scenario, when comparing bill impacts for customers that electrify first (participants) versus those that have not yet done so (non-participants).[6]

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[1] PGW Diversification Study, Slide 33. Comparison of participant annual energy costs in 2050 for the Decarbonized Gas vs Electrification scenarios.

[2] PGW Diversification Study, Slide 26.

[3] PGW Diversification Study, Slide 41.

[4] PGW Diversification Study and EIA. Hybrid Electrification scenario gas volume in 2050 estimated at 8 million MCF (slide 62 of PGW Diversification Study). 2019 PGW gas volume to Buildings calculated as 54 million MCF, using EIA Natural Gas Annual Respondent Query System (EIA-176 Data through 2019). Based on Residential Sales Volume, Commercial Sales Volume, and Commercial Transport Volume.

[5] Ibid. 2050 gas volume from electrification estimated at 2.5-3 million MCF, based on chart on PGW Diversification Study, Slide 63. Denominator from 2019 EIA data.

[6] PGW Diversification Study, Slide 47, and Slide 32: "hybrid approach creates a more equitable outcome between participants and non-participants."

There are several broader equity considerations when discussing Hybrid Electrification that counter this conclusion. First, Hybrid Electrification results in higher bills for all customers, as PGW shifts from fossil gas to costly decarbonized gases. By 2050, the Study estimates that annual energy bills in the Hybrid Electrification scenario – even for participants – would be nearly twice those in the Full Electrification scenario.[7] This is an inferior outcome for all customers, but particularly low-income residents in Philadelphia who already spend nearly 10% of their annual income on energy.[8]

Second, escalating bills would hit low-income customers the hardest. As expensive decarbonized gases are mixed into the gas supply and raise rates, higher-income households will leave the gas system at faster rates and opt for full electrification instead. As gas system costs are spread across fewer customers, gas bills will increase further for remaining ratepayers. Without incentives and policy support for full electrification upgrades, lower income households will be left with sky-high gas prices.

Lastly, while the Hybrid Electrification scenario lowers gas use versus today, the Study should clarify the potential health impacts of continued gas use from the Hybrid Electrification and Decarbonized Gas scenarios given strong interest from stakeholders on this topic. The link between air pollution and health is especially salient in Pennsylvania, which a recent Harvard Chan School of Public Health study noted is #2 in the nation for premature deaths from building-related air pollution (with over $6 billion per year in monetized health impacts from fossil fuel combustion in buildings).[9]

Given the benefits of electrification and risks of decarbonized gas for low-income customers, the Study should prioritize scenarios that enable electrification for low-income residents *and* manage bill impacts to those still on the gas system. This can be achieved through a combination of new revenue streams and targeted cost savings on fossil fuel infrastructure.

3. The Study should assess potential for new revenue streams and planned transition to improve a shift to electrification

The Summary Findings point to a transitional challenge – without mitigation along the way, customers that electrify first enjoy lower energy bills while those still on the gas system see energy bill increases.

First, assessing new revenue streams would allow PGW to mitigate revenue gaps and promote equity in the decarbonization pathways. These include: Geothermal MicroDistricts, heat as a service, weatherization, and strategic electrification. The Study highlights the public support PGW has in

[7] PGW Diversification Study, Slide 33. Based on 2050 participant bill impact chart, we estimate Hybrid Electrification participants have annual bills of $3,000 per year, compared with Electrification participants at $1,500.

[8] Drehobl et al., "How High Are Household Energy Burdens?", ACEEE, September 2020, https://www.aceee.org/research-report/u2006

[9] These values are based on additional analysis from Jonathan Buonocore, Sc.D, the study's lead author, RMI used median estimates from the results of 3 reduced complexity models used in: Jonathan J Buonocore (Harvard T.H. Chan School of Public Health) et al, "A decade of the U.S. energy mix transitioning away from coal: historical reconstruction of the reductions in the public health burden of energy", 2021 Environ. Res. Lett. 16 054030, https://doi.org/10.1088/1748-9326/abe74c

pursuing other lines of business like these,[10] but it does not yet provide details on how the utility can shift its business model to accommodate these options. Authors may add still other potential revenue sources, including innovation grants, partnerships with electric utilities, or healthcare/payer collaborations.

Second, the PGW Diversification Study should also factor in opportunities for PGW to strategically cut down costly gas infrastructure investments via a planned transition. This could include avoiding infrastructure expansion via non-pipe alternatives. It could also include strategic decommissioning of segments of the distribution system through geographically targeted electrification. This may become especially important, given Philadelphia's aging gas infrastructure that is expensive to upkeep, increases costs for consumers, and presents safety risks.[11]

Lowering the cost burden of gas infrastructure maintenance – even partially – reduces pressure on PGW to produce significant amounts of revenue from other lines of business. PGW could scale back gas main replacement projects, remove subsidies for gas infrastructure in new developments, and cut proposed gas capacity expansion projects. In these cases, replacement of gas infrastructure with Non-Pipe Alternatives may be lower cost investments. Because the Hybrid Electrification and Decarbonized Gas scenarios require gas infrastructure utilization, they can't take advantage of these cost reduction measures. Rather, the scenarios' continued expenditure on gas infrastructure increases their revenue gaps and stranded asset risks.

4. The Study should highlight immediate, no-regrets actions to support PGW's transition

The Study mentions a number of potential considerations and research items. It should also outline specific examples of short-term actions that can set PGW up to explore new revenue streams and reduce long-term system costs. A few examples mentioned in the Study:

Invest in multiple pilot projects: Given the scale of the challenge ahead, PGW should invest early in innovative pilot projects exploring new sources of revenue and cost reduction. Geothermal MicroDistricts have been highlighted as one example with potential to support Philadelphia's climate and health goals and align closely with PGW's existing workforce and capabilities.[12] Another pilot might deploy weatherization and electrification to strategically reduce gas system expenditures. Early pilot projects would allow PGW to anticipate and troubleshoot complications, streamline processes, collect feedback, and test ideas. After initial stages of implementation, PGW should review the programs to best determine how to scale them up.[13]

Promote all-electric new construction: All-electric new construction prevents PGW from investing in costly new gas infrastructure, and it helps homeowners avoid expensive retrofits and rehabilitation in

[10] PGW Diversification Study, Slide 24.
[11] Oona Goodin-Smith, "What to know about Philly's old, brittle gas mains after a crack caused a deadly explosion," Philadelphia Inquirer, January 18, 2020, https://www.inquirer.com/news/philadelphia/philadelphia-gas-mains-explosion-break-20200118.html
[12] PGW Diversification Study, Slide 35.
[13] Fairbrother, et al, "Pathways for Innovation: The Role of Pilots and Demonstrations in Reinventing the Utility Business Model," RMI, 2017, https://rmi.org/insight/pathways-for-innovation/

the following decades. All-electric new construction also utilizes cost-effective, highly-efficient new technologies.

Implement heat pump incentives: Although PGW is currently a gas-only utility, it could play a role in transforming Philadelphia's heat pump market. RMI analysis indicates that even with today's electric grid and reasonable expectations for continued electricity decarbonization, a heat pump installed in Pennsylvania in 2021 will produce lower lifetime greenhouse gas emissions than a comparable gas furnace.[14]

By developing heat pump incentives within or outside of PGW's existing energy efficiency programs, PGW will begin moving customers off gas-dependent appliances and set itself up for a new revenue stream in heat pump servicing. Additional incentive measures should be taken to ensure equitable heat pump access to low-income customers, especially because electrified appliances can reduce bills for households.[15]

Introduce bill/rate caps to protect low-income customers: As PGW introduces decarbonization innovation, bill caps can prevent potential rate increases for its most at-risk customers. Programs like these cap rates based on percent of income and can also be implemented as an incentive for customers who agree to participate in innovative programs. These protections would be relevant for PGW customers on the gas system, with parallel protections required from electric utilities.

Modify or remove utility allowances for gas line extensions: PGW offers gas line extension allowances for new customers, which are then socialized among all remaining ratepayers.[16] In light of expected throughput declines of up to 80%, Philadelphia should remove subsidies for gas system expansion where viable alternatives (e.g. electric heat pumps) exist. Removing the incentive would discourage new infrastructure that is likely to become underutilized within decades. The cumulative impact of encouraging all-electric new construction over a 15-20 year period could also materially reduce gas system costs.

Engage in transparent, long-term gas planning: The Study should recommend long-term gas planning efforts by the Philadelphia Gas Commission. Transparent forecasting of long-term gas demand can provide a baseline for public discourse on capital strategy, pilot projects, and viable business pathways for PGW. It would also provide a platform to update this understanding, as new technologies, public input, and pilot outcomes become available.

Conclusion

The City of Philadelphia and PGW have a substantial task ahead, and this Diversification Study represents an important first step. A critical function of the Study is to distinguish the likely (though complex) pathways from false solutions which are unlikely to meet Philadelphia's climate, equity, and

[14] Claire McKenna, Amar Shah, Mike Henchen, "It's Time to Incentivize Residential Heat Pumps," RMI, June 8, 2020, https://rmi.org/its-time-to-incentivize-residential-heat-pumps/
[15] PGW Diversification Study, Slide 47.
[16] Gas Service Tariff, Philadelphia Gas Works, effective April 1, 2021, https://www.pgworks.com/uploads/pdfs/PGW_Gas_Service_Tariff_Through_Supplement_141.pdf

economic goals. Within that context, a second function of the Study is to pair identified risks with potential solutions. The City, PGW, and Regulators can take near-term action to implement pilot projects, new business models, and cost reduction strategies down the road.

PGW itself has a once-in-a-generation opportunity to transform and secure economic opportunity for its employees and the city, but only through proactive and transparent planning.

We appreciate for your time and attention. Should the city working group have further questions, RMI will gladly assist.

Sincerely,

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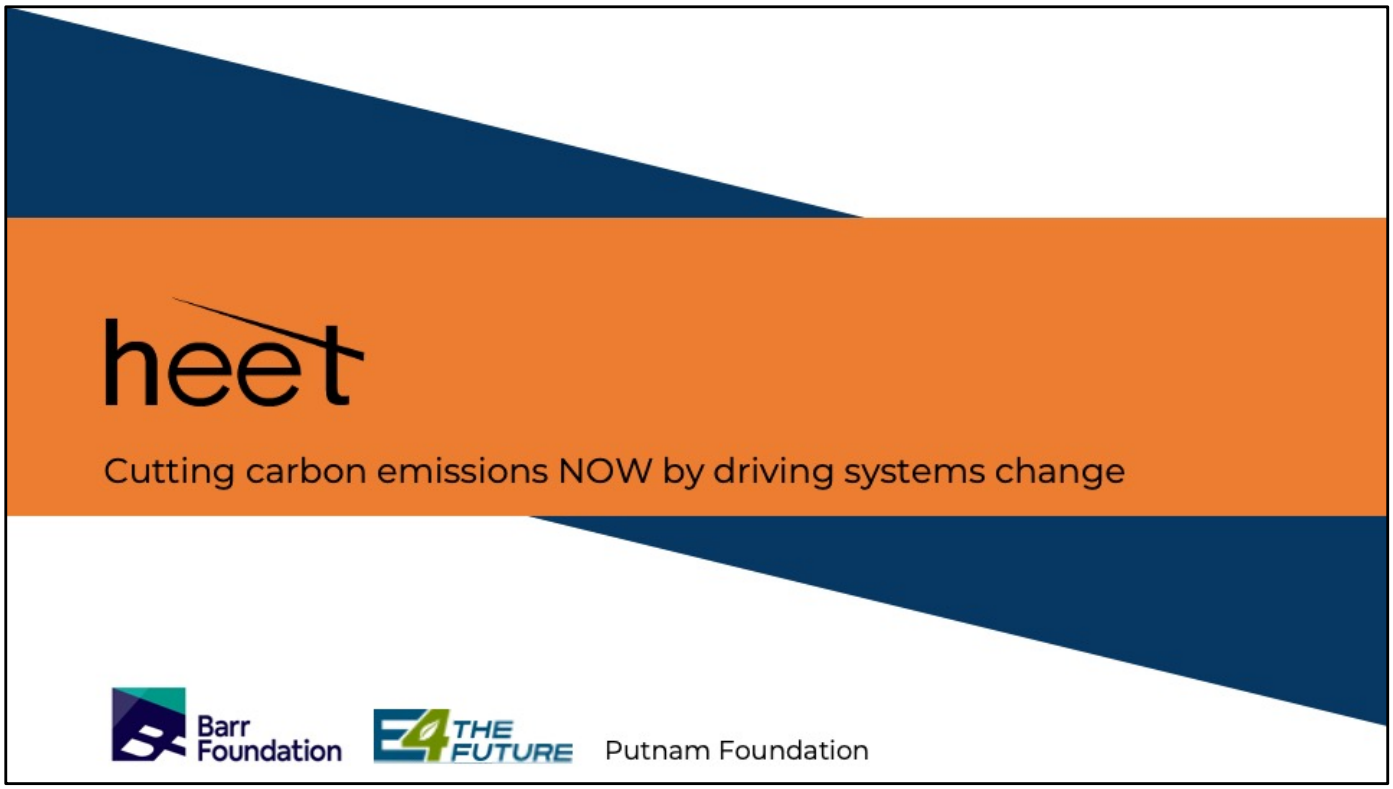
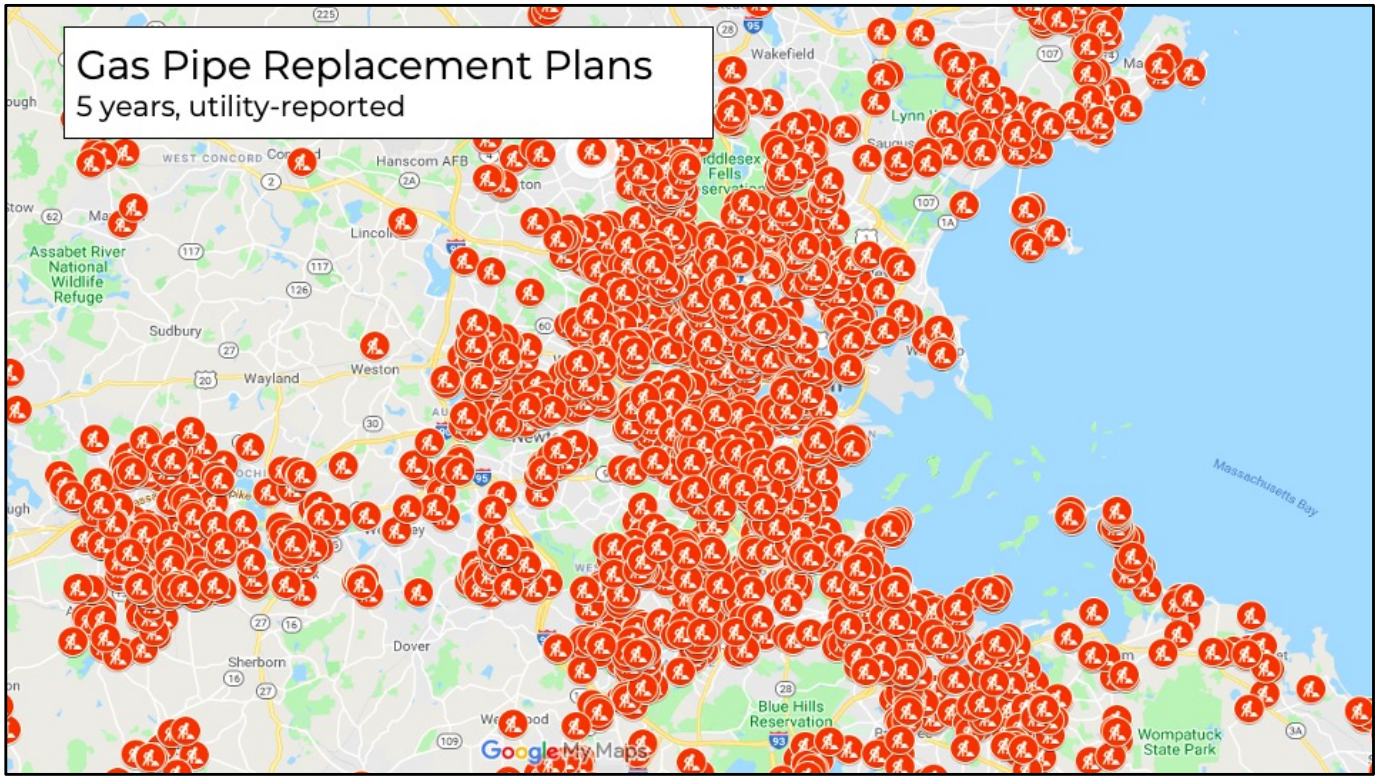


HEET is a nonprofit working with all stakeholders to create, test and iterate a decarbonized method of heating that can be delivered equitably to all. We do not accept funding from the gas or geothermal industry.

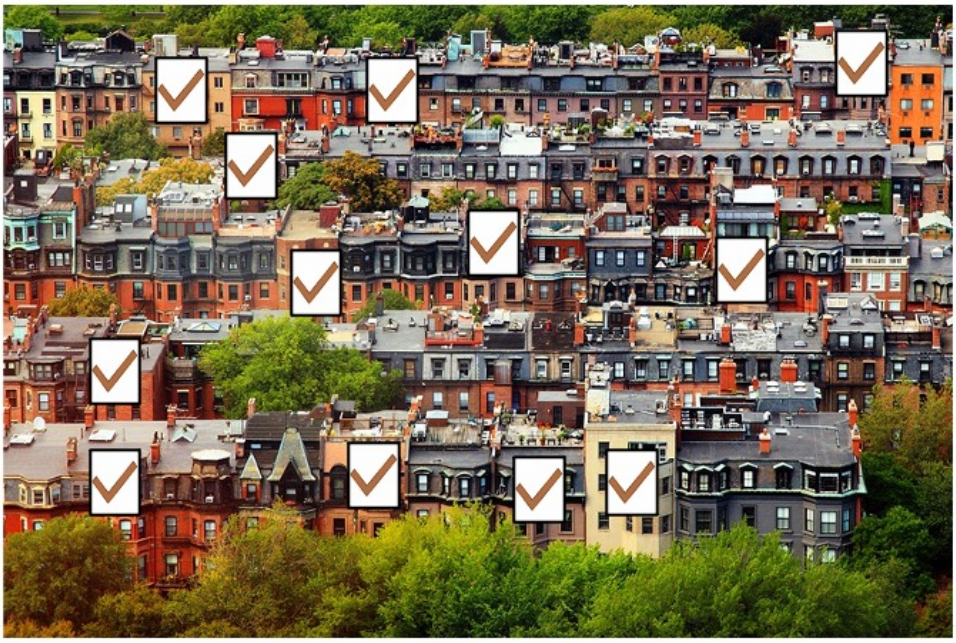


In MA, a lot of our infrastructure is old, including gas pipes under our streets. I'm sure the same is true in Philadelphia. Here are the next 5 years of the MA gas utilities' mandated work to replace those old pipes.

The total amount spent over the next 20 years will be somewhere between $12 and $14 B. That cost is greater than the value of all the gas infrastructure in the ground now in its depreciated state.

Normally these pipes are paid for by us gas customers over 50 years or more. Paying the cost off this slowly decreases the impact on our energy bill. Unfortunately, right now, that payment method is in direct conflict with our state's net zero mandate. In less than 30 years, we aren't likely to be using gas widespread anymore. At that point, we won't need these pipes but will still need to pay them.

Current Electrification Strategy



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And to complicate the matter more, the state's strategy to reduce emissions from the building sector is to move all their needs (heating, cooking, etc) to electricity and then produce that electricity with renewables.

We are doing that is one building at a time. Each of these buildings moving off the gas system means fewer customers remaining, shouldering the system's fixed costs. At some point the price of gas is going to get too high, and customers will flee faster, increasing costs further.

In the end, the only ones left will be those who cannot afford a new heating system.

Importance

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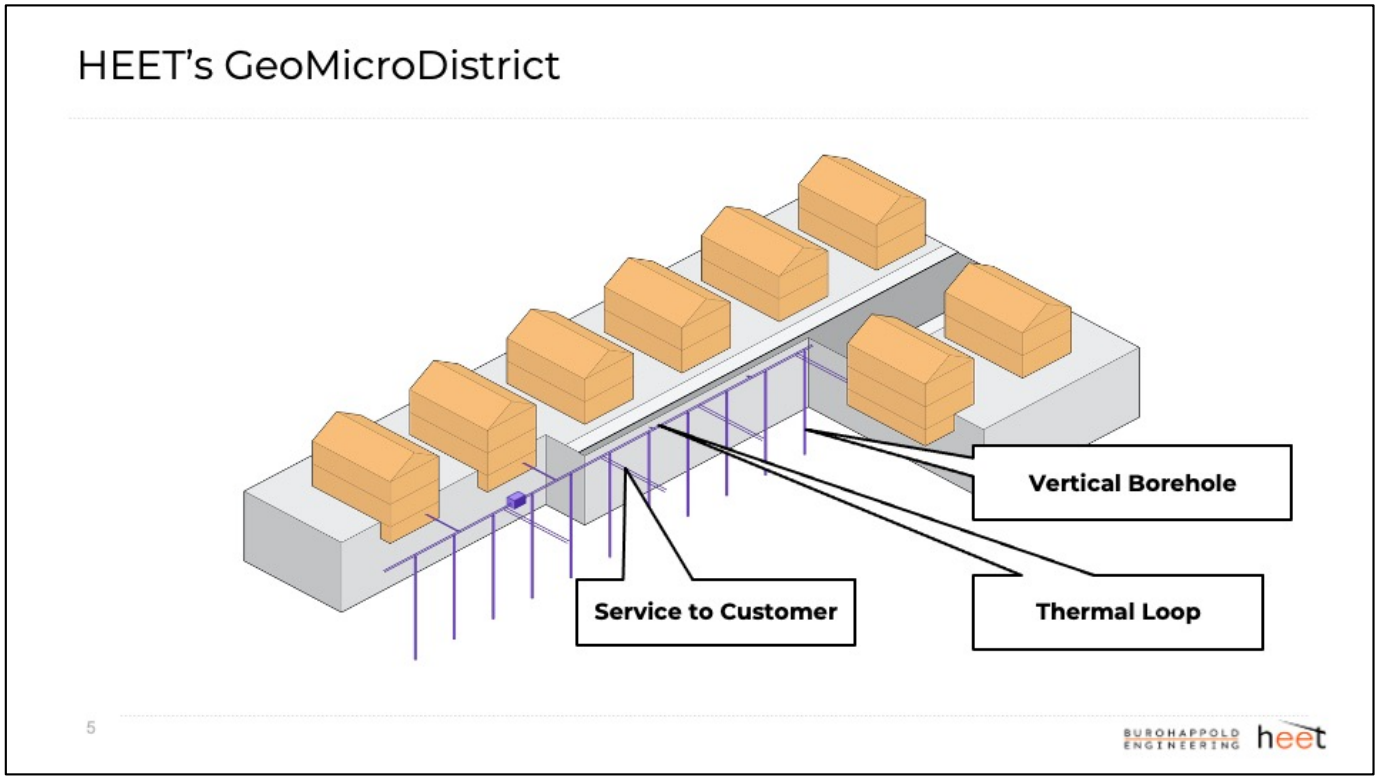
And let's remember why this is important. The gas system serves primarily urban areas, where there are significant amounts of low income people. They can't afford rising energy bills.

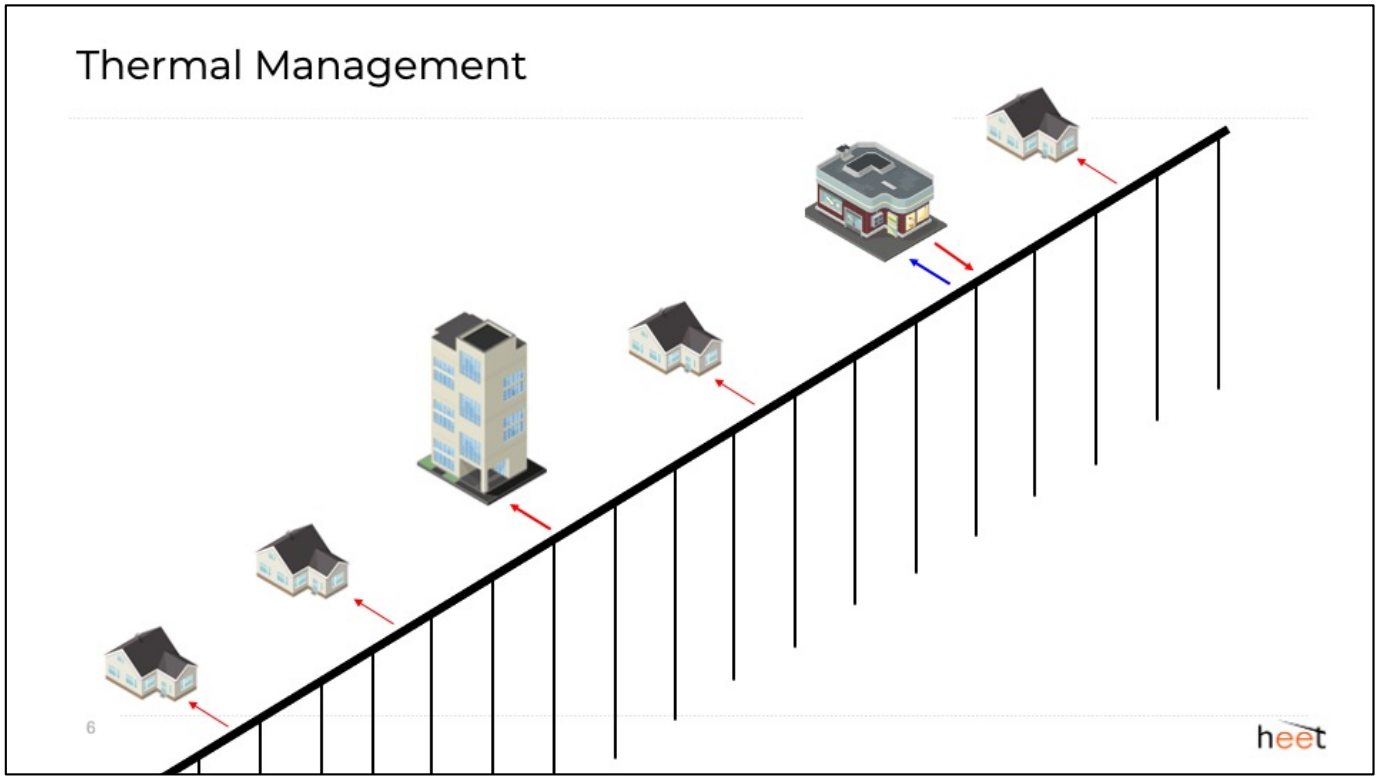
So the question is how can the utilities replace all those pipes and deliver decarbonized heating without raising costs, without starting that vicious downward cycle to stranded assets.



One possible answer is HEET's GeoMicroDistrict. A system of networked ground source heat pumps. This is proven and reliable technology.

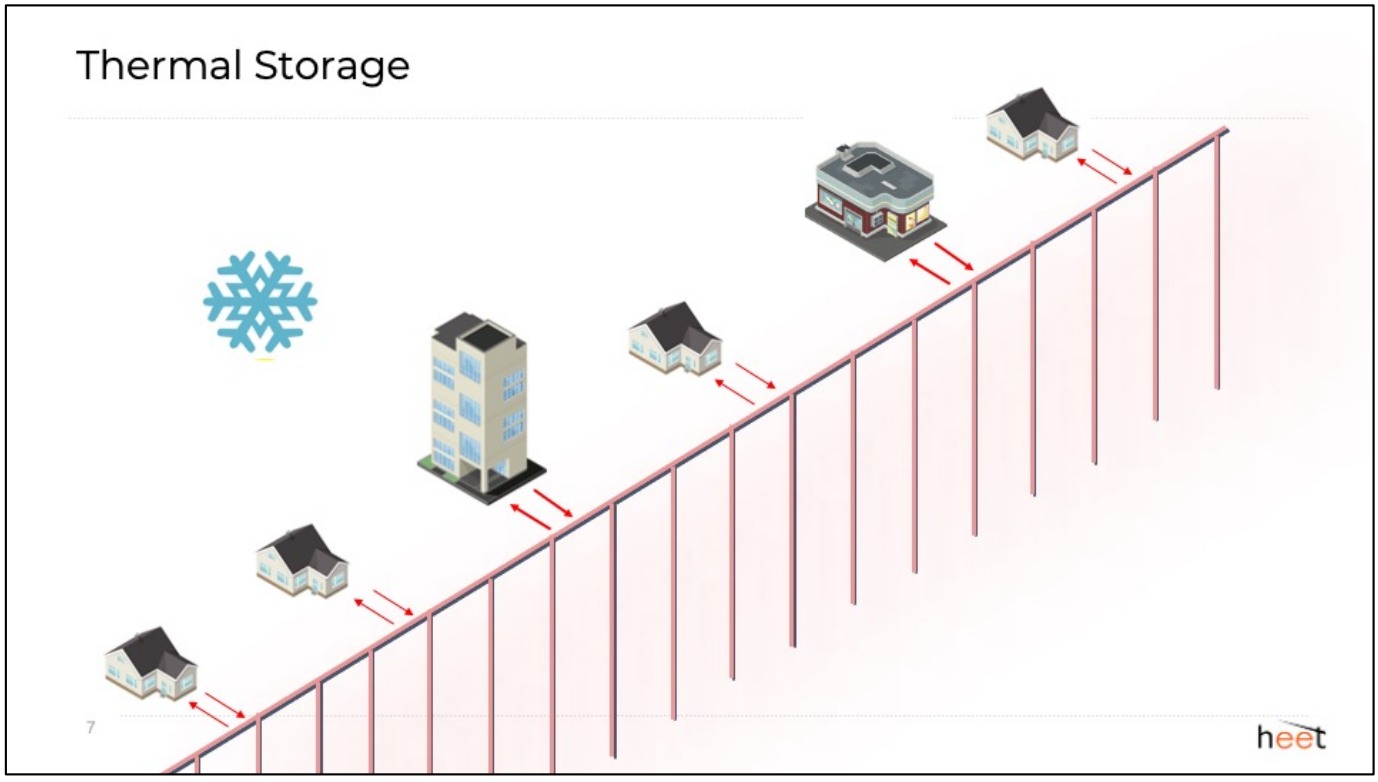
Like with gas, the infrastructure is in the street, with service lines going to each building. There are boreholes attached, going down just a few hundred feet. Not into the earth's core.

The pipes are filled with plain water, which absorb the temperature of the ground. Heat pumps in each building pull off the heating or cooling that building needs.



Networked geothermal has advantages.

Imagine a supermarket with its fridges humming all the way through the winter. It's going to be rejecting heat into that shared loop of water, making the water hotter. That heat can then be used by the homes down the street.



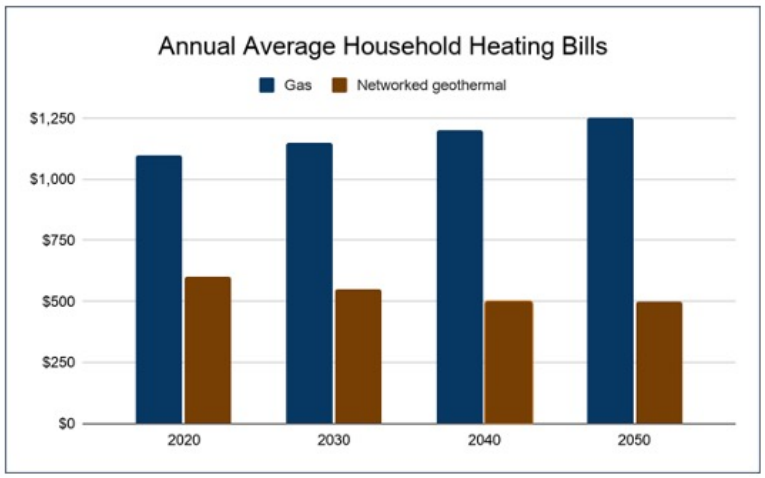
The second advantage, is it can store excess energy (for instance heat in the middle of the summer) in the ground until it's needed, months later in the winter.

The gas utilities can install this system in their right of way in the street. They have the customers and the financing to get this done. They can spread the cost of the system across all of us and over decades, as they do with the gas pipes.

Better for Consumers

- Safer
- Healthier indoor air
- Provides cooling
- Energy bill savings

MA Energy Bill Projection
(Applied Economics Clinic Brief)



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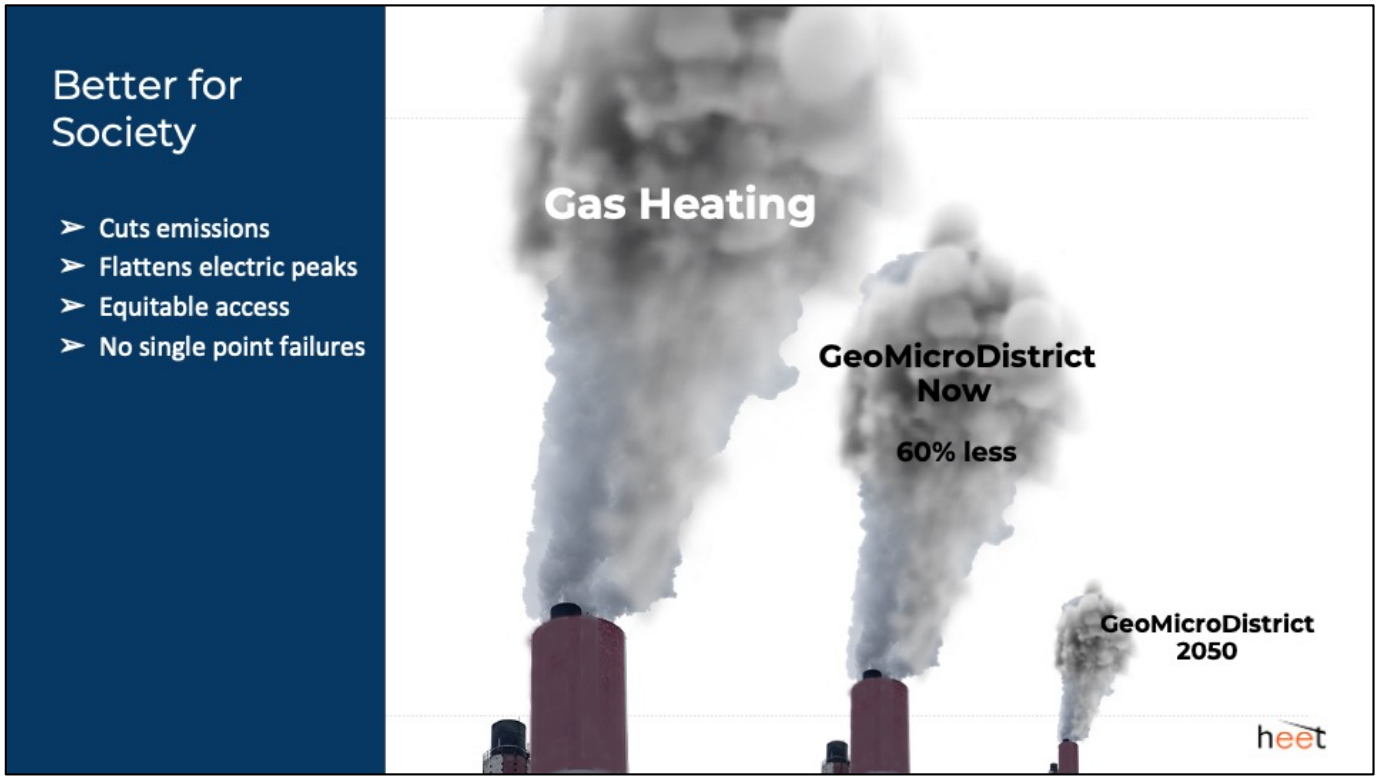
If they did, the benefits would be many. The system is safer since, Unlike gas, water doesn't explode.

No combustion, means the indoor air is cleaner.

The system can provide cooling. We will need that in the future.

in terms of heating bills, you should understand that the cost of the gas itself, the fuel, is about 60% of your current bill. With this system, there is no gas. That cost is gone. You only need a little electricity to run the heat and water pumps. Applied Economics Clinic projected average annual heating bills of gas vs networked geothermal. Admittedly they are not regulators and can't do ratemaking. However, you can see they calculated geo to cost much less than gas.



The production of the electricity used is the only source of emissions associated with this system. Given our MA electric grid fuel mix, any building connected to the geo system would reduce its emissions about 60% in comparison to gas. As our electric grid moves renewables, those emissions will continue to decline.

It would be more reliable also. With the gas system, gas only travels in one direction. From the production fields through pipes to your stove. If anything goes wrong anywhere along that system, gas can stop. In Jan 2019, in Ohio, a large transmission pipe malfunctioned and all of Newport RI, the end of the pipe, lost heat. The temperature that day was 12 degrees. With this system, there are no single point failures, since the temperature is right there in the ground under your feet.

Better for Workers

- Retraining easy
- Safer

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Since the water pipe running up and down the street is the same type as is installed now for gas, workers can easily retrain. And of course they like the increased safety. Thus this concept has some support from labor.

Initial Installations

MA

- **Eversource**: Approved, urban environment, ~100 homes & businesses
- **Merrimack Valley**: Approved, competitive grant by AGO & DOER
- **National Grid**: Filed, 100 to 200 units (businesses & homes)

Outside of MA

- **Con Edison**: Approved
- **New York City**: Commits to geothermal utility
- **NYSERDA**: Committed $15 million
- **Niagara-Mohawk**: Filed
- **Bridgeport**: Municipal installation, approved

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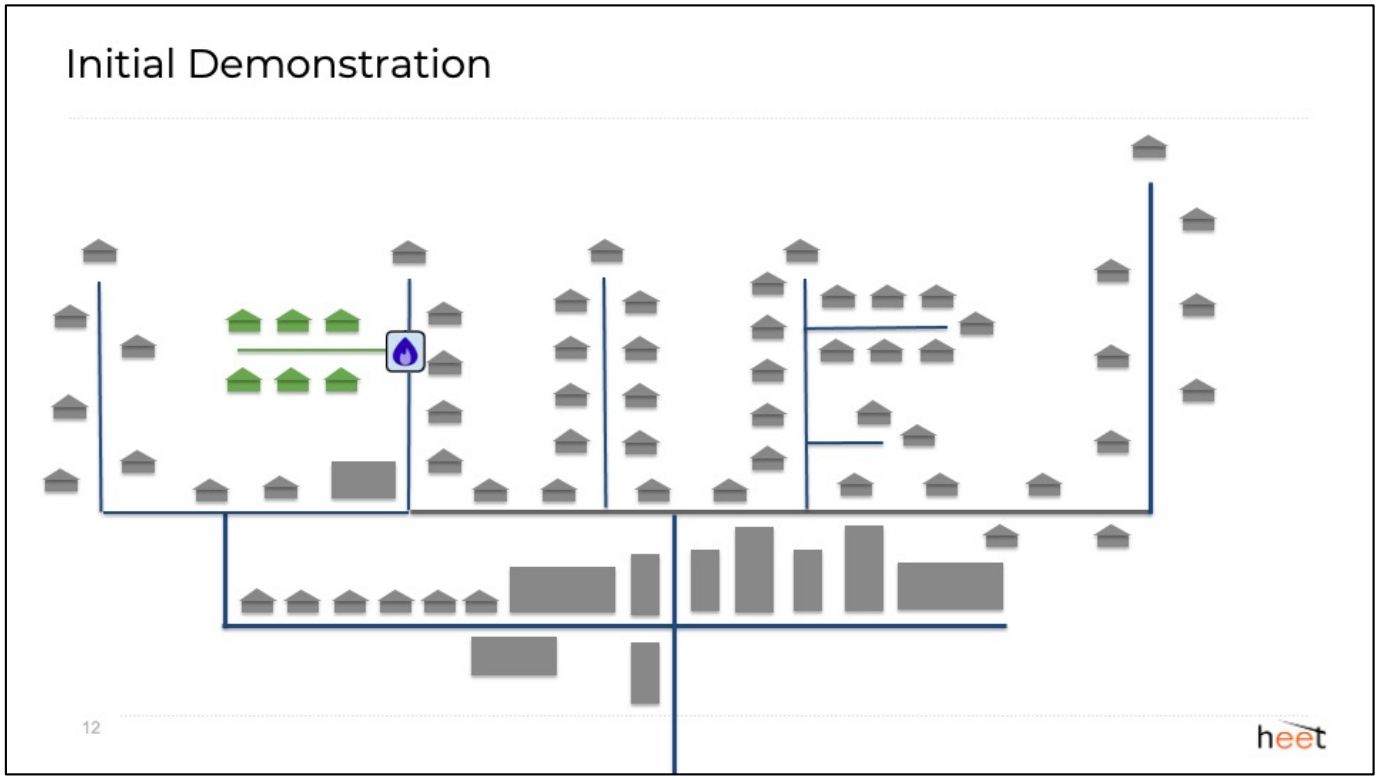
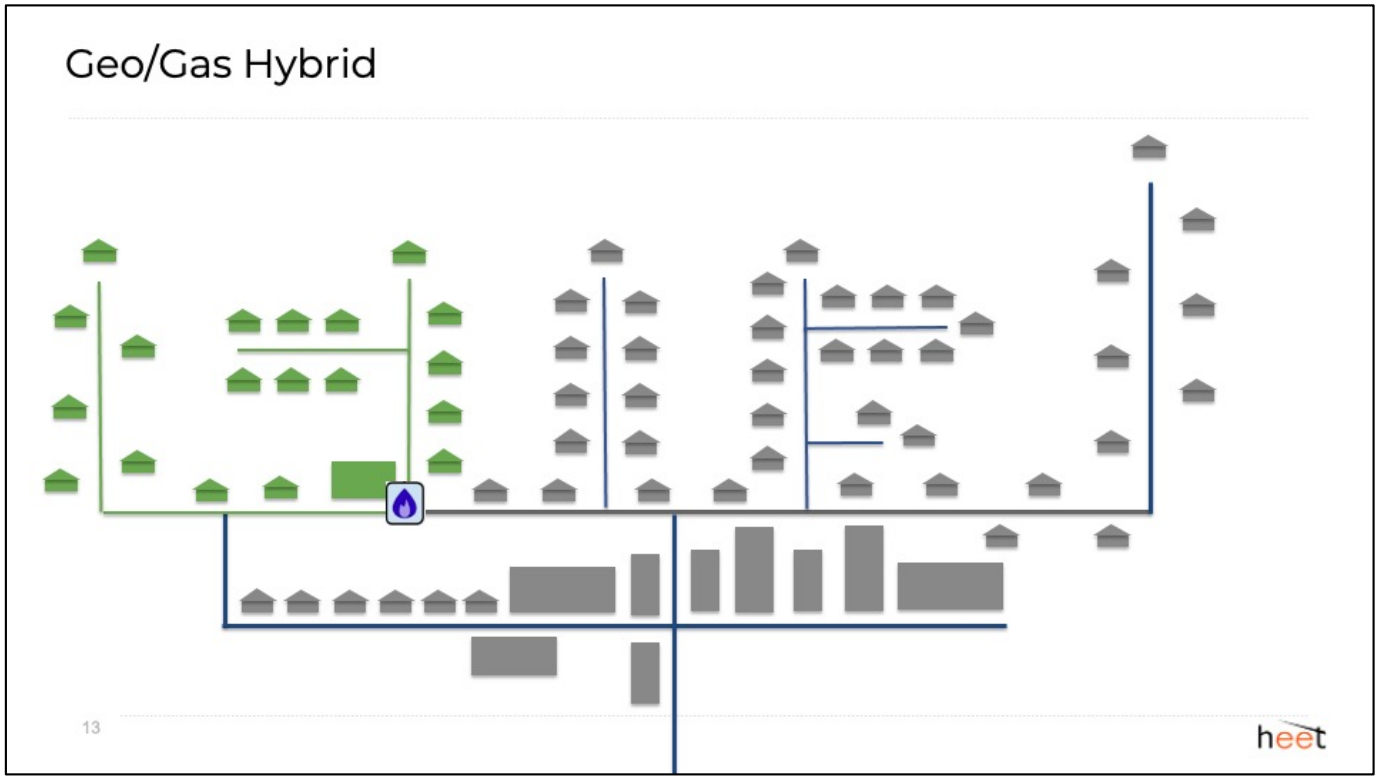
Because of all of these benefits, there are a variety of installations going into the ground in MA and NY this year. Eversource will be the first.
On earth day, Mayor de Blasio announced potential legislation to allow the futures installations to scale. And there's a lot of interest nationally.



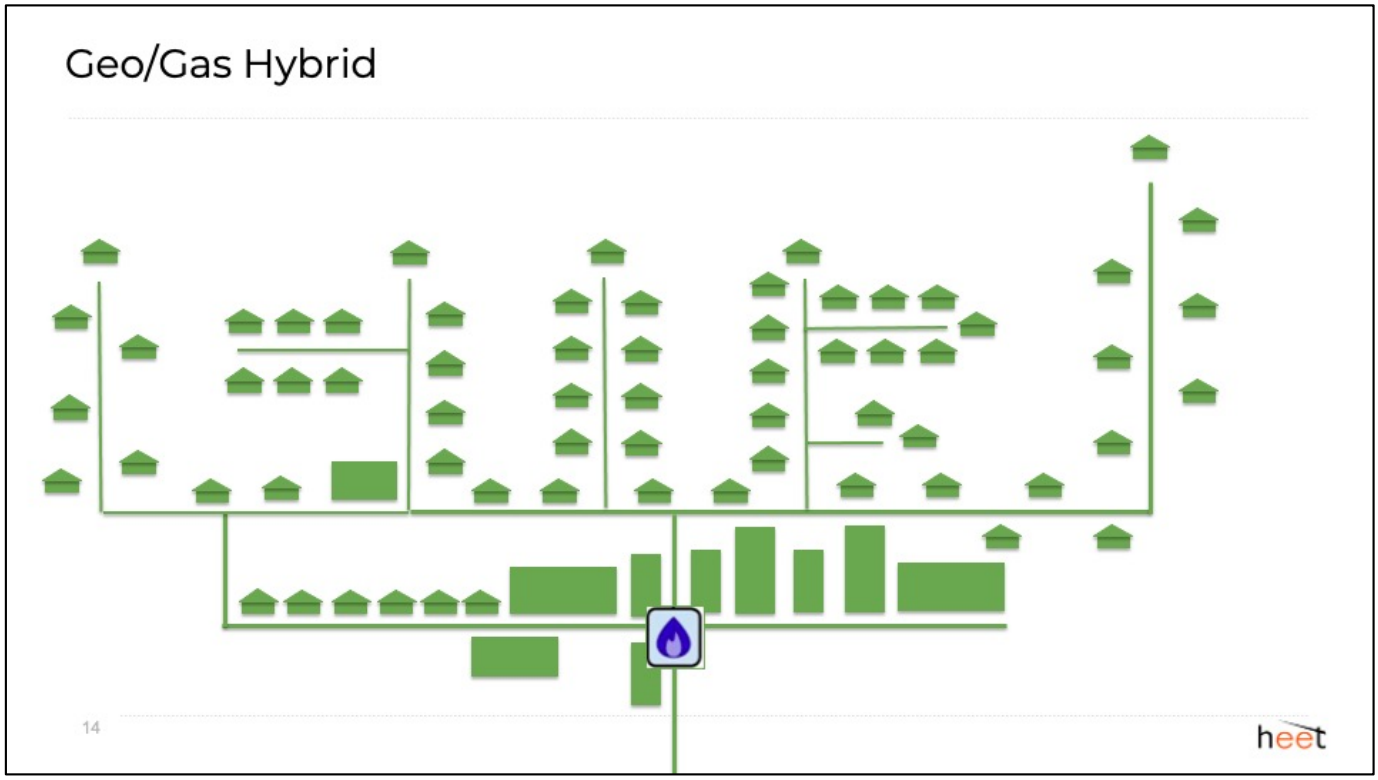
So let's imagine that first ideal installation. It would be grafted onto some distal end of the gas infrastructure. The gas would be backed out of the street but still connected to the system through a backup heater. if the geothermal system had any difficulty delivering heat, the gas heater could warm the water in the pipes to help deliver heat to the buildings.

There's a system like this at Colorado Mesa University with a gas heater on it. There, the heater hasn't been turned on for supplemental heating for 13 years. I suspect as the utilities here get used to managing this system, they will need it less and less.

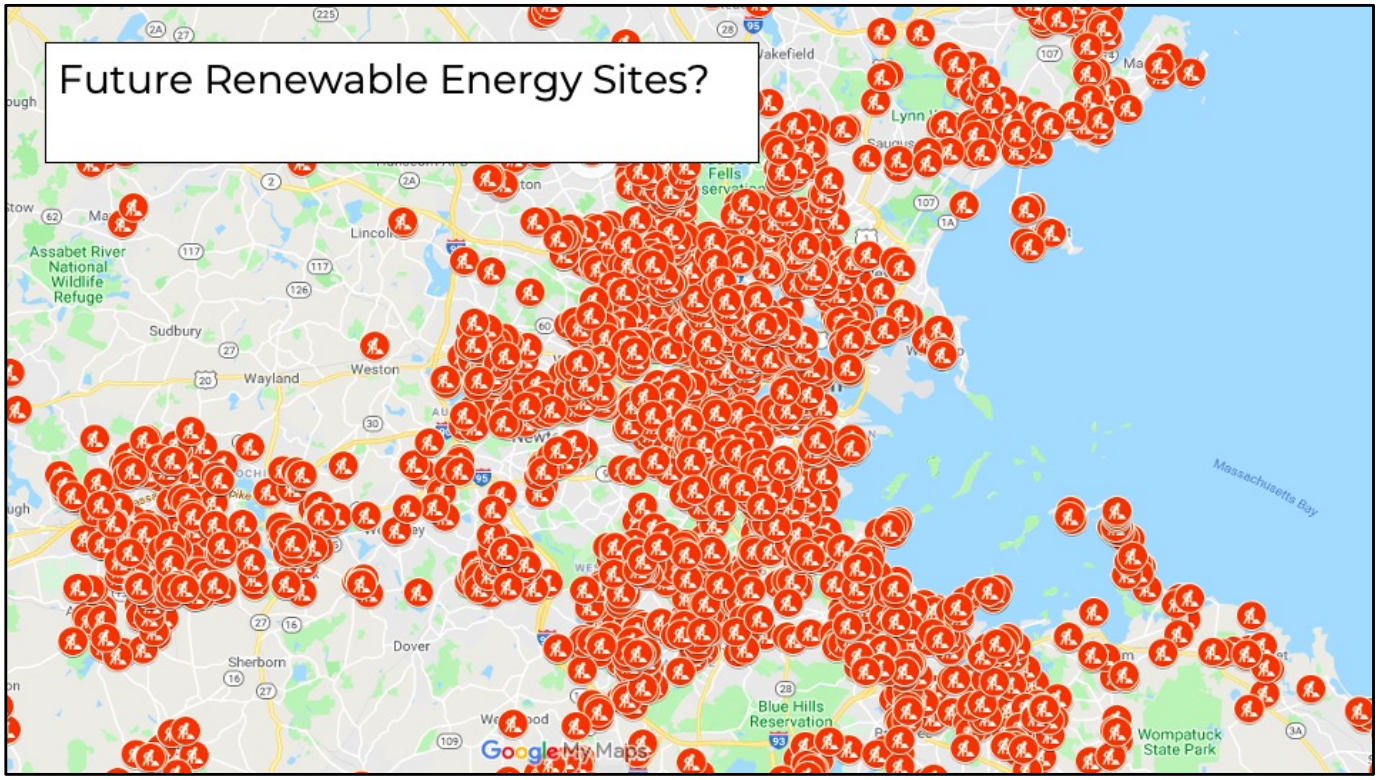


Next we scale up and iterate. GeoMicroDistricts are designed to interconnect with each other like Lego Blocks. In terms of regulation, customers and financing, this is a single system. The costs would be spread across all, gas customers and geothermal customers. Doing so will avoid stranded assets.

This is a geo/gas hybrid, delivering heat more safely and reliably at a lower cost and with lower emissions. This is truly a gas system enhancement.



In the end gas would only serve as backup supplemental heat in the center of the system. This scale is an appropriate one for biogas or hydrogen.



So let me return to this image. With this bill, it's possible that all these sites could became future installations of renewable infrastructure, grafted onto the gas system. Delivering safer, less expensive energy to all regardless of income level.

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Cutting carbon emissions NOW by driving systems change

References & Resources

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To Whom it May Concern at the Philadelphia Office of Sustainability,

My name is Theo Banks and I am a Philadelphia resident and member of Sunrise Philadelphia on the Green New Deal for Housing Campaign Team.

I am excited about the opportunities outlined in the PGW diversification study and want to throw my support behind the proposals that advance decarbonization and enhance equity by transitioning PGW to an installer of electrified heat pumps and appliances.

Having read the diversification study it is clear to me that ratepayer and workforce stability are crucial considerations for PGW, but there are ways that PGW can support these constituents and still support the crucial work we need to do to decarbonize our homes and city.

Crucial to this work is an immediate halt of PGW's supporting organizations that lobby for policies that block or slow electrification. If PGW is going to find an alternative business model that allows them to sustain their workforce and protect ratepayers they cannot continue to use taxpayer dollars to block this work.

Thank You.
Theo Banks

Written Testimony for Gas Commission Town Hall
Rev Edward A Drew
May 27, 2021

Hello Commissioners,

My name is Rev Edward A Drew. I am the East Coast Regional Organizer for the Climate Witness Project of the Christian Reformed Church in North America (CRCNA), as well as the organizer for the Hunting Park Community Solar Initiative. I am very glad that the city has gone forward with this Diversification Study for PGW. It is an important first step.

The bottom line, made very clear by the IPCC, is that Philadelphia, just like every other municipality, state, and nation around the globe, needs to de-carbonize as quickly and equitably as possible in order to keep the planet under 1.5 C of warming above pre-industrial levels and avoid the most catastrophic impacts of planetary climate unravelling. Emissions must be reduced by half no later than 2030, and need to reach net zero by 2050 (and probably sooner). The costs to humanity for inaction – or slow action – are severe on a scale we have no current categories for. Put simply, the fossil fuel industry must be transitioned into a clean energy industry as quickly as humanly possible. Any "solution" that does not do this is not a solution at all. More than this, it is a criminally negligent lack of action that will cause enormous suffering for our children and future generations, with the greatest suffering born by poor, black, and brown communities.

Therefore, the only conceivable near-term future for PGW must be one where fossil fuels are no longer part of the equation. Building electrification, heat pump and geothermal heating and cooling, and clean electricity production are our future – and we must move in this direction as quickly as possible. Society has reached and passed the tipping point on fossil fuels – the urgency to leave them is already strong and will only grow. Therefore, if PGW wants its workers to continue to have jobs (something which is extremely important), it cannot remain a natural gas heating provider – it needs to adapt now.

Fortunately, there are exciting possibilities for how PGW could move into the future.

Geothermal micro-districts are a compelling prospect being piloted in Boston right now. These systems are extremely efficient, run on electricity, and can use much of the infrastructure and skill sets PGW workers already have, such as laying and maintaining pipes. The upfront cost is steep, but the long-term financial benefits for PGW are tremendous, not least because geothermal heating doesn't have to buy gas to provide its heat (it just uses water). It still requires a comparable amount of work to maintain the system, meaning a similar number of jobs – and the transition of gas pipe systems over to geothermal micro-districts will mean a lot of work for employees for a long time.

PGW could also be involved in energy efficiency, weatherization, and electrification retrofit work for Philadelphia's buildings. This could be another branch of their business model and provide a great deal of work for employees.

What absolutely *cannot* continue for PGW is business as usual. And the transition *cannot* be gradual. We simply don't have the time. We are at a critical point for humanity, human civilization, and the planet as a whole – and only bold action on every level of society can pull us out of the hole the fossil fuel industry has sunk us into. It is therefore utterly unacceptable that PGW has been funding fossil fuel lobbying efforts in Harrisburg. PGW is overseen by the City of Philadelphia, and the city has made very clear its commitments to rapid decarbonization in line with the Paris Climate Goals. PGW should not only stop this effort to subvert the will of the citizens it is supposed to serve – it should be publicly reprimanded by City Council for this behavior and forced to end this practice.

So to sum up, I would like to propose the following concrete actions:

1) The next phase of the diversification study does a pilot with PGW that converts several sections of its natural gas pipe system in Philadelphia into geothermal micro-districts. Ideally, the sections would involve both lower income and higher income neighborhoods.
2) PGW strongly considers transitioning towards geothermal micro-district heating and cooling, as well as energy efficiency, weatherization, and electrification retrofitting as its new business model. This will keep its workforce employed while helping the city meet its urgent climate goals.
3) City Council publicly reprimands PGW leadership for using rate-payer money to fund fossil fuel lobbying efforts in direct opposition to the will of Philadelphians and the climate commitments of the city and forces them to end this practice.

Thank you for your consideration.

Rev Edward A Drew

CLIMATE WITNESS PROJECT

HUNTING PARK COMMUNITY SOLAR INITIATIVE