To: City of Philadelphia
From: Rocky Mountain Institute
Date: April 26, 2019
Subject: The Opportunity for Philadelphia Gas Works to Lead the Transition to a Clean Energy Future

To meet the city's climate goals and manage risks associated with operating a fossil fuel distribution system, Philadelphia Gas Works can plan now for a managed transition to a clean energy future. This future will require sharp reductions in use of natural gas across Philadelphia, and a fundamental change in PGW's business. As the owner of the nation's largest municipal gas utility, the city of Philadelphia is uniquely positioned to lead on the issue of the gas transition. In the text that follows, we describe the need for a managed transition and potential new business models for PGW to pursue while sustaining high quality service to the residents and businesses of Philadelphia.

Meeting climate goals will require sharp reduction in natural gas use

The city of Philadelphia has an opportunity to lead cities across the nation in the transition to a low-carbon future. City leaders have already pledged to uphold the goals of the Paris accord, consistent with limiting global temperature rise to two degrees Celsius, and an 80% reduction in city emissions by 2050. Meanwhile, Philadelphia Gas Works (PGW) delivers approximately 80 billion cubic feet of natural gas per year, contributing more than four million tons of CO2 emissions, along with another 1-2 million tons associated with upstream methane leakage. According to Philadelphia's 2014 greenhouse gas inventory, the city's carbon footprint was 17.5 million metric tons CO_2e[1]. PGW gas sales account for more than 22% of the city's footprint. However, in its annual report, PGW celebrates its efforts to expand gas service to new customers. We acknowledge that the City's climate goals are fundamentally at odds with central elements of PGW's mission. However, expanding access to natural gas safely, reliably, and at low cost are important near-term objectives for the utility. Although these goals seem irreconcilable, they are not, especially if the focus is on heating service agnostic of fuel type or energy source.

Meeting the city's emissions goals will require stopping the expansion of fossil fuel infrastructure, including the natural gas system operated by PGW. Fatih Birol, executive director of the International Energy Agency, emphasized this point globally last year when he concluded, "we have no room to build anything that emits

[1] Powering Out Future: A Clean Energy Vision for Philadelphia
https://www.phila.gov/media/20180821150658/Powering-Our-Future-Full-Report.pdf

CO_2 emissions" while limiting warming to two degrees Celsius.[2] Nationally, natural gas now contributes almost 30% greater carbon emissions than coal.[3] Along with action to stop expanding fossil fuel infrastructure, major reductions in use of gas and other fossil fuels will be required over the coming years to meet these goals.

Other cities across the U.S. are showing that climate leadership requires planning to move away from natural gas. Two months ago, Los Angeles mayor Eric Garcetti declared "the beginning of the end of natural gas in Los Angeles … the climate crisis demands that we move more quickly to end dependence on fossil fuel."[4] Just last week New York City passed new legislation to substantially reduce carbon emissions from buildings, largely from natural gas.[5]

The scale and complexity of the natural gas transition is challenging for cities, and much work needs to be done to test and scale solutions that equitably transition utilities and customers toward a new paradigm. We applaud Philadelphia City Council for demonstrating leadership with a proactive approach in soliciting feedback from stakeholders early in the process.

Continued investment in the gas system poses financial risk to the city

Even if the city does not take major action to reduce natural gas use, other forces may drive such reductions anyway, exposing PGW to risks of stranded costs in infrastructure which becomes underutilized. By continuing to operate and expand the gas distribution system, PGW is exacerbating the scale of this risk.

These forces may come from future federal or state policy, or from economics and a transforming market. The recent momentum behind proposals such as the Green New Deal indicate a renewed public and political concern for climate change and foreshadow future policy actions that may drive down natural gas use across the country, including in Philadelphia. Meanwhile, alternatives to natural gas such as heat pumps are gaining market share nationally as their performance improves and costs are forecast to continue declining.

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[2] Vaughan, Adam, "World has no capacity to absorb new fossil fuel plants, warns IEA," The Guardian, November 12, 2018. https://www.theguardian.com/business/2018/nov/13/world-has-no-capacity-to-absorb-new-fossil-fuel-plants-warns-iea

[3] *March 2019 Monthly Energy* Review, U.S. Energy Information Agency. Available at https://www.eia.gov/totalenergy/data/browser/xls.php?tbl=T12.01&freq=m

[4] Buhl, Larry, "This is the Beginning of the End of Natural Gas in Los Angeles," City Watch, February 18, 2019. https://www.citywatchla.com/index.php/375-voices/17137-this-is-the-beginning-of-the-end-of-natural-gas-in-los-angeles-mayor-garcetti

[5] Ivanova, Irina, "New York City slashes its biggest source of carbon emissions," CBS News, April 18, 2019. https://www.cbsnews.com/news/new-york-city-carbon-emissions-from-trump-tower-and-other-buildings-80-percent/

Rapid declines in fossil fuel use have already exposed massive risk held by utilities and other businesses, but also provide an opportunity for fuel switching to cleaner electric loads. U.S. coal use is down almost 40% in the last 12 years,[6] and the market value of the top U.S. coal companies has fallen 80% in under 8 years.[7] Utilities around the country with coal assets suddenly see these assets as uneconomic, and they are struggling to manage the stranded costs associated with undepreciated infrastructure. Electricity regulators and policymakers are grappling with decisions that will allocate these stranded costs between ratepayers and utility shareholders.

Economic or policy forces may drive a similar trend in gas use between now and 2050, creating massive risk for both owners and customers of gas infrastructure and gas businesses. PGW holds over $1B in undepreciated utility assets, a number that has grown in recent years as annual capital expenditure has grown to $100M.[8] With continued growth in utility investment, the city is exposed to this risk both as a shareholder and on behalf of the customers and employees of the gas utility. Every new investment made today in building out the city's gas system compounds the risk by adding costs that may not be recoverable in a decarbonized future.

It is critical to for the city to lead a managed transition at PGW

These two factors – achieving the city's climate goals and mitigating stranded cost risk – point toward a transition strategy for PGW and its gas infrastructure. A forward-looking, carefully considered strategy implemented now is more likely to be successful than maintaining the status quo while risk is compounding, only to require a transition anyway years from now.

To address both the emissions reduction imperative and the economic risk to the city and its residents, it will be critical to develop a strategy for decarbonizing buildings that is hand in glove with a strategy for transition of the PGW business. For instance, a strategy that reduces gas consumption at random around the city is likely to be costlier than a strategy focused on the highest cost or lowest margin gas assets and customers, aiming to retire assets in an orderly sequence as customers transition to cleaner alternatives.

Furthermore, as electric alternatives to gas gain market share both for environmental and economic reasons, more customers will leave the gas system. Over time, this may create pressure to increase gas rates on remaining customers and become a self-reinforcing cycle encouraging more customers to leave the gas

[6] U.S. Energy Information Administration
[7] Ivanova, Irina, "Mission Coal files for bankruptcy—5th coal company in 3 years," CBS News, October 17, 2018. https://www.cbsnews.com/news/mission-coal-bankruptcy-marks-5th-coal-company-in-3-years/
[8] PGW Comprehensive Annual Financial Report, fiscal year ending August 31, 2017.

system. The city and PGW's combined strategy and business model transition can manage this risk by designing a program in a way that ties customer switching and reduction in the gas asset base, all while managing the equity implications of this transition. Critically, low- and moderate income (LMI) customers often have older appliances that present health, safety, and cost risks. A transition from natural gas commodity delivery to energy services would disproportionally benefit LMI customers that suffer the greatest burden from antiquated appliances and low energy efficiency– customers who are most exposed to commodity cost risks from natural gas.

There is a limited option set for decarbonizing the city's buildings, all of which moves away from fossil gas

73% of PGW gas is delivered to residential and commercial buildings, so reducing its emissions must focus on these buildings' gas use. Strategies to decarbonize buildings' fuel use, particularly in colder climates, generally require reducing buildings' energy demand through efficiency measures like insulation and air sealing, then meeting the remaining demand with low carbon energy sources. While energy efficiency is a critical and cost-effective component of any building decarbonization strategy, it is insufficient on its own to achieve carbon reduction targets of 80% or greater, especially in dense urban environments where buildings tend to contribute a high share of total emissions. Below we describe the range of additional levers to decarbonize building energy use.

Electrification: A clear and attractive path to decarbonize the majority of buildings – replacing gas or other fuels with electricity to deliver heat and other end uses in buildings. Combined with decarbonized electricity supply, this allows buildings to eliminate GHG emissions associated with their energy use. Modern heat pump technologies are capable of heating buildings while outdoor temperatures reach well below zero Fahrenheit and are several times more efficient than gas furnaces and boilers. Further, heat pumps offer both heating and cooling for buildings, as compared to separate gas furnaces and air conditioning systems. Efficient electric solutions exist for all major gas end uses, from space and water heating to clothes drying and cooking, and across a wide variety of residential and commercial building types. Electrification has many additional benefits, including eliminating NO_2 pollution in homes and businesses from gas combustion and reducing safety risks associated with gas leaks.

District heat: Viable and attractive for new construction – district heating systems can also enable a zero-carbon building stock by leveraging geothermal heating and cooling, recycled waste heat, and a variety of other electrified systems. District heating and cooling is well-suited to meeting the diverse residential, commercial, and industrial heating and cooling loads in a dense urban environment, and district systems are quite common in many of the United States' major cities.

While construction can be more expensive for servicing existing buildings, existing utility infrastructure and new business models can be leveraged to deliver cost-effective, carbon-free heating and cooling to connected buildings. Carbon-free geothermal heating and cooling systems are almost always cost-effective for new construction building projects and can often utilize existing infrastructure.

"Green" molecules: Niche applications when fuels are at scale –
Several options have been proposed elsewhere to deliver alternative gases to buildings for on-site combustion. These may include biomethane – sourced from livestock waste, landfills, or other sources – hydrogen produced by electrolysis with renewable energy, or synthetic methane formed by methanation with renewable hydrogen and CO_2. Despite the appeal of such solutions which may continue using existing gas infrastructure, they have several drawbacks or uncertainties:

- The available feedstock of biomethane is limited and unlikely to be able to meet a significant portion of building energy demands (NREL has estimated potential supply nationally at 420 billion cubic feet, around 5% of today's residential and commercial building demand).[9] With limited availability, its use may be higher value in harder to abate sectors such as heavy industry, or for seasonal power generation. Shortages of biomethane also contribute to higher prices, which will have disproportionate impacts on low and fixed-income gas users.
- The carbon-neutral credentials of biomethane depend on clear additionality – that is, ensuring that biomethane use captures methane that would otherwise be leaked to the atmosphere. Clear standards for ensuring additionality are not in place in many applications. Burning biomethane still produces on-site emissions of both greenhouse gases and air pollutants like NO_2.
- Hydrogen can only be blended into existing gas supply at low levels (estimates vary from 2 to 20% and additional R&D is ongoing) without upgrades to gas distribution infrastructure and end use appliances. If hydrogen alternatives become available at scale, it will be important to weigh the cost of upgrading gas infrastructure to accommodate this fuel against using that capital for building electrification.
- Hydrogen and synthetic methane (which requires hydrogen as a feedstock) require substantial electricity in their own production and are very expensive today; the level of cost reductions that may come in the future are very uncertain.
- Even if these alternatives achieve scale and low-cost, the natural gas transmission, storage, and distribution system remains leaky across the United States. Methane in particular is a potent greenhouse gas, and these

[9] "Biogas Potential in the United States," National Renewable Energy Laboratory, https://www.nrel.gov/docs/fy14osti/60178.pdf

leaks will continue to contribute to climate change even if methane is manufactured sustainably.

Concepts for transition at Philadelphia Gas Works

In any low carbon future, PGW must transition its current business of selling fossil natural gas to half a million of customers across the city. And as the business transitions, so must the infrastructure. Particularly in a future where electrification is the dominant decarbonization pathway, much or all of the natural gas distribution infrastructure may no longer be needed. Transitioning away from this infrastructure will required a phased approach to reducing and then discontinuing gas delivery by neighborhood or branch of the gas system. Such a phased approach should, as much as possible, seek to decrease system costs in proportion to a decline in gas delivery volume and customers, so that customers do not bear excessive cost during a period of transition.

As sales of fossil gas decline and underutilized infrastructure is phased out, new revenue opportunities can supplant gas commodity and capital revenues. Below we describe four alternate business models as potential transition options for PGW. These options are not mutually exclusive – they can be combined.

PGW has unique assets and capabilities to support this transition: a skilled workforce, experience with large infrastructure projects, ongoing management of the logistics of commodity delivery, and trusted relationships with customers and their energy data. PGW is a company that with some changes and retraining is in a prime position to deliver all of these other services to the same customers, while building off of the city's history of sustainability and Greenworks, particularly for workforce development and training.

1. *Heating service provider*

In this model, the utility provides *services* such as comfort and heat, rather than commodities like cubic feet of gas or kilowatt-hours of electricity. The utility performs many new functions that extend into homes and businesses, such as:

- Conducting energy audits and performing building efficiency upgrades
- Monitoring energy use and home comfort, and diagnosing and resolving problems
- Performing routine preventive maintenance on appliances and major mechanical equipment in buildings
- Identifying appliance replacement needs and selecting and installing new devices, either through the utility workforce or approved contractors

The customer pays consistent monthly bills while the utility manages financing new capital investments and scheduling and coordinating equipment upgrades and

replacements, simplifying the customer experience and freeing the customer from the need to manage their own HVAC and cooking equipment. Service offerings could vary, focusing on improving comfort, reducing energy use and environmental impact, and adopting the newest appliance features and technology.

This model could enable a managed transition away from fossil fuel infrastructure while minimizing cost shifts and disruptions. Customers could subscribe while still receiving gas delivery, and PGW could strategically schedule the transition to all-electric buildings, combined with necessary efficiency upgrades, in order to optimize the planned retirement of gas assets. All the while, the customer could receive reliable heat and comfort while paying a consistent monthly bill.

2. Clean heating and cooling district utility

In this model, the utility manages the engineering, procurement, construction, operations, management, and maintenance of clean district heating and cooling infrastructure. Geothermal district heating solutions are well-suited for utility ownership and management, as they rely on capital-intensive shared underground infrastructure, which can be paid for by many customers accessing the same system. PGW's existing capabilities in financing and running capital-intensive infrastructure, along with customer service and billing, make it a natural candidate to lead the development of such systems.

The extent to which Philadelphia buildings and neighborhoods are technically and economically suitable for such solutions will require further study, but this business model offers a transition to a similar business model to PGW's current model. This type of district solution is also compatible with the heat as a service model described above, as customers can be transitioned either to single-facility heat pumps or to shared district energy systems depending on their suitability, all while customers pay a consistent "heat as a service" monthly bill. We also expect that this business model would be immediately viable to service new construction building developments or institutions with accessible district infrastructure in place already (e.g., large educational campuses).

This model could be expanded to offer additional district energy solutions. For instance, combining district heating and cooling (powered by electricity through large ground source heat pumps) with distributed generation and energy storage could enable local microgrids to increase energy resilience. Such systems could offer additional value to the city, such as ensuring continuity of operations and public safety or healthcare facilities in the event of large-scale power outages.

3. Repurpose infrastructure for low-carbon uses

Some of PGW's infrastructure may be repurposed to support a low-carbon future for Philadelphia. For instance, if demand for hydrogen grows for industrial end uses or for seasonal power generation and storage, PGW may use or develop infrastructure to produce, store, and distribute this hydrogen. PGW's experience in managing gas infrastructure could translate well to managing hydrogen production, storage and delivery. With some modification, existing gas infrastructure could be made suitable for hydrogen. A limited amount of biomethane use may also be appropriate, particularly for hard-to-abate industrial end uses or for seasonal power generation.

However, it is doubtful this would include significant fuel delivery to residential and commercial buildings, and many existing customers would need to transition to alternate models as described above, while gas distribution infrastructure is decommissioned.

4. Distributed resource finance utility

In this model, the utility provides on-bill financing to existing utility customers to help them improve energy efficiency and transition their HVAC equipment and other appliances away from fossil fuels. Customer bills and rates could also include incentives for their new electric devices to shift the timing of their energy consumption to support the electric grid. Customers who participate in these financing offerings can select from a menu of qualified options, including heat pumps, water heaters, induction cooktops and other appliances, to insulation and air sealing projects that improve building efficiency. The utility could manage a network of qualified contractors to perform the work and help those businesses market their offerings to customers. The utility could then verify contractor performance and the quality of installations, compensating these service providers based on results. Customers can pay for upgrades on their utility bill, and the utility can use its existing financing mechanisms to fund these new investments.

Considerations

With these models or any other transition plan for PGW, the city will need to address several crucial challenges and considerations:

- Equity and access: In other sectors, such as rooftop solar and electric vehicles, early adopters of clean energy technologies have tended to be wealthier, while low- and moderate-income people have had less access to the benefits of clean energy ownership. A transition from fossil gas to clean heating will affect not only energy costs but also comfort, air quality, and health. City leaders have an opportunity to design a transition plan now that prioritizes equity and access to these benefits.

- Employees and workforce development: Any transition in business model will include changes in the job functions and employment needs at PGW. New plans should include workforce development and training planning for growing employment fields, such as heat pump installation and maintenance.
- Infrastructure stranded costs, depreciation, and financing: With over $1 billion in undepreciated utility assets on its balance sheet, PGW will need to deliberately plan for and sequence the transition of these assets. Many factors may contribute to prioritization, including the cost and revenue of customers served by asset, the remaining depreciation schedule, prevalence of leaks, suitability for clean district heating and cooling by area, and potential to repurpose infrastructure for other uses. A critical start to a managed transition will include a system-wide assessment of this infrastructure based on these or other criteria.

The City of Philadelphia is presented with a unique opportunity. As the owner of the nation's largest municipal gas utility, it can align a long-term business plan for PGW with the public policy objectives of mitigating climate change and reducing financial risk to the city. Cities, states, and businesses around the country are just starting to grapple with the challenges of transitioning buildings away from natural gas. Philadelphia has the opportunity to be a leader and a hub of innovation that will set an example for the rest of the country to follow.

RMI has worked with regulators, governments, and utilities across the country and around the world on their transitions to a low-carbon future. In particular, cities are taking a strong leadership position in moving forward greenhouse gas goals, while balancing the challenges associated with stranded assets, institutional inertia, the integration of new technologies, and the assurance that customers partake equitably in the transition. Rarely does one solution work in all contexts; instead, diverse stakeholders must work together to identify goals and priorities, and determine a pathway of experimentation and testing to explore which solutions work, which do not, and how best to proceed. We welcome the opportunity to serve as thought partners in Philadelphia's transition, but encourage that City Council and others to ensure all voices are represented in the discussion, and that an ambitious, collaborative, and creative approach is taken.

In particular, RMI understands the interactions between the gas system, private buildings, and the electricity system. We have the infrastructure to support PGW's transition via Philadelphia's involvements in the American Cities Climate Challenge, supported by Bloomberg Philanthropies, of which Philadelphia is a city eligible for support. There remains a significant amount of philanthropic interest to support the gas transition broadly, and specifically how cities like Philadelphia can be a vector for change to accelerate the transition to a low-carbon urban economy.

We wish you the best of luck as you embark on this challenging, exciting endeavor.

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