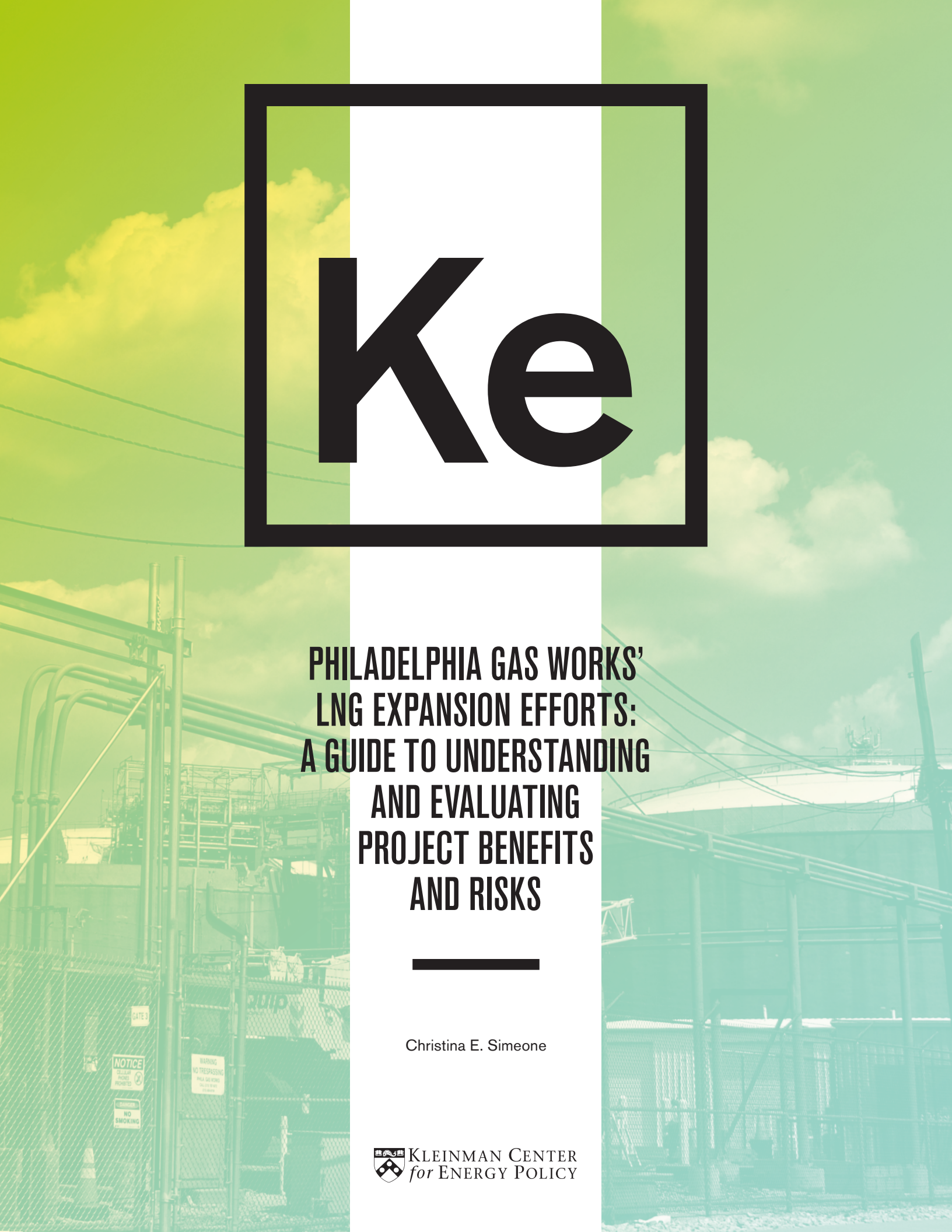

PHILADELPHIA GAS WORKS' LNG EXPANSION EFFORTS: A GUIDE TO UNDERSTANDING AND EVALUATING PROJECT BENEFITS AND RISKS

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CONTENTS

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EXECUTIVE SUMMARY

The goal of this report is to provide policymakers and the general public with:

- Information needed to understand Philadelphia Gas Works' (PGW) liquefied natural gas (LNG) expansion proposals,
- An overview of some (not all) potential benefits and concerns associated with these plans,
- A presentation of some issues to consider during and after the public evaluation of the LNG proposals.

PGW's current LNG assets—including the Richmond liquefaction and storage plant and Passyunk storage facility—**are critical to maintaining reliability of natural gas supply and delivery, and enable the company to lower gas costs for consumers.** Storing natural gas as a liquid allows PGW to meet winter peak gas demand needs (i.e. reliability) given existing large-scale pipeline capacity. It also allows PGW to buy gas and store it as LNG when prices are low for re-gasification and use when prices are high (i.e. cost savings). Natural gas demand has decreased in PGW's firm customer base over time, leaving the LNG storage assets underutilized as incrementally less gas needs to be stored for peak demand needs. PGW has been successfully selling excess LNG to the private sector. From 2013 to 2015 PGW's LNG sales created $6.5 million in profits that can be used to defer rate cases or accelerate pipeline replacement. With additional investments in the expansion of its liquefaction assets, PGW believes it can enhance profitability to further benefit its firm consumers.

Expansion of PGW's LNG assets is not a new idea. Numerous reports have identified the value of these asset and the potential to expand and leverage them for consumer benefit. In response to these studies, PGW has taken several steps to analyze, survey and test market interest in enhanced LNG sales. PGW's April 2016 request for proposal (RFP) for "LNG Sales and Asset Optimization" will determine if there is enough formal business interest to warrant capital investment for construction of expanded LNG liquefaction facilities, to support firm LNG sales and to add redundancy to PGW's existing equipment. For context, in the past, PGW's Richmond Plant hosted equipment that produced LNG at volumes higher than what is envisioned in the RFP's initial liquefaction expansion phase.

Depending on the outcome of the RFP, **PGW may need to tackle specific project feasibility issues** related to ability to secure permits, maintain the grandfathered status of the facility(s), and navigate certain legal and administrative complexities.

There is a compelling business case to support expansion of PGW's LNG facilities. Unlike an investor-owned utility that has high equity capital costs and dividend expectations, PGW is run similar to a not for profit organization with a customer reinvestment structure. The LNG sales expansion plan represents a rare growth opportunity PGW can implement to increase revenues and profitability. New debt to support the expansion is expected to be credit neutral or positive, and long-term contracts for LNG sales have the potential to create stability in these new revenue

streams. The value of gas storage near demand centers is intrinsic and PGW's plants have operated safely for decades, with the exception of two incidents.

On the other hand, **there are also compelling reasons why the Philadelphia community may not support the growth of LNG facilities and activities.** The industrial LNG manufacturing, storage, and sales plans envisioned present the potential for low probability, high risk plant and transportation accidents that create health and safety concerns to the local community and beyond. A 2006 resolution passed by Philadelphia's City Council opposed the considerable marine-based LNG traffic that would have been created through PGW's past large-scale LNG import terminal proposal. It is unclear if the same concerns and opposition will exist based on PGW's potential exploration of much smaller-scale LNG exports. There may also be environmental concerns about facility-based pollution or the potential to destabilize toxic pollution at the U.S. Environmental Protection Agency's (EPA) Superfund site that neighbors the Richmond facility. Based on previous public dialogue, there are likely to be broad-based environmental concerns about the climate change, air, land, and water impacts related to increasing natural gas production and use in Pennsylvania.

Key questions about the methods and ability to manage economic and other risks may help bound the conversation. For example, does PGW maintain adequate insurance to remediate and compensate for damages in the instance of a catastrophic event? How will PGW insulate its captive customers from the risks associated with using its assets to serve competitive markets? Also, what methods will be used to avoid ratepayer contributions to planning costs associated with determining project feasibility, and how will PGW avoid construction cost overruns?

This report does not offer an opinion on whether or not to move forward with PGW's LNG expansion plans. Ultimately, this is a conclusion that only the public and their policy makers can formulate. However, the report presents key issues to be considered, during and after a decision has been reached. If there is public interest in moving the project forward, PGW and policymakers will need to navigate project feasibility, health, safety, and environmental concerns, risk management and other issues. If there is not public support for moving the project forward, the conversation should not simply end. Rather, PGW's reduced firm sales trend coupled with its at-risk cast iron and unprotected steel pipe infrastructure require an immediate exploration of previously identified and new strategies to develop an actionable plan to boost revenues, and/or public acceptance of increased rates to maintain safe service.

INTRODUCTION TO PGW AND ITS LNG ASSETS

PGW's mission is to provide safe, reliable natural gas service to its Philadelphia customers at a reasonable cost. PGW developed liquefied natural gas (LNG) production and storage assets in the 1960's as part of its strategy to achieve this mission.

With respect to reliability of supply, PGW's receives natural gas supply into its distribution system through city gate stations (a physical transaction point where gas is measured, pressure is reduced, and odorant is added) from two large transmission pipelines owned by Spectra and Transco-Williams. During off-peak periods (e.g. non-winter) PGW stores a portion of its purchased gas supply in off-system underground storage facilities connected to the pipelines, or in its LNG facilities. The LNG facilities provide gas supply to PGW's firm customers during the winter season. The LNG facilities provide up to one third of Philadelphia's gas demand on very cold days (i.e. "design days"), and can supply gas when customer demand exceeds available gas supply from currently existing interstate pipelines.[a] In addition, having the ability to store gas near end-use areas increases the security of supply.

PGW originally constructed the LNG facilities in order to ensure adequate gas supply during peak periods, when existing pipelines could not deliver sufficient gas volumes to meet customer demand. In the absence of the existing LNG facilities, a new pipeline would need to be constructed to ensure access to sufficient gas volumes in peak periods. Pipelines are extremely expensive and notoriously difficult to permit and construct due to public and land owner opposition.

With respect to cost control, PGW can use its LNG assets to time the purchase of gas in order to reduce delivery and commodity costs. For example, the LNG assets allow PGW to "peak shave," by procuring and storing natural gas when demand and prices are low and then use this stored gas when prices and demand are high (i.e. winter). The ability to store gas in the LNG facilities allows PGW to reduce the capacity that needs to be reserved on interstate pipelines during peak seasons, thus reducing pipeline transportation costs. It also allows PGW to reduce the amount of gas purchased during high-cost winter periods. According to an independent engineer's report, PGW estimates that using its existing LNG facilities instead of additional pipeline and off-system storage capacity saves approximately $75 million per year.[b] PGW calculates that from 1970 to 2015, the LNG facilities have allowed about $3 billion in avoided pipeline demand charges.

A liquefaction facility processes natural gas into LNG by condensing, cleaning and cooling the gas to -260 degrees Fahrenheit, bringing it to liquid form. This process reduces the volume of the natural gas by more than 600 times, making the resultant LNG product compact, energy dense and more space-efficient to store. Produced LNG is stored in insulated tanks that maintain pressure and manage gas vaporization. LNG can be re-gasified into natural gas by vaporization units that warm the liquid back to ambient temperatures, returning it to gaseous phase. PGW's primary LNG assets include the Richmond LNG Plant in Port Richmond, north of Center City Philadelphia, and the Passyunk LNG Plant in southwest Philadelphia. According to PGW, the company's Richmond LNG plant is one of the nation's largest LNG facilities and has been in service since 1969. The Richmond Plant includes:

- Two (2) full-containment, pre-stressed concrete tank LNG storage tanks with more than 4 billion cubic feet of storage capacity,
- The "Expander" LNG liquefaction facility capable of creating 16 million cubic feet of LNG per day. The Expander unit has been operational since 2005.
- Vaporization capacity of 450 million cubic feet per day
- LNG truck/trailer loading capacity of over 12 million cubic feet per day

The Passyunk facility includes a single-containment storage tank with 250 million cubic feet of total storage capacity and two LNG vaporizers rated at 45 million standard cubic feet per day. LNG produced from the Richmond Expander facility is transported to the Passyunk storage tank via truck or trailer.

The Richmond Plant is located close to the Delaware River, rail lines, interstate 95, and the Tioga Marine Terminal, creating potential opportunities for marine, rail and truck transportation of LNG. Similarly, the Passyunk Plant is located near the Schuylkill River, rail lines, and major highways. Maps of both the Richmond and Passyunk Plants and surrounding neighborhoods are available in Appendix A of this report.

BACKGROUND ON PGW'S LNG EXPANSION EFFORTS

PGW is considering expansion of its LNG facilities for two reasons, 1) to enable capture of revenues and margins by serving new firm LNG customers, and 2) to provide redundancy to its existing LNG liquefaction capacity.

Over the years, financial and infrastructure challenges facing PGW prompted a variety of efforts to identify strategies to improve the company's fiscal and operational performance. As early as 2008, a report from The Economy League funded by the Pew Charitable Trusts and William Penn Foundation identified PGW's LNG facilities as being potentially attractive to private sector buyers and also found the assets could be more valuable under a different or enhanced use (compared to just peak shaving).[c] In 2012, PGW commissioned a report by Pace Global to identify small-scale LNG markets and examine strategies to enter into these markets.[d] Also in 2012, the City of Philadelphia commissioned a report from Lazard Freres & Co. LLC, examining strategic options for PGW that centered on selling the municipal utility. Subsequently, the City launched an effort to identify a private sector buyer for PGW.

In 2014, Philadelphia's City Council commissioned a report from Concentric Advisors aimed at examining alternatives to privatization of PGW that would still create value for the City and its residents.[e] The report listed optimization of PGW's LNG assets as the second highest value option, behind diversification of PGW's gas supply. On October 27, 2014, Philadelphia City Council sent a letter to Philadelphia's Mayor recommending alternatives to PGW privatization, which included PGW taking actions to explore LNG asset optimization, including 1) develop a more site-specific design study with cost estimates, 2) confirm the strength of emerging markets (i.e. heavy duty vehicles, Marcellus drilling and fracking, and marine vessel) and assess its competitive position, and 3) address any legal issues associated with developing a public-private partnership.[f] In April 2015, the Pennsylvania Public Utility Commission's (PUC) Staff Report on PGW supported further exploration of how to best leverage PGW's LNG assets, including sale, expansion, public-private partnership, and other considerations, while also highlighting specific associated risks.[g]

In January 2015, PGW held a non-binding open season in which respondents indicated an annual LNG demand of 5.0 Bcf.[h] In May 2015, CH-IV consultants finalized their "Feasibility Study for Liquefaction Capacity at the Passyunk and Richmond Facilities" commissioned by PGW, which assessed a variety of design, safety, technical, and cost issues related to five LNG expansion options.[i] The analysis included development of four options for LNG liquefaction capacity buildout at the Richmond Plant including 12, 21, and 24 (in two phases) million standard cubic feet per day (MMSCFD), and one option for addition of a 35 MMSCFD liquefaction unit and new storage capacity at the Passyunk Plant.

On June 17, 2015, PGW released a request for information (RFI) for its "LNG Sales Expansion Project" to understand potential public-private partnership options for expansion of its LNG assets and sales.[j] Most of the RFI focused on expanding liquefaction capacity at the Richmond Plant by 12, 21, or 24 (in two phases) MMSCFD. PGW outlined various technical parameters, development issues, and potential project options that focused on expanding liquefaction capability and optimizing the use of its storage assets. The company posed specific questions and requested creative input to its project ideas.

To provide context, PGW's has previously operated liquefaction capacity at the Richmond Plant that exceeds what is proposed in the initial phase of PGW liquefaction expansion (via the 2016 RFP, to be discussed in the next section). PGW's "Cascade" liquefier had an annual LNG production capacity of 7.1 billion cubic feet (Bcf). PGW retired the Cascade unit in 2012. Prior to Cascade's retirement, PGW embarked on an effort to install new, lower emissions liquefaction technology as part of a two-phase replacement plan. In the first phase, the "Expander" unit began operations in 2005 with annual LNG production capacity of 1.8 Bcf, thereby resulting in a combined annual production capability of 8.9 Bcf during the time period between 2005 through 2012. After the Expander unit was built, PGW did not move forward with the second expansion phase due to limitations on available capital. PGW is envisioning installation of a new liquefier with annual LNG production capacity of 5.7 Bcf. The combined annual output capacity of the existing Expander and new liquefier units would be 7.5 Bcf, significantly lower than the capacity of the original Cascade facility plus the Expander unit that operated on the site from 2005 to 2012.

Black and Veatch prepared an independent consulting engineer's report of PGW's gas works system and financials, in connection with certain bond issuance requirements.[k] The report examined LNG liquefaction expansion at the Richmond facility, noting that in addition to allowing for increased LNG sales, the new liquefaction capacity would provide the following benefits:

Increase the season over which natural gas can be liquefied, allowing for flexibility in the timing of natural gas purchases that will reduce gas delivery and commodity costs. This is estimated to result in savings between $5 million and $25 million during a winter season.

Increase capability to meet design conditions by raising the current 1.8 Bcf of annual liquefaction capacity to meet the design day storage requirement of 2.2 Bcf. This would be especially useful if there are back-to-back colder than normal heating seasons.

Provide redundancy and back-up for the existing 15-year old Expander facility as it nears the end of its useful life. This will also provide greater flexibility in the timing of routine maintenance and will minimize liquefaction down time due to maintenance activities.

2016 RFP FOR LNG SALES AND ASSET OPTIMIZATION

On April 5, 2016, PGW released its request for proposal (RFP) for "LNG Sales and Asset Optimization." The RFP explained how PGW's existing LNG facilities are underutilized and outlined the business case for investing to expand these assets. The RFP states PGW potentially plans to fund, construct, and operate (via a subsequent design and build RFP) a new 21 MMSCFD liquefier at the Richmond Plant. The CH-IV Liquefaction Feasibility Study estimated the capital cost of a single 21 MMSCFD nitrogen cycle liquefier (and supporting equipment) at the Richmond Plant to be $99.3 million with annual operations and maintenance costs of $5.1 million. PGW's CEO has indicated the costs would be between $120 million and $240 million. The solicitation seeks proposals to optimize and maximize the value of its new and existing LNG assets, outlining five proposal options it will entertain:

Option 1: Contracts for PGW's sale of LNG to the proposer. These contracts can take two forms:

Option 1A: Long-term, firm sales contracts of LNG from PGW to the proposer. The natural gas commodity cost will be passed through at PGW's cost. PGW will collect a sales/service fee, and a liquefaction/loading fee.

Option 1B: Long-term, firm liquefaction services (i.e. tolling) contracts where the proposer procures gas supply for delivery to PGW then pays PGW a liquefaction/loading fee.

Option 2: Pipeline capacity and asset management for the portion of PGW's interstate pipeline transportation portfolio associated with the new liquefaction capacity. For example, via arbitrage (e.g. buy low, sell high) opportunities. Revenues realized from this agreement would be shared between PGW and the proposer. PGW will only entertain option 2 services from a single proposer that has a contract executed under option 1.

Option 3: LNG development at the Passyunk Plant. PGW states it does not have plans to invest in new facilities at the Passyunk Plant, but is willing to entertain proposals to fund such development and/or utilize existing assets.

Option 4: Subsequent Richmond Plant expansion. PGW is looking to understand interests in further expansion at the Richmond Plant, such as additional liquefaction capacity and other infrastructure, to serve local, regional, and export markets. This would be contingent on the proposer executing an option 1 contract.

Proposals in response to the RFP were due May 31, 2016. Although all dates are subject to change, the following provides an idea of potential next steps as outlined in the RFP and appendices. Notification of the winning proposal is expected on July 1. Contract negotiations are set to conclude on August 1. The contract approval process could begin on September 1. Contract approval would require action by the Philadelphia Facilities Management Corporation board of directors with an amendment to PGW's capital budget. The Philadelphia Gas Commission would then have to approve the budget amendment, estimated to be November 2016. Contract award is scheduled for January 2017, once City Council approves the budget amendment and contract award.

Provided contracts to purchase LNG are established and project financing is viable, PGW envisions issuing an RFP for "Turnkey LNG Expansion" (e.g. design and construction) of the LNG liquefier at the Richmond Plant as early as September 2016, with responses received in December 2016. Regulatory orders clarifying key permitting issues would be received by December 2016. Award for facility design and expansion is estimated for February 2017 with the new liquefier being tested and completed by February 2019.

PROJECT FEASIBILITY: CAN THIS BE DONE?

There are technical and regulatory issues that may prevent realization of LNG project development. This section provides an overview of some of these issues.

ABILITY TO SECURE PERMITS

If LNG spills or leaks into the ambient environment, it will convert back to natural gas vapor. Initially, the natural gas vapor will be much heavier than air and will form a dense cloud that will remain near the surface of the ground until the vapor further mixes with the air and dissipates. This vapor cloud is extremely flammable and can ignite and burn if it comes in contact with an ignition source. An "exclusion zone" is a regulatory term for an area around an LNG facility in which an operator or government agency legally controls all activities in accordance with specific federal regulations for as long as the facility is in operation.[1]

In order for PGW to secure a permit to build an expanded LNG facility, regulations require that thermal radiation (i.e. heat from a fire) and vapor dispersion hazards be quantified and proven not to pose risks to people or property outside of the exclusion zone. In addition, some LNG liquefaction equipment uses refrigerant chemicals that are flammable and risks associated with these materials also need to be evaluated.[2] CH-IV's Liquefaction Feasibility Study included a preliminary hazard analysis that examined exclusion zone (thermal and flammable vapor) requirements, impoundment sizes, truck loading operations, refrigerant hazards, and other factors.

Vapor dispersion concerns for the Richmond Plant

For the Richmond Plant, CH-IV's preliminary modeling found that the vapor hazard zone distances associated with each of the three liquefaction expansion scenarios modeled (adding 12, 21, or 24 MMSCFD of new LNG liquefaction capacity) would exceed the exclusion zone, and thus would not comply with federal requirements.[o] Inability to meet these requirements would prevent the facility from securing a permit. PGW is planning to add a 21 MMSCFD liquefier with an annual production capacity of 5.7 Bcf.

To determine the exclusion zone exceedance, CH-IV used a regulator-required modeling tool (i.e. PHAST model) for preliminary analysis and developed an overlay map of the area. CH-IV noted the preliminary model does not account for three dimensional features (e.g. terrain that would enhance dispersion through turbulence) or other passive mitigation techniques or measures (e.g. vapor fences and walls, berms, site geometry) that could impact compliance. Only the more advanced three dimensional FLACS model can provide these data, but the FLACS model requires significant information that is typically not available until several months after the facility design effort has begun. CH-IV indicated the potential for the vapor dispersion cloud to remain within the exclusion zone if: 1) there is use of passive mitigation measures, 2) acquisition of the Tioga Terminal, and c) verification that dispersion across the road and rail systems are compliant with federal regulations. It should be noted that the Tioga Terminal is government-owned (i.e. Philadelphia Regional Port Authority), and therefore may or may not be considered under the same control as PGW's Richmond facility. CH-IV notes that in this instance, both FLACS and PHAST models would need to be used for the formal permit filing.[p]

The CH-IV Liquefaction Feasibility Study calculated potential thermal heat exclusion zones based on the size of required impoundments (e.g. concrete dikes used to capture and control LNG leaks) and concluded that risk would be contained within the property

[1] Federal regulations include 49 CFR 193.2057 (pertaining to thermal radiation protection) and 49 CFR 193.2059 (pertaining to flammable vapor-gas dispersion protection)

[2] Per PHMSA, in addition to vapor dispersion and thermal radiation, the following hazards should be evaluated in the siting analysis for an LNG plant: "According to NFPA 59A-2001 Paragraph 2.1.1(d), (incorporated by reference in 49 CFR Part 193), all hazards that can affect the safety of the public or plant personnel are to be considered. In addition to LNG, the applicant should consider hazards associated with flammable gases, flammable refrigerants, flammable or combustible liquids, or acutely toxic materials. If present at the LNG plant, hazards including vapor dispersion from liquid pools, vapor dispersion from jetting and flashing phenomena, thermal radiation from pool fires, thermal radiation from fires involving jetting and flashing phenomena (jet fires), overpressure from vapor cloud ignitions, toxic gas dispersion, and boiling liquid expanding vapor explosions (BLEVEs) involving pressurized storage vessels should be included in an LNG plant's hazard evaluation." (http://primis.phmsa.dot.gov/lng/faqs.htm)

boundary.[q] Due to the nitrogen technology planned for the new liquefier, refrigerant hazards were not a concern identified in the CH-IV report.

Vapor dispersion concerns for the Passyunk Plant

CH-IV's Liquefaction Feasibility Study modeled two scenarios for the Passyunk Plant, one that proposed upgrading the truck loading area and one that proposed adding 35 MMSCFD of liquefaction capacity with more than 4 million gallons of new storage tank capacity. For the truck loading upgrade, CH-IV's PHAST tool found the vapor dispersion hazard zone would extend beyond the exclusion zone. However, CH-IV notes that with passive mitigation measures (e.g. fences, berms, and site geometry) and verification that dispersion across the road is compliant with federal regulations, the vapor dispersion scenario may be contained to the PGW property. This indicates the potential for compliance with related permitting requirements.

The PHAST 35 MMSCFD liquefaction scenario found that vapor dispersion is modeled to exceed the exclusion zone and that even with the use of passive mitigation measures the cloud would be difficult to contain.[r] The liquefaction technology planned for the Passyunk site involved flammable refrigerants, like propane. CH-IV performed a propane storage failure scenario and found associated hazards would exceed the exclusion zone and may prove difficult to keep within the PGW property line even with passive mitigation.[s] These data suggest an inability to meet permit requirements given the liquefaction volume and technology scenario studied.

MAINTAINING GRANDFATHERED STATUS

The RFP refers to LNG activities and facilities that potentially fall under the regulatory framework of the Federal Energy Regulatory Commission (FERC). The RFP notes that PGW's current LNG activities do not fall under FERC jurisdiction, any proposed activities that would be subject to FERC jurisdiction must be addressed in advance by the proposer to PGW's satisfaction, and the grandfathered status of PGW's existing LNG facilities must not be affected. Activities that would fall under FERC jurisdiction include, but are not limited to, importing, exporting or interstate trade of LNG.

PGW's LNG facilities operate under federal standards established by PHMSA and enforced by the PA PUC (see text box on page 15 for more information). Significant alterations to certain plant equipment may impact the grandfathered status of the facilities.[3] For example, certain alterations to the storage tanks may trigger compliance with siting standards under FERC's jurisdiction. PGW's expansion plans may or may not have the potential to meet exemption criteria for altered facilities.[4] Greater clarity on this point should be required before additional taxpayer or ratepayer funds are contributed to the planning effort. For example, PHMSA can provide a written interpretation in advance about how project activities or alterations may impact FERC oversight or grandfathered status. PGW's RFP (at Section 2.1.1.5) envision the project partner taking administrative and financial responsibility for obtaining such an opinion on LNG activities in advance of contract execution.

ADMINISTRATIVE AND LEGAL FEASIBILITY

A variety of legal and administrative questions have been raised related to PGW's LNG plans. For example, does municipally-owned PGW have constraints that could prevent it from entering into certain forms of public-private partnership that aim to mitigate competitive risks associated with LNG sales?[t] Are there any limitations on the use of bond proceeds for this capital project?[u] Assuming these and other legal issues are not impediments, PGW (via its management through the Philadelphia Facilities Management Corporation) must also navigate a complex governance structure that could include obtaining approvals from the Mayor, Philadelphia City Council, the Philadelphia Gas Commission, and the Pennsylvania Public Utility Commission (PA PUC).

PROJECT BENEFITS: WHY SHOULD THIS BE DONE?

Assuming the LNG liquefaction expansion and storage optimization project(s) is feasible, it is logical to examine why policymakers, PGW and its customers may want to pursue the effort.

[3] For example, Title 49, Part 193.2005 (Applicability) contains grandfathering provisions and criteria in which an altered facility would have to meet updated siting, design, installation, and construction requirements. Available at http://www.ecfr.gov/cgi-bin/text-idx?SID=f1b246a0e20334997ec5af850b24f077&node=49:3.1.1.1.9&rgn=div5

[4] This paper offers no opinion on this or any other legal or regulatory questions posed.

CUSTOMER REINVESTMENT STRUCTURE

Unlike investor-owned for-profit utilities, PGW is municipally-owned and run similar to a not-for-profit organization. This structure creates important differences in financial costs and incentives that can benefit customers. Investor-owned utilities require a rate of return (based on the company's cost of debt and equity) for certain energy system investments, which is recovered through customer rates. PGW does not require a rate of return for investors, instead, it operates on a cash flow system where the PA PUC develops customer rates sufficient to cover operating expenses and to service debt. To raise capital, PGW relies on debt, which is generally less costly than equity capital. Lastly, investor-owned utilities typically distribute a portion of profits to shareholders through dividends. PGW does not pay dividend payments, however, the company is required to provide the City of Philadelphia an $18 million annual payment that goes to the City's general fund. In essence, PGW is not under the same type of financial pressure to benefit shareholders. All things being equal, this allows reduced costs or enhanced revenues to benefit consumers (e.g. deferral of rate increase or reduce reliance on debt financing), rather than shareholders.

Also, PGW has been crediting consumers for the input costs associated with supplying the LNG. From 2013-2015, firm customers were credited (via credits to the gas cost recovery filing) approximately $2.25 million in total demand costs and $8 million in commodity costs associated with the LNG sales.[v]

INCREASED REVENUES AND PROFITABILITY

According to PGW, firm customer gas use has been declining due to efficiency and conservation, resulting in 50 percent less LNG needed to meet peak needs and leaving half (2 billion cubic feet) of its storage capacity underutilized. The company has been able to leverage this underutilized capacity by developing a LNG sales supply business that has sold over 2,000 trailers (each with 10,000 gallons of LNG) from 2013 into 2015, mostly for use in long-haul trucking and high horsepower equipment (e.g. for drilling and fracking operations). A 2015 management audit of PGW found that LNG sales from 2013–2015 resulted in a $6.5 million total margin, even though actual LNG sales were less than 50 percent of contracted levels.[w] This means that PGW could have earned additional margins if it had the capacity to deliver the full contract volumes through firm sales contracts. Concentric believes that with expansion of liquefaction capacity PGW could increase the profitability of its LNG operations to a range of $7.7–$10 million annually, which would result in a four to eight year payback based on $40–$60 million construction costs for a 12 Mcf/day liquefaction facility.[x] Black and Veatch found that for 5Bcf of annual LNG sales, revenues would increase by $47.5 million per year, while gas costs would increase by $22.7 million per year and operating costs would increase by $1.6 million per year.[y]

The new liquefier's technology would also allow for LNG production in the summer months when gas prices are typically lowest. Currently, PGW's Expander facility can't take advantage of low summer gas prices because the technology relies on a certain threshold of system flow that is not achieved in summer months. This would provide more flexibility to reduce both commodity and pipeline delivery costs.

Deferral of Rate Increases

Increased profits could potentially reduce the need for rate increase requests. For example, Moody's indicated that additional revenues from the expanded LNG operations could be used to reduce future increases to base rates.[z] The Black and Veatch report indicated that factoring in costs, 5 Bcf of annual direct LNG sales would allow PGW to reduce its projected $40 million rate increase in 2018 to $30 million.[aa] Also, this figure does not account for cost savings associated with greater year-round liquefaction capability.

Accelerated Pipeline Replacement

Increased profits could also be used to accelerate replacement of PGW's at-risk cast iron and unprotected steel pipe infrastructure, which are degraded, leak-prone, and present failure risks. In fact, 66 percent of PGW's distribution system is comprised of at-risk cast iron and unprotected steel mains which could take from 50-90 years to replace (depending on pipe material, cost and replacement rates).[bb] PGW's 2012 Long Term Infrastructure Improvement Plan (LTIIP) is a five year plan ending August 31, 2017, which estimated the cost of these replacements to be between $6.3 and $11.1 billion.[cc] In February 2016, PGW filed a petition with the PA PUC to approve a modified LTIIP intended to accelerate the replacement

of at-risk cast iron and unprotected steel pipes to reduce risks and enhance reliability.[dd] In June 2016, PA PUC approved the modified LTIIP, accelerating PGW's at-risk pipe replacement from the current 86 years to 48 years.[ee] Approval of the modified LTIIP also allowed PGW to implement an increase to its Distribution System Improvement Charge (DSIC) from 5 percent of annual revenues to 7.5 percent. The DSIC is an automatic rate adjustment on customers' bills that funds eligible infrastructure improvements between rate cases. PGW's new DSIC allows the company to access an additional $11 million annually in ratepayer funds to support the accelerated pipe replacement schedule. As an example, the $11 million in annual ratepayer funds used to accelerate at-risk infrastructure replacement is comparable to the estimated $10 million in expected annual profitability from firm LNG sales.

GROWTH OPPORTUNITIES

PGW's has limited opportunities to grow its rate base to generate additional revenues needed to support the operation and maintenance of its aging system. Related to its firm customer base, growth is relatively stagnant, customers are at above average unemployment, and the company experiences collection difficulties related to the large portion of low income customers it serves. PGW's firm sales volumes decreased, on a weather normalized basis, by approximately 6.5 billion cubic feet (Bcf) from 57 Bcf in 2002, to 50.5 Bcf in 2015.[ff] Most of this reduction occurred in the residential sector due to the installation of energy efficient appliances, implementation of conservation measures, and warmer weather. When sales volumes decrease, PGW's base rate case revenue requirement (i.e. the cost to operate PGW) is spread over lower sales volumes eventually resulting in higher volumetric rates for firm customers. The LNG project presents a rare sales growth opportunity that could benefit PGW's firm customers.

IMPLEMENTATION POTENTIAL

Concentric identified a host of strategies to grow PGW's business and improve the economic efficiency of its operations. These strategies included reducing long-run gas supply costs through supply portfolio diversification, increasing gas sales (through combined heat and power and oil to gas conversions), and workforce development, optimizing LNG assets and compressed natural gas markets, and helping customer use gas more efficiently.[gg] However, some of these recommendations require events outside of PGW's control to occur in order to materialize value. For example, savings from gas supply diversification require development of new pipeline capacity from the Marcellus Shale region, construction of which is controversial and speculative. Development of a robust compressed natural gas market that creates new gas demand to grow revenues is similarly outside of PGW's control. Energy efficiency programs can help reduce the $70 million in annual subsidies provided to certain low-income customers, on the other hand, associated reduced usage from full-pay firm customers may negatively impact PGW's ability to cover certain system costs.

LNG optimization also requires threshold interest from external entities to be financially viable. However, if this threshold is reached (for example, through the RFP), the financial commitment and revenue opportunity can be solidified through long-term contracts.

CERTAINTY OF LONG-TERM CONTRACTS

PGW developed its LNG supply business on an interruptible basis, meaning the supply could be interrupted if PGW needed the LNG to support its firm natural gas customers, via short-term (one year, with extension options) contracts. This interruptible contract design is currently needed, as opposed to firm contracts that can't be postponed, due to limitations on PGW's liquefaction capabilities. For the 2013 through 2015 gas years, PGW had LNG interruptible contracts to sell 4.1 Bcf of gas, but colder than normal winters reduced actual LNG sales to 1.79 Bcf.[hh] Although PGW has significant excess storage capacity, it only has the capability to produce 82 percent of the LNG required for peak winter days. By expanding its liquefaction capacity at the Richmond Plant, PGW believes it will be able to leverage its existing storage assets and enter into long-term (ideally not less than 15 years), firm contracts for LNG supply or services. PGW estimates that annual firm sales of LNG could total over 5,200 MMSCF, with the potential for additional interruptible sales.[ii] Long-term contracting reduces financial risk and provides greater revenue stability.

REVENUE STABILITY POTENTIAL

Market prices of commodities, like natural gas, are typically volatile due to the fluctuating relationship between supply and demand factors. Gas price fluctuations may create long-term revenue uncertainty from LNG asset operations. For example, if the price of LNG increases compared to substitutable fuels (e.g. diesel for long-haul truck transportation), demand for PGW's LNG product could drop, thus reducing revenues, lengthening payback periods and reducing profitability. To prevent such uncertainty, long-term contracts with external entities interested in PGW's LNG supply or services (RFP Option #1) can be structured on a "take-or-pay" basis. This means the external entity either takes the supply/service at the agreed upon price or pays a penalty (typically slightly lower than the "take" price), up to a certain threshold. Of course, the details in a take-or-pay contract are critical to the potential for the clause to maintain revenue stability, for example, the ability and frequency to adjust take-or-pay amounts, price review provisions, hardship clauses, force majeure clause definitions, and many other considerations.[jj]

CREDIT NEUTRAL OR POSITIVE

In July 2015, Moody's upgraded the bond rating of certain PGW offerings from Baa2 to Baa1 primarily based on an improved financial position owing to operational efficiencies and cost savings, favorable labor negotiations, a supportive regulatory environment, and other factors, while also mentioning strengths related to LNG sales.[kk] Moody's indicated that the bond rating could further improve with the expansion of PGW's LNG assets, provided PGW's current financial metrics are maintained. Moody's predicted PGW would need to issue new debt of $250 million in FY 2017 and $100 million in FY 2020 to support the LNG expansion and other improvements, but these liabilities are not expected to increase the utility's leverage on a net basis. In FY 2014, PGW's debt ratio was 68.5% higher than most other gas utilities, but its lowest debt level in about 20 years. Black and Veatch estimated that a 5 Bcf liquefaction expansion would cost $120 million, with $100 million coming from additional long-term debt issued in 2017, raising debt service costs by $6.5 million per year, and $20 million from internally generated funds.[ll]

Figure 1: *LNG Facilities in the U.S. Northeast (Source: U.S. EIA LNG Markets and Uses: June 2004 Update)*

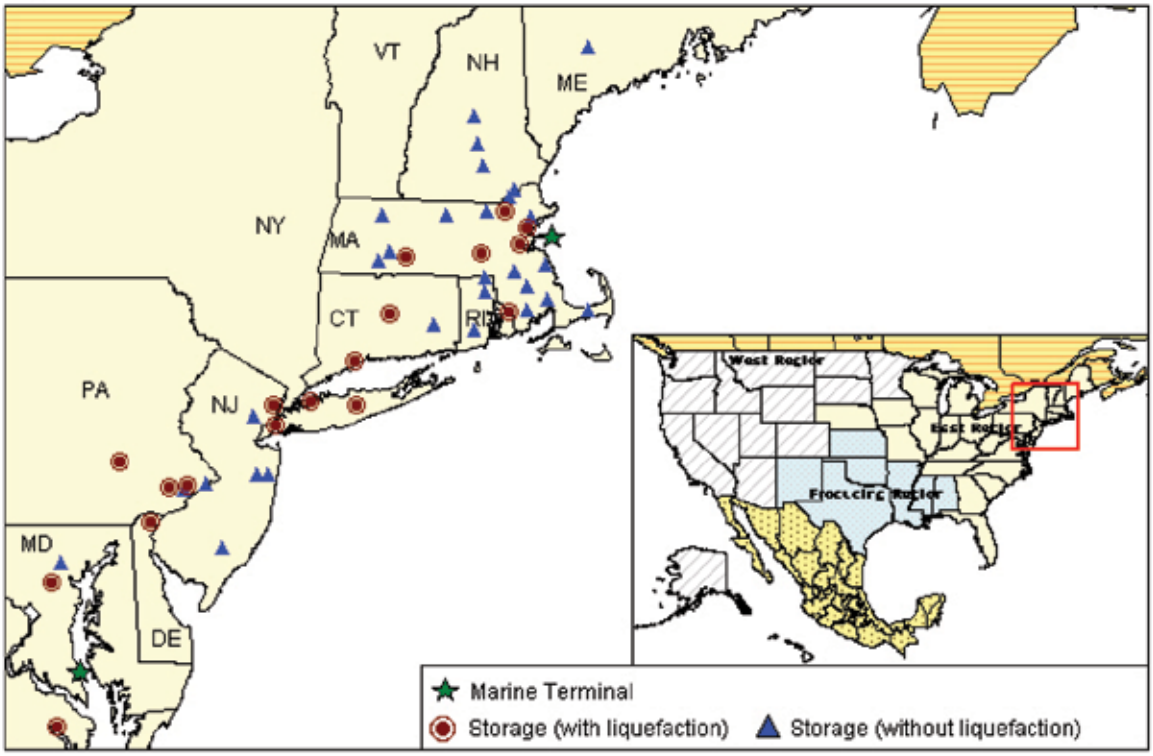
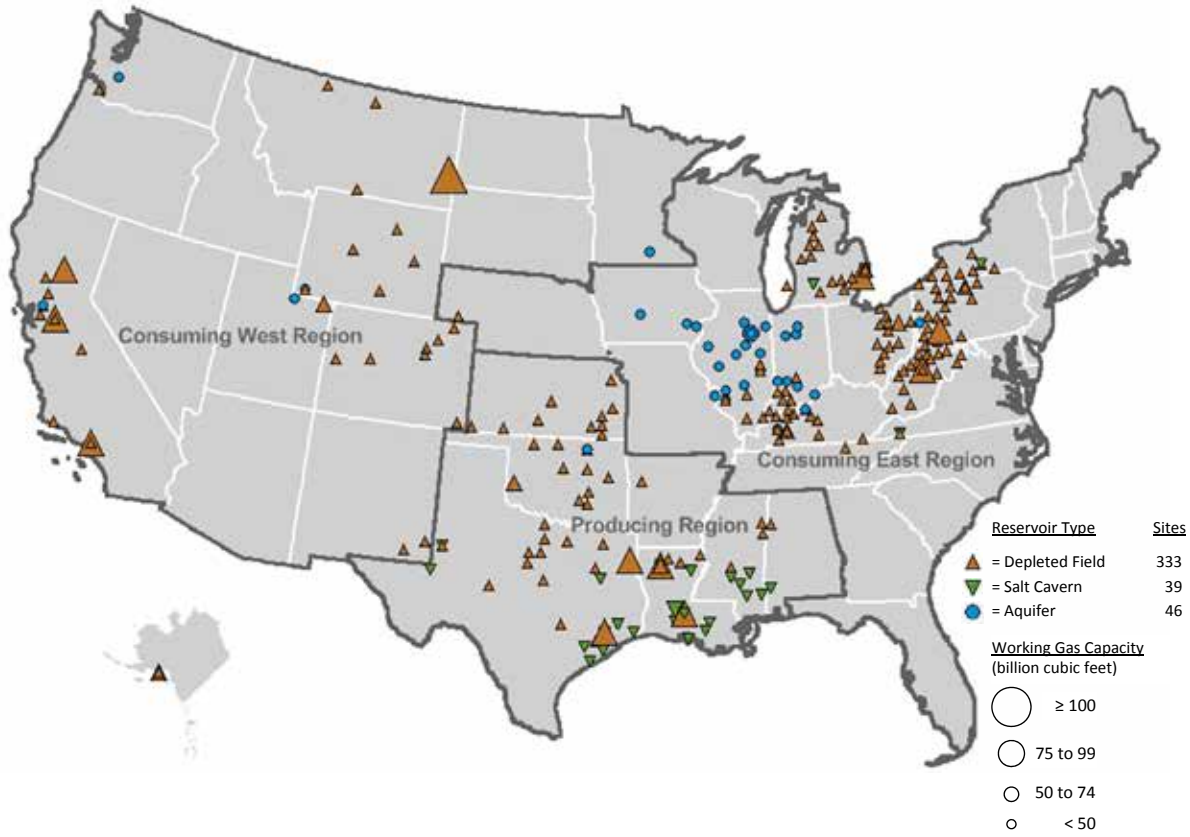


Figure 2: *Location of Existing Underground Natural Gas Storage in U.S., 2014 (Source: U.S. EIA Natural Gas Annual)*



VALUE OF GAS STORAGE

Natural gas is more challenging to store than other types of fuel, like coal and oil. The most common type of natural gas storage is geologic storage, for example, in underground depleted reservoirs and aquifers. Compared to geologic storage, LNG storage facilities have the potential to be strategically located (e.g. near high-demand urban areas) thus avoiding pipeline-constraint related costs and improving security of supply. As you can see from Figures 1 and 2, existing geologic storage capacity does not typically exist near high-demand urban areas of the Northeast and Mid-Atlantic, creating demand for LNG storage facilities in these areas. In addition, pipeline constraints currently exist in these areas, compounding pricing and delivery issues. However, numerous efforts have been proposed to alleviate these constraints.[mm] Today, there are about 100 LNG "peak-shaving" and satellite facilities that produce and/or store LNG, most owned by utilities or pipeline companies. Approximately 60 of these facilities have liquefaction capacity (like the Richmond Plant) and 40 are just satellite storage facilities (like the Passyunk Plant) that receive supply from truck, and sometimes rail or barge.[nn] Expansion of demand—for example in the electric power and industrial sectors—for natural gas is increasing as a result of sustained low prices. The combination of strategically located liquefaction and storage capacity and increased gas demand are positive indicators of the value of additional gas storage capacity, especially given pipeline constraints that current exist in the region. For example, value could be derived through arbitrage (RFP Option #2)—buying low price gas, storing as LNG and selling it at a premium when gas prices are high.

PLANT AND OPERATIONAL SAFETY

The Richmond Plant must comply with over 1,000 safety, security, operations and maintenance procedures required by regulation. These procedures must also be reviewed every 12-15 months and the facility is inspected by the PA PUC once a year.

A 2015 management audit of PGW commissioned by the PA PUC found the Richmond and Passyunk

facilities to be appropriately managed. While not a technical assessment, the report noted 1) there are seven staff members dedicated to safety and plant protection, 2) a computerized system that identifies, plans and schedules maintenance activities is in place at the LNG facilities, and 3) approximately 60% of work orders were related to preventative maintenance and 40% were for corrective maintenance.[oo] According to the audit, one of the goals of effective maintenance management it to increase preventative work orders to reduce corrective work, which the audit believes to be the trend at the LNG gas processing facilities. PGW staff also verbally reported the Richmond facility has gone as long as 7 years without a "lost time injury," defined by the Occupational Safety and Health Administration (OSHA) as an injury to an employee that results in at least one full day of lost work time.

The Richmond and Passyunk Plants have each experienced one significant facility incident. At the Richmond facility in its first year of operation (1969) one of the vaporizing units used to convert LNG back to natural gas caught fire. The issue was traced back to the isopentane fluid used in the heater, which was subsequently replaced with water glycol with no subsequent issues. At the Passyunk facility in 2000, a malfunctioning vaporizer allowed cold gas to enter into the distribution system pipeline. The super cold gas caused the pipeline to crack, with a subsequent explosion and fire, reportedly causing one of the most damaging physical incidents in PGW history.[pp] Neither one of these incidents caused injuries to the public, according to PGW.

EMERGENCY RESPONSE

The Richmond plant has a three tiered alarm system. A general alarm notifies plant workers of a potential issue, a plant evacuation alarm signals immediate evacuation of plant employees, and a civic evacuation alarm notifies the local community of the need to evacuate. The Philadelphia Fire Department attends training at the facility once a year, including a facility tour and training on vital building information manuals. Truck transportation of LNG to the Passyunk facility is coordinated with the Philadelphia Fire Department. According to verbal communication with PGW staff, the organization is also in the process of updating its community action and communications plan related to the LNG facilities.

HEALTH, SAFETY, AND ENVIRONMENTAL CONCERNS: SHOULD THIS BE DONE?

Even if there is a sound and compelling business case to justify expansion and optimization of PGW's LNG facilities, some may question whether the investment should take place based on health, safety and environmental concerns.

SAFETY OF LOCAL COMMUNITY

LNG vapor is extremely flammable, creating the potential for explosions and fires that can present hazards to people and property. LNG vapor can cause asphyxiation, lung damage, and cryogenic burns to human skin. There is also international dialogue expressing concerns about LNG assets as attractive targets for terroristic aggression.[qq] The U.S. Department of Energy maintains that, "For more than 40 years, the safety record of the global LNG industry has been excellent, due to attention to detail in engineering, construction and operations."[rr] In spite of this assessment, members of the local community may have concerns about low probability, high-risk accidents that could harm property or present health and safety concerns.

In March 2014, there was an explosion at a Williams Companies Inc. LNG storage facility located in rural Plymouth, WA. An investigation of the incident faulted inadequate procedures and other factors at the facility for allowing conditions (e.g. oxygen buildup in the system) that generated the explosion.[ss] A pipeline within the facility exploded, causing shrapnel from the explosion to pierce one of the LNG storage tanks, resulting in a large leak. Five plant workers were harmed in the incident and approximately 1,000 area residents and agricultural workers within a 2 mile radius of the plant had to be temporarily evacuated. [tt] Some believe this accident may enhance public concerns about the safety of LNG and could draw greater regulatory scrutiny over LNG facilities.[uu]

INCREASED LNG TRANSPORT TRAFFIC

In general, the public is not likely to be exposed to LNG, as it is typically produced, stored and re-vaporized on a controlled site. However, transport of LNG creates the potential for greater public exposure. Potential

public hazards could include exposure to fire or vapor cloud fire, as well as cryogenic burns that could occur if the extremely cold LNG comes in contact with skin. In addition, a natural gas vapor cloud could act as an asphyxiate. The emerging markets being targeted for LNG supply would primarily take bulk deliveries by tanker trucks.

Truck based transport will increase LNG traffic in and around the industrial area of the Richmond Plant and on the Interstate 95 corridor, as the plant has near direct access to I-95 allowing truck traffic to avoid residential areas. Similarly, the Passyunk Plant has near direct access to major highways, largely avoiding residential district traffic. PGW staff verbally reported that the company has been bulk hauling LNG via trailer truck from the Richmond Plant to the Passyunk Plant since 1969 without incident. PGW also asserts it has sold LNG via trailer truck on an occasional basis to third parties (i.e. other utilities) for decades and approximately 2,000 truck-loads from 2013 to 2015, all without incident.

Woodward and Pitblando (2010) categorize the risks of LNG land transportation to include highway collisions, truck rollover, spills upon loading the storage tanks and storage tank leaks.[vv] However, ability to locate data about the safety performance of bulk transportation of LNG by trailer trucks was limited, and most information simply identifies incidents rather than analyzes comparative safety.[ww] One draft working paper from the National Petroleum Council presented a qualitative safety analysis comparing bulk trailer transportation of LNG to that of hauling gasoline or diesel.[xx] The study noted LNG fuel tanks are double walled compared to the single walled design of gasoline and diesel tankers, providing a comparative advantage to withstand rupture related to physical collisions. In general, the analysis found that the consequences of collision-induced spills, tank failure due to fire, and small leaks were similar or higher for LNG tankers, compared to gasoline or oil tankers. However, the relative probability of these events occurring were all lower for LNG, compared to gasoline or diesel.

The RFP also envisions the potential for marine or rail deliveries; activities that would require access to the Tioga Marine Terminal or Philadelphia Beltline Railway, respectively. Given these associated barriers, a discussion of rail or marine-based LNG transport safety is speculative at this point, and beyond the scope of this paper. Additional research is needed to analyze any potential risks and concerns associated with these transport modes.

REGULATORY BASICS FOR PEAK SHAVING LNG FACILITIES

U.S. DOT—The U.S. Department of Transportation (DOT) sets safety standards for the siting, design, construction and operation of onshore LNG facilities, which are listed under Title 49, Part 193 of the Code of Federal Regulations.[yy] DOT's Pipeline Hazardous Materials Safety Administration (PHMSA) oversees the enforcement of these safety standards. DOT's safety regulations incorporate by reference many siting, design and construction standards for LNG facilities developed by the National Fire Protection Association (NFPA). NFPA is an international nonprofit organization that develops codes and standards meant to save lives and reduce losses associated with fire, electrical and related hazards. PHMSA is not a permitting organization, though PHMSA inspects and overseas LNG peak shaving facilities during construction, after construction, and during operations—and then takes enforcement actions.

FERC—The Federal Energy Regulatory Commission (FERC) grants approval for the siting of new onshore LNG facilities used to facilitate transportation of natural gas in interstate commerce. FERC follows PHMSA's LNG safety standards, but has the ability to issue more stringent standards, when warranted.

Given the split federal authority over LNG facilities, FERC and DOT signed a memorandum of understanding stipulating that, for example, DOT provide FERC with technical assistance related to applicable LNG activities.[zz]

Pennsylvania—The PA Public Utility Commission (PUC) has been certified by the U.S. DOT to carry out inspection and enforcement of federal standards pertaining to LNG peak shaving facilities. The certification process requires state adoption of federal standards and state inspector training. The Commonwealth does not have its own regulations related to LNG peak shaving facilities. However, PA Title 52, Chapter 59.11 requires accidents (e.g. causing injury, costly damages and/or leaks) and any emergency shutdown of a LNG facility to be reported to the PUC. State and local laws pertaining to codes, zoning, environmental permitting (e.g. air, water, waste), and other factors can apply to LNG facilities.

More info about LNG peak shaving facility regulations can be found at http://primis.phmsa.dot.gov/lng/faqs.htm#G2

LNG EXPORT TERMINAL

Some may have concerns that PGW's LNG liquefaction expansion at the Richmond Plant—coupled with its existing storage capacity, location in the Marcellus Shale region, and proximity to the Tioga Marine Terminal on the Delaware River—could one day make the site attractive to serve export markets. Although PGW's RFP is not targeting export market access in this phase, option #4 of the RFP does welcome proposals for a potential second phase of LNG expansion at the Richmond Plant to serve emerging markets, including exports. However, PGW limits the potential second phase to an expansion of up to 500,000 gallons per day or 0.22 million metric tons per annum (MTPA) of LNG. By comparison, most of the national dialogue about export facilities center around much larger facilities. For example, the Cheniere's Sabine Pass facility has the potential for six liquefaction trains, each with 4.5 MTPA of production capacity.

Developing export operations at the Richmond Plant may create concerns in Philadelphia, Camden, and throughout other riverside communities along the Delaware. In fact, in February 2006, Philadelphia's City Council adopted a resolution to memorialize its opposition to PGW's former plans (when gas prices were very high) to convert the Richmond Plant into a large-scale (0.6 Bcfd or 4.23 MTPA) LNG import facility.[aaa] The resolution expressed concerns about regular marine tanker shipments of LNG traversing the Delaware, referenced documents identifying the risks of terrorists targeting the LNG shipments, noted specific strategic concerns about the location of the facility, and identified potential costs to the City for facilitating LNG shipments through populated areas. For this latter point, the resolution cited a cost of $80,000 per shipment to the City of Boston in order to provide security services for each LNG tanker shipment to the Everett LNG facility.[5] The resolution also expressed City Council's intention not to enact the legislation needed to implement the import facility. It is unclear if smaller volume marine-based shipments of LNG, commensurate with the small scale export operations PGW is entertaining, would present similar risks, costs, and political opposition.

In 2013, CH-IV performed an "Export Feasibility Study" for PGW, examining various regulatory considerations and potential technologies for liquefaction capacity volumes ranging from 0.2 to 5 MTPA—approximately 30 to 714 MMSCFD—for the Passyunk and Richmond sites.[bbb] The feasibility study determined the Passyunk plant would not be a good option to host an export facility given the volumes and technologies examined. The report found the Richmond site could potentially be suitable for 4.5 MTPA (about 650 MMSCFD) of liquefaction capacity, given specific assumptions. However, the report also identified certain project obstacles and "fatal flaws" that would prevent development of a large-scale export facility from being realized at the Richmond site. These flaws included 1) the ability of LNG vessels to navigate the Delaware River, 2) alterations to in-tank pumps that could affect the grandfathered status of the storage tanks, 3) expanded infrastructure that could require larger exclusion zones, and 4) uncertainty regarding the ability to acquire or lease property necessary for the export project (e.g. Tioga Marine Terminal).[ccc] In addition, the report estimated over $2 billion in investments needed to convert the Richmond Plant into a 4.5 MTPA export terminal.

On the other hand, Concentric focused its skepticism about large-scale export terminal viability on economic risks related to export plant development costs and robust competition from other LNG export facility proposals. Before spending almost $2 billion to construct export capabilities, PGW (and/or its partner) would have to invest millions in permitting and other development costs that could be stranded if the project does not come to fruition.[6] In addition, there are a significant number of export plants that have already begun the process of seeking the required federal permits to export LNG. According to the U.S. Federal Energy Regulatory Commission, as of May 19, 2016, there were nine LNG export terminals approved and under construction, three approved but not under construction and 22 proposed or pre-filed applications for LNG export terminals in North America.[ddd]

Lastly, serving global LNG markets is particularly risky, due to competition from new LNG export supply facilities (e.g. from Australia), market displacement from

[5] According to Woodward and Pitblano (2010, p. 14) marine shipments of LNG bound for the Everett LNG terminal are highly secured, because they pass through the highly-populated Boston harbor area. Security measures include but are not limited to: suspension of overhead flights by commercial aircraft, advanced notification of local police, fire, emergency agencies, the Federal Aviation Administration and U.S. Navy, enforcement of a security zone two miles ahead and one mile to each side of the LNG tanker, harbor escort by armed patrol boats, and additional measures, some of which cannot be disclosed to the public.

[6] On the other hand, $2 billion in construction and millions in development costs is extremely cost-competitive with proposals for new LNG export facilities, which can cost $10 billion or more to build.

foreign competitors (e.g. Russian pipeline expansion), uncertainties about growth in global demand (e.g. from Asia), and assumptions about price indexing (e.g. indexing to oil prices, Henry Hub).

The factors above combine to create a bleak outlook for large-scale export ambitions at the Richmond facility, while the viability of smaller scale operations is less clear.[7] Please refer to Figure 3 for more information on comparing various LNG project and proposal volumes.

ENVIRONMENTAL CONCERNS

Some may have concerns about the environmental impacts of the facility's operations. Members of the local community may also be concerned with environmental contamination neighboring the PGW site. In addition, some members of the public have concerns about the environmental impacts of natural gas development (e.g. related to hydraulic fracturing) and use (e.g. related to fossil fuels and climate change) in Pennsylvania and beyond.

[7] However, it is worthwhile to note that enhancing Richmond's access to low-cost Marcellus Shale gas supply via construction of new pipeline capacity could improve export plant economics.

Facility Pollution

Environmental issues to potentially manage at a generic LNG peaking facility may include but are not limited to: air emissions (e.g. fuel combustion for power or heat, exhaust gases, venting or flaring), wastewater (e.g. for LNG process cooling and reheating), waste and hazardous material management. According to the U.S. EPA, the Richmond Plant does not report to the Toxic Release Inventory (TRI) since it does not exceed TRI's threshold of toxic chemical use. However, TRI reports the facility holds permits (e.g. Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act) that expect production, release, or management of TRI-reportable chemicals.

Publically available data indicates that over the past three years the Richmond facility has been in compliance with the Clean Water Act, Resource Conservation and Recovery Act and Clean Air Act (CAA), except for two CAA violations (in Q4 2014 and Q2 2015). The 2014 and 2015 CAA violations both pertained to the use of backup generators during non-emergency conditions. Both violations were later

Figure 3: *Volume and Flow Rate Chart for Various LNG Scenarios*

Project	Daily			Annual	
	MMSCFD	Bcfd	Gallons	MTPA	Bcf
2006 Import Proposal					
Philadelphia Freedom Center	600	0.6	7,263,923	4.23	219
CH-IV Export Feasibility Study	30	0.03	362,175	0.2	8.2
	714	0.71	8,929,000	5	260.6
CH-IV LNG Plant Feasibility Study	12	0.012	145,278	0.06	3.3
	21	0.021	254,237	0.11	5.7
	24	0.024	290,557	0.13	6.6
	35	0.035	423,729	0.19	9.6
2016 RFP					
New Liquefier	21	0.021	254,237	0.11	5.7
Option #4 (Phase Two, Maximum)	41	0.041	500,000	0.22	11.3
Richmond Plant					
Cascade (Retired)	25	0.03	312,569	0.14	7.1
Expander (Operational)	16	0.16	193,705	0.03	1.8

rescinded by the City of Philadelphia's Air Management Services, after recognizing the need for the generators to run to ensure plant safety during maintenance activities.[eee] There was no data reported to TRI on the Passyunk facility.

PGW submits data to EPA on its distribution system-wide greenhouse gas (GHG) emissions, however eligible LNG facilities must report as a separate industry segment. According to PGW, the Richmond and Passyunk facilities are not required to report to the EPA's GHG reporting database, because they emit less than the reporting threshold.

In the 2016 RFP, PGW discloses there is hazardous substance contamination at both the Richmond and Passyunk Plants. Although the nature of the contamination is not disclosed in the RFP, PGW maintains the contamination is related to the now ceased Franklin Smelting operations. PGW monitors the groundwater and soil contamination at the Richmond (facility #660666) and Passyunk (facility #660669) Plants through the Pennsylvania Department of Environmental Protection voluntary Land Recycling (Act 2) program. PGW expressed it has plans to seek Act 2 closure for the Franklin Smelting portion of its property (which has undergone surface remediation by the EPA) with the assumption that PGW will continue to use this land to support PGW operations.

Neighboring Superfund Site

Some members of the local community might have concerns about LNG activities destabilizing environmental contamination near or on the PGW property. The site of the now inactive Franklin Smelting and Refining Corporation lies immediately east of the Richmond plant. The 3-acre Franklin Smelting property is designated by the U.S. Environmental Protection Agency (EPA) as a Superfund site, due to a pile of copper-smelting byproduct waste (called slag) that exists at the site.[8] The U.S. EPA owns and controls the Superfund site. Although the site has not been remediated, the slag material that is contaminated with lead, beryllium, copper, and other materials is currently listed as being under control for human exposure through a system of fencing and a high density polyethylene cover.

[8] For more information about the Franklin Slag Pile (MDC) superfund site, please visit https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0305549

[9] The RFP also preserves the right for PGW's Director of Risk Management to approve alternatives to the stated minimum coverage.

Environmental Impact of Natural Gas Development

The debate about the benefits and drawbacks of "fracking" for natural gas with respect to land, air and water pollution, and/or the role natural gas plays in helping or harming global climate change is beyond the scope of this paper. It is material to note that perspectives in these debates tend to be polarized and emphatic, resulting in controversial and publicized discourse. Any discussion in Philadelphia surrounding the expansion of infrastructure to use natural gas is likely to be subject to these passionate debates.

MANAGING ECONOMIC RISK: HOW WILL THIS BE DONE?

There is the potential for economic risks associated with the LNG expansion and optimization project. This section explores some of the economic risks policymakers and the public should be aware of in order to require and assess appropriate risk mitigation strategies.

ADEQUACY OF INSURANCE COVERAGE FOR CATASTROPHIC RISK

The RFP identifies specific minimum insurance requirements that potential partners must obtain if they plan to engage in filling tanker trucks from the LNG fueling station at the Richmond Plant.[9] The RFP identified coverage quality criteria and specified policies to include workers compensation and employer's liability, commercial general liability, automobile liability, and excess/umbrella liability. The insurance policies must name applicable City entities as additional insured and there is a separate indemnification clause protecting these City entities. The RFP envisions the potential for the buyer/partner to self-insure, provided they have proper qualifications (e.g. state approval).

The RFP does not address existing or additional insurance requirements applicable to the LNG facility or expansion, most likely because this information is beyond the scope of the RFP's goals to identify potential product buyer/partners. In fact, there are no U.S. DOT requirements for insurance at LNG peak shaving facilities, rather, it seems coverage may be an

individual company's business decision. In general, PGW self-funds its casualty liability coverage at $1 million per occurrence and $1 million per claimant, in addition to $210 million in excess liability coverage provided by a third-party vendor.[fff] Also of relevance is PGW's $250 million property insurance coverage provided by a third party vendor.[ggg]

As a comparable, Securities and Exchange Commission (SEC) filings of Cheniere Energy Inc—owner of the Sabine Pass LNG production, storage, and export terminal—were examined to understand potential risks, planning, and insurance practices.[10] Cheniere's 10-K filing identifies certain business related risks of relevancy, the document states the company is "…subject to significant operating hazards and uninsured risks, one or more of which may create significant liabilities and losses…"[hhh] More specifically:

> *"The operation of our LNG terminals and construction of liquefaction facilities are subject to the inherent risks associated with these types of operations, including explosions, pollution, release of toxic substances, fires, hurricanes and adverse weather conditions and other hazards, each of which could result in significant delays in commencement or interruptions of operations and/or in damage to or destruction of our facilities or damage to persons and property. In addition, our operations and the facilities and vessels of third parties on which our operations are dependent face possible risks associated with acts of aggression or terrorism.*
>
> *We do not, nor do we intend to, maintain insurance against all of these risks and losses. We may not be able to maintain desired or required insurance in the future at rates that we consider reasonable. The occurrence of a significant event not fully insured or indemnified against could have a material adverse effect on our business, contracts, financial condition, operating results, cash flow, liquidity and prospects."*

Certainly, Cheniere's large-scale marine terminal and export market activities create additional risks and loss/liability potential, beyond the risks associated with PGW expanding and operating a smaller scale liquefaction, storage and truck fueling and transport operation. However, there are basic risk parallels between these industrial energy operations.

COMPETITIVE RISKS

There are a variety of factors that could negatively impact the market opportunity or competiveness of PGW's expanded LNG assets, therefore, negatively impacting consumers. Emerging market opportunities could fail to materialize. For example, diesel prices could become more attractive compared to LNG, impacting LNG demand from long-haul trucking, gas drilling and other emerging markets. Alternatively, new infrastructure (e.g. gas pipelines, gas processing or new LNG storage) that allow for access to lower-cost gas could be constructed that could more attractively serve emerging markets.

For PGW, exposure to these competitive market risks raises questions about how these risks will be allocated between PGW owners (the City) and its customers.[iii]

COST OVERRUNS

The LNG liquefaction expansion construction project or annual plant operations and maintenance costs could be higher than anticipated. In addition, significant sunk costs could be contributed to design and planning of the expansion project, without realization of the completed facility. If cost overruns occur, PGW may need to issue new debt to support these costs. PGW will have to carefully manage the risk of plant construction or operation cost overruns. If these overruns do occur, it is not clear, for example, how to separate out costs to the City (for debt) versus costs to consumers.

According to data supplied by PGW, the company successfully managed the 2005 addition of the Expander liquefaction unit at the Richmond Plant at approximately $10,000 under budget, indicating the company has relatively recent experience in efficiently managing a project of similar scope.

[10] All things being equal, the risks associated with PGW's liquefaction, storage, and land transport plans are likely to be less than the risks associated with Cheniere Energy's higher volume liquefaction, storage, and marine-based export plans. A better comparison would be to compare like-to-like peak shaving facilities. However, the accessibility of Cheniere's SEC filings coupled with the company's LNG business focus provided a more LNG-specific risk profile, compared to businesses that operate LNG within a broader portfolio of activities.

CONCLUSION

This report will not offer an opinion on whether or not to move forward with PGW's LNG sales and optimization plans. Rather, this report provides a framework for understanding and evaluating the feasibility of the project, project benefits and risks, and key risk management considerations. Ultimately, if PGW generates enough private sector interest in developing the project, it will be policymakers and the public that must determine willingness to move forward.

If the public and policymakers ***want to move forward*** with the PGW's LNG sales and optimization plan, the following considerations may be valuable:

Project Feasibility

Insofar as possible, seek regulatory and legal opinions on project feasibility—related to grandfather status, permit requirements and legal constraints—as early as practicable, with the goal of minimizing taxpayer and ratepayer investments on speculative enterprises.

Health, Safety, and Environmental Concerns

Education about LNG, and related safety measures may be beneficial to addressing community, ratepayer and policymaker concerns about LNG safety risks. Input from state and federal regulators can add context to the discussion, which could include best practices that exceed regulatory minimum standards.

Provide education on existing emergency response and coordination plans to allow policymakers and other relevant officials to determine if enhancements are desired.

Seek early clarification from City Council on their views of PGW's small-scale LNG exports option, given Council's 2006 opposition to large-scale LNG imports. This will allow the private sector and the public to understand if this option is feasible. If feasibility is affirmed, further research will be needed to identify specific concerns, risks, benefits, and risk mitigation strategies associated with small-scale export operations.

Given the prolonged, national debate about the environmental benefits and drawbacks of increased natural gas production and use, it is unlikely agreement will be reached in the context of this project. Therefore, the discussion may need to center around Philadelphia-area consumer willingness to pay increased rates to avoid the environmental impacts of increased gas use via the LNG expansion. There may or may not be acceptable compromises that focus on environmental outcomes. For example, expansion of PGW's robust consumer-focused energy efficiency programs could serve as an environmentally neutral trade-off for LNG expansion. This compromise would result in forgone revenues, and may warrant exploration of complimentary policy (e.g. revenue decoupling).

Economic Risk Management

Transparently identify and determine the optimal balance between risk reduction and customer benefits. Maximizing project revenues and margins can create significant benefits for customers. On the other hand, adequately managing project, operational, and economic risks also benefits customers, though there are associated costs or foregone revenues. Policymakers should consider requiring transparent identification and evaluation of project risks, various risk reduction strategies and their related costs. This evaluation can assist in making decisions about the level of costs or foregone revenues to accept in exchange for risk mitigation, with the goal of maximizing net customer benefits.

Evaluate the adequacy of PGW's insurance coverage for operational and catastrophic risk, based on expanded LNG activities.

Transparently identify methods for limiting competitive risk and construction project overruns and identify how these risks will be shared between the City and PGW customers.

If the public and policymakers ***do not want to move forward*** with the LNG sales and optimization there should be an immediate examination of alternatives to address revenue issues.

Numerous analyses have identified PGW's LNG assets as a valuable leverage to benefit consumers, for example by increasing revenues to allow for deferred rate increases and/or accelerated replacement of at-risk cast iron and unprotected steel pipes. PGW is responsibly examining expansion of these assets, as a result. If policymakers and the public do not want to leverage these assets, there needs to be an acknowledgement that revenues will be foregone, likely leading to increased rates for firm customers and/or slower safety-related infrastructure improvements.

This paper suggests that rejection of the LNG optimization effort should be accompanied with an immediate effort to investigate (including examination of existing studies, such as the PUC Staff and Concentric reports) feasible alternative strategies (i.e. within the control of Pennsylvania policymakers) and policies to address revenue issues.

APPENDIX A – MAPS OF RICHMOND AND PASSYUNK PLANTS

Figure 4: *Richmond Plant at 3100 East Venango Street, Phila, PA 19134*
(Image Courtesy of CH-IV Liquefaction Feasibility Study)

Figure 5: *Richmond Plant Neighborhood*

Figure 6: *Passyunk Plant at 3100 West Passyunk Avenue, Phila, PA 19145*
(Image Courtesy of CH-IV Liquefaction Feasibility Study)

Figure 7: *Passyunk Plant Neighborhood*

ENDNOTES

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