



PHILADELPHIA GAS WORKS

HIGHEST AND BEST USE STUDY

**PREPARED FOR
PHILADELPHIA CITY COUNCIL**

OCTOBER 2014

EXECUTIVE SUMMARY

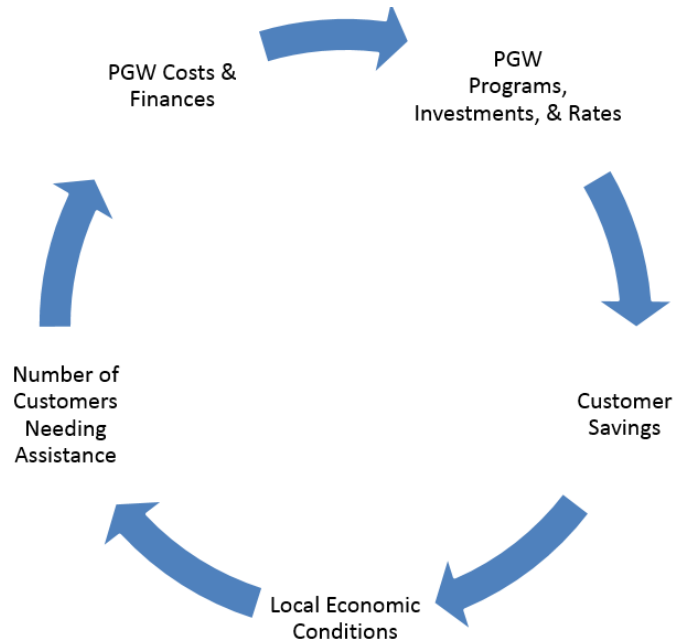
INTRODUCTION

An assessment of the “highest and best use” (“HBU”) of the Philadelphia Gas Works (“PGW”) examines the potential and credible use of PGW’s assets to increase their value for its customers, owner, employees, and the citizens of Philadelphia. These assets include an underground network of distribution pipes and related facilities, liquefied natural gas (“LNG”) facilities, an experienced workforce, existing customer relationships with a large proportion of Philadelphia households and businesses, and access to attractive markets. PGW’s core business, the sale and delivery of natural gas, has a substantial price and environmental advantage over distillate and residual fuel oils that are used in residential, commercial and industrial applications. PGW has also begun selling its surplus LNG inventories into transportation and other emerging markets based on a competitive advantage over diesel oil. PGW can also leverage the various strengths of the City of Philadelphia, including its location within a large and diverse Northeast/Mid-Atlantic metropolis, access to well-developed road, rail, and marine infrastructure, outstanding higher education and medical institutions, and most recently, proximity to the Marcellus Shale, one of the largest natural gas developments in the history of North America which promises to contribute to competitively priced natural gas commodity for the foreseeable future.

This HBU report recognizes and builds upon: (1) PGW’s current mission: to deliver competitively priced natural gas safely and reliably to all customers and to help these customers use natural gas as efficiently as possible; (2) PGW’s long history of ensuring an affordable energy supply for customers that are in need of support; and (3) the role PGW can and does play in the economy and social fabric of Philadelphia. PGW and its customers stand to gain from increased utilization of existing distribution facilities by spreading the fixed costs of these assets over larger volumes and the City will benefit from an improved economy. As shown in Figure ES-1, the fortunes of PGW, its customers, and the City of Philadelphia are linked, placing PGW in a unique position to both contribute to the community and improve its own financial position. A strong PGW will have the resources

necessary to meet its public service obligations, pursue new markets, and finance new infrastructure.

Figure ES-1: PGW's Integration with the City



HIGHEST AND BEST USE STRATEGY

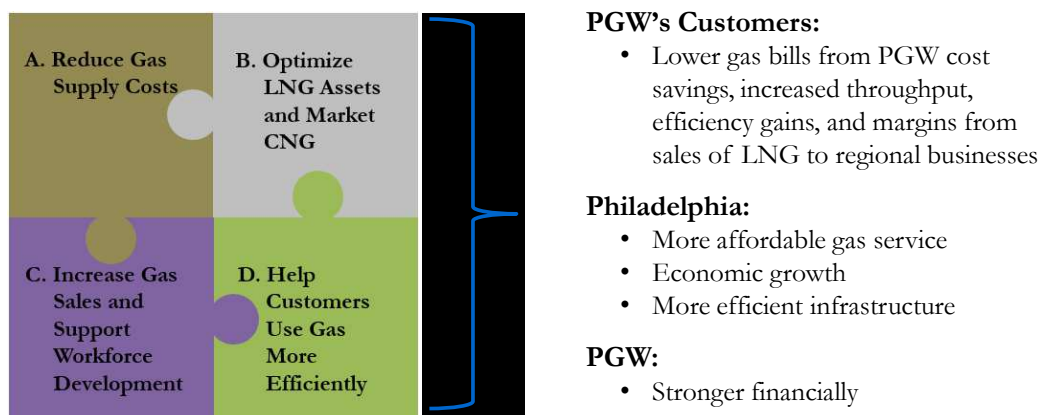
Concentric has identified six specific opportunities for PGW to contribute to the City of Philadelphia's economic growth and public welfare, while enhancing its own financial strength. Significantly, all of these opportunities derive from its core gas business: the sale and delivery of natural gas and related products and programs that help customers use less energy. PGW is already engaged in several of these activities and Concentric is proposing that it either continue or expand these efforts. While the opportunities can be considered individually or in subsets, Concentric has crafted them as an integrated collection that can work together to achieve the following goals:

- Minimize PGW's gas supply and delivery costs over the long-run;
- Contribute to Philadelphia's economy by retention and attraction of businesses and by providing employment opportunities to its citizens;

- Grow top-line and net revenues from traditional regulated services and emerging competitive market opportunities to enhance PGW's financial position;
- Increase energy efficiency of PGW customers in the near term, and improve the efficiency of buildings in Philadelphia over the long-run; and
- Support Philadelphia's economic and social policy goals.

As shown in Figure ES-2, Concentric has identified a highest and best use strategy with four components.

Figure ES-2: PGW Opportunities



Six HBU Opportunities => \$27 - \$33 Million/Year for PGW

- | | |
|---|---|
| <p>A. ① Diversify the Gas Supply Portfolio</p> <p>④ Pursue CHP, Help Businesses Grow and Convert Customers to Gas</p> <p>C. ⑤ Support Energy Industry Workforce Training Programs</p> | <p>B. ② Optimize LNG Assets</p> <p>③ Support Development of a Regional NGV Market</p> <p>D. ⑥ Invest in Customer Premises to Lower Energy Bills</p> |
|---|---|

These opportunities are closely related. Taken as a whole, they have the potential to reduce the natural gas bills of PGW's customers over the medium to longer-term, particularly if PGW is able to achieve additional efficiencies in acquiring gas supply or in performing its distribution function. PGW customers can apply these savings to improve their own finances, invest in their businesses, or spend on goods and services within and outside of the City. It may also be best for PGW to retain a portion of these savings to support programs that help attract new businesses to Philadelphia, help existing customers use less natural gas,

and invest in the integrity of the distribution network. An improved local economy, with job training for Philadelphia's workforce, can potentially improve the quality of life of many families and reduce the number of customers that have to depend on financial assistance to heat their homes. Finally, select investments in new competitive business opportunities that are closely related to PGW's core business, such as growth of LNG and compressed natural gas ("CNG") sales, can provide substantial new margins to flow directly back to PGW's customers or to defer contemplated increases in rates.

Each of the six opportunities are discussed in detail in Section IV of the report and are summarized below, organized by the four components presented in Figure E-2.

A. Reduce Gas Supply Costs

Opportunity 1: Diversify PGW's Gas Supply Portfolio

Diversifying PGW's gas supply portfolio could potentially lower the cost of gas to PGW and lower customer gas bills. PGW currently sources all of its natural gas from the Gulf Coast, relying on long-term contracts with pipeline companies to deliver the gas to PGW's facilities. This strategy has served PGW and its firm sales customers well, insulating them from price spikes and volatility. In fact, the stable Gulf Coast prices provide a near-term opportunity for PGW to take advantage of arbitrage sales, when Mid-Atlantic prices spike as they did this past winter. However, both PGW firm sales and transportation customers would likely benefit in the medium to longer-term if new pipeline capacity is developed to serve the Philadelphia market and PGW has the option to transition a portion of its existing supply portfolio from the Gulf Coast to Marcellus-based production (assuming the economics make sense). While new pipeline capacity may be more expensive than PGW's current capacity, the current Marcellus price advantage is significant and expected to remain favorable. In addition to likely reductions in gas supply costs, further diversifying PGW's supply would provide a hedge against future price increases in either the Gulf Coast or Marcellus.

To put this in perspective, a relatively modest \$0.20/Mcf reduction in the average delivered cost of gas to PGW's sales customers would yield savings of approximately \$11 million per year. New pipeline capacity connecting Marcellus production to the Philadelphia area would also reduce the cost of natural gas for PGW's transportation customers that acquire their supplies in the Philadelphia market. These transportation customers - which are large consumers of natural gas and among the City's largest employers - would save approximately \$6 million per year if they were to achieve the same \$0.20/Mcf in savings.

However, these developments require financial commitments from large shippers. While PGW cannot cause new pipeline capacity to be developed, it can signal its interest to the market and respond to requests for expressions of interest (“open seasons”) from entities that are considering developing pipelines to the Philadelphia market. These projects can take a few years to develop, particularly if they encounter siting challenges.

B. Optimize LNG Assets and Market CNG

Opportunity 2: Optimize the Value of PGW’s LNG Assets

PGW has an opportunity to expand its existing LNG facilities to serve new emerging markets, earning margins that will benefit its customers. PGW’s ability to maximize the value of its two LNG facilities is limited by their current configuration and technology, resulting in an underutilization of PGW’s 4 Bcf storage tank capacity. While PGW has been able to sell surplus LNG into emerging markets and earn meaningful margins since April 2013, PGW forecasts diminishing “off-system” sales as it must husband its LNG inventories to be available to serve sales customers should Philadelphia experience a colder-than-normal winter or extended periods of cold weather. Concentric’s assessment indicates that the market opportunity is certainly viable, with consideration to market risks. An expansion of the liquefaction capacity at the Richmond facility would address the sub-optimal configuration and support more aggressive pursuit of the emerging markets. Our preliminary analysis indicates that PGW can more than double its margins from off-system sales to the \$7.7 to \$10.0 million range, yielding a four to eight-year payback period on the investment depending on the actual costs to construct the liquefaction expansion and the margin earned on LNG sales. Concentric recommends that PGW perform a detailed site-specific engineering analysis of an optimally sized expansion of its LNG liquefaction capacity as well as a more detailed market study and provide the PGC and City Council with a business case to consider, supported by any necessary legal opinions, particularly if a Public Private Partnership is contemplated to avoid some of the risk of competing in this market.

Opportunity 3: Support the Development of a Regional Natural Gas Vehicle (“NGV”) Market

NGVs are a potential longer-term market for PGW with the opportunity to increase revenues and margin. CNG is used primarily in vehicles, ranging from small passenger cars to heavy trucks and busses. While more expensive to purchase than gasoline-fueled vehicles, they have lower operating costs as a result of the current price differential between CNG and gasoline products and reduced maintenance requirements. NGVs also emit approximately 20% less greenhouse gases, significantly less smog-inducing Nitrous Oxide gases and almost no fine particulate matter (one of the most harmful pollutants to human health when ingested into the lungs). However, despite Federal

Government tax incentives, the national NGV market has not yet sufficiently progressed to support the development of regional or cross-country networks of filling stations that would be required to encourage conversions, especially among long-distance travelers. PGW has an opportunity to support the development of the regional NGV market by converting its own fleet to CNG and working with the City to convert other City-owned fleets. Municipal fleets and other fleets that travel within a smaller geographical area are an ideal target because CNG vehicles have only half the range of conventional gasoline vehicles. PGW has recently acquired 24 NGVs (sedans) and is evaluating the development of a private CNG refueling station on PGW property. PGW is also marketing to a dozen privately-owned fleets in the area with a goal of selling 1 Bcf/year by 2020. PGW would benefit by generating margins from the sale of CNG to third-party public and private fueling stations that are built in the area. While PGW can demonstrate support for this market by converting its own vehicles, the highest and best use opportunity depends on conversion of other fleets that are based within the City and refuel at private or public CNG refueling stations that rely on natural gas delivered by PGW. This opportunity does not have as large an economic value as the prior two opportunities and depends largely on whether PGW can support conversion of City-based fleets to CNG and the development of public and private refueling stations within Philadelphia.

C. Increase Gas Sales and Support Workforce Development

Opportunity 4: Pursue Combined Heat and Power (“CHP”), Help Businesses Grow, and Convert Customers to Natural Gas

PGW can help business customers lower their energy costs and expand their operations within the City. This opportunity includes support and subsequent sales of natural gas to larger customers that would benefit from CHP as an efficient solution for their significant electricity and thermal needs. PGW has already installed CHP at the Four Seasons Hotel, and at six other locations that are projected to have a total annual natural gas demand of over 100,000 Dth which should add approximately \$450,000 in revenues that are recovered through PGW’s Delivery Charge. PGW has an active marketing campaign with proposals to over 25 other customers with a potential total load of over 2.5 million Dth/year. CHP may be the most promising and immediate opportunity that PGW has to add load and generate margins

There are other opportunities for PGW to contribute to economic growth, engaging directly with business customers that are considering expanding existing facilities or relocating to Philadelphia as well as working collaboratively with industry and City government agencies. These include marketing of PGW’s existing CHP and energy efficiency programs, and working with customers to help them take advantage of government funding that may be available. Local efforts to turn Philadelphia into an

Energy Hub, including businesses that compete in the NGL market, also create potential large consumers of natural gas that can be served by PGW. PGW can work with firms that are building or expanding operations in the City and increase the capacity of the local distribution network to reliably serve a growing load and provide a financial contribution toward any main extensions that may be required under its existing Tariff 10. There is an opportunity for PGW to collaborate with other leading public and private organizations in the City to support the growth of NGL and other energy-related businesses, although Concentric recommends emphasis on technical advisory and other support services over rate discounts.

Finally, there is an opportunity to convert homes and businesses from oil to natural gas for heating and other end-uses, although PGW already has a relatively high saturation of residential and commercial end-uses. Expanded conversion programs require an investment in PGW's marketing capabilities but the contribution to margins and the ability to spread the fixed costs of PGW's facilities over larger volumes are significant. For example, each additional 1 Bcf of sales to business customers generates approximately \$4.5 million in non-fuel margin revenue (at \$4.50/Mcf), most of which contributes to the recovery of system fixed costs. Although some loads may require a financial investment from PGW, pursuit of the most economic opportunities will reduce rates to all customers.

Opportunity 5: Support Energy Industry Workforce Training Programs

The City will need a larger pool of trained workers to support expansion of its energy industries. Like many LDCs, PGW has an aging workforce and will need trained workers to manage, operate, and maintain the distribution system after the retirement of its most experienced workers. More importantly, Philadelphia's ability to attract energy-related businesses in its efforts to become an energy hub will be greatly enhanced if businesses are able to draw from a larger pool of trained workers. Philadelphia has both workers and students that could take advantage of this opportunity with the right training. PGW can serve in coordinating and sponsorship roles, working with other local businesses, City government, and local educational institutions to design and develop training programs at Philadelphia-based vocational/technical high schools, trade schools, community colleges and four-year colleges to provide greater access to Philadelphia residents. PGW and its customers will benefit from a trained workforce, as will other energy businesses. The City will benefit by helping citizens gain the training that they need to secure energy industry and related employment.

D. Help Customers Use Gas More Efficiently

Opportunity 6: Invest in Customer Premises to Lower Energy Bills

Lower energy bills help residential and business customers by freeing up funds that can be devoted to other uses. PGW is faced with a unique challenge to reduce the energy costs of its CRP customers whose bills are based on their income level, and not directly on the amount of natural gas that they use. Since CRP customers' gas consumption is more than 50% higher than for non-CRP residential customers, this contributes to the approximately \$70 million in annual CRP subsidies paid for by PGW's other customers. PGW and its customers have a direct interest in improving energy efficiency by CRP participants and indeed, PGW has been focused on providing these programs through its Enhanced Low Income Retrofit Program ("ELIRP"). PGW should maintain this focus while pursuing improvements to program design and execution.

At the same time, an effort should be made to spend up to the budget for programs that target business customers, as relatively less attention has been paid to the business segment of the energy efficiency market. On June 21, 2012, City Council passed an ordinance that provided for benchmarking of the energy and water usage of large commercial buildings (50,000 square feet or more). Philadelphia is one of several cities across the United States that has recognized the value of benchmarking energy usage against buildings of similar size and characteristics. This benchmarking data will be publicly available in 2015 and should generate interest in retrofit investments among PGW's commercial and industrial customers. This may not require any increase in funds allocated to energy efficiency in the next five-year energy efficiency program (assuming it will be developed over the coming year), but energy efficiency actions that are driven by benchmarking results will provide immediate gas savings to participating business customers. The early evidence from benchmarking in other Cities indicates that some buildings have reduced their energy bills (electricity and natural gas) by as much as 25%.

CONCLUSION

Each of these six opportunities is either part of or closely integrated with PGW's core business. Indeed, PGW is already providing many of these services to varying degrees. They each rely on existing PGW competencies. Collectively, the six opportunities identified by Concentric will make significant strides toward achieving the highest and best use for PGW. Opportunities 1, 2, and 4 have the potential to generate \$27 million to \$33 million of cost savings or incremental revenues per year, contributing to both lower customer bills and a financially stronger PGW. To the extent that some portion of these savings are either spent

or invested in Philadelphia, this would increase the benefits. Although more difficult to quantify, Opportunities 3, 5, and 6 also contribute substantially to these constituencies and more broadly to the City of Philadelphia.

There are certainly challenges to achieving PGW's highest and best use that will have an impact on the overall strategy, selection and prioritization of particular opportunities, and the approach to execution. Execution, in particular, is always a challenge and requires an informed and well-conceived strategy, public support, strong leadership, and commitment to success throughout the organization. Opportunities such as the sale of LNG that involve competing in a market environment introduce market and execution risks that differ from and are riskier than more traditional utility services. This is a matter that becomes particularly significant because a major investment is required to support the new business. Further, the enterprise would have to be defined in such a way that it would be a permissible use of PGW's capital financing, and would have to be structured to fall within the available legal framework.

In contrast, Concentric considers to be non-viable any opportunity that is either clearly outside of PGW's core business, relies primarily on competencies that it does not currently possess and that cannot be easily acquired, or would impose unacceptable financial risk on PGW such that it might threaten its ability to meet its obligations as a public utility. There are two such opportunities that have been a topic of discussion in the context of transforming Philadelphia into an Energy Hub. These would either have PGW (1) develop an LNG export facility, or (2) become a transporter and/or seller of NGLs. Each of these markets is a well-developed global market dominated by large corporations that possess the resources necessary to finance the required infrastructure and absorb the market risks. Concentric views a dramatic expansion to serve LNG export markets as unrealistic and non-viable under any PGW partnership or ownership structure. PGW is too late to the competition and does not have an advantaged location. Concentric views the NGL opportunity as a potential source of new customer load but taking on an active role as a buyer, transporter, or seller of NGLs is beyond PGW's core business.

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GLOSSARY

Bcf	Billion cubic feet
Bcf/d	Billion cubic feet per day
CBA	Collective Bargaining Agreement
City	City of Philadelphia
City Council	Philadelphia City Council
CH-IV	CH-IV International
CHP	Combined Heat and Power
C&I	Commercial and Industrial
CICIP	Commercial Industrial Customer Incentive Program
Concentric	Concentric Energy Advisors, Inc.
CNG	Compressed Natural Gas
CRP	Customer Responsibility Program
DCED	Pennsylvania Department of Community & Economic Development
DEP	Pennsylvania Department of Environmental Protection
DIMP	Distribution Integrity Management Program
DOE	United States Department of Energy
DOT	United States Department of Transportation
DSIC	Distribution System Improvement Charge
DSM	Demand Side Management
Dth	Dekatherm
ECA	Emission Control Areas
EIA (or USEIA)	United States Energy Information Administration
ELIRP	Enhanced Low Income Retrofit Program
EPA	United States Environmental Protection Agency
FERC	U.S. Federal Energy Regulatory Commission
FY	Fiscal Year
FPL	Federal Poverty Level
HBU	Highest and Best Use
HDV	Heavy Duty Vehicles
IMO	International Maritime Organization
kW	kilowatt
LCP	Landlord Cooperation Program
LDC	Local Distribution Company
LIHEAP	Low Income Home Energy Assistance Program
LNG	Liquefied Natural Gas
LTIIP	Long-Term Infrastructure Improvement Plan
MA DHCD	Massachusetts Department of Housing and Community Development
MARPOL	International Convention for the Prevention of Pollution from Ships
Mcf	Thousand cubic feet
MMBtu	Million British Thermal Units
MMcf	Million cubic feet
MMcf/day	Million cubic feet per day

MW	Megawatt
NEPA	National Environmental Policy Act
NGL	Natural Gas Liquid
NGV	Natural Gas Vehicle
NPV	Net present value
NYMEX	New York Mercantile Exchange
O&M	Operation and Maintenance
PA PUC	Pennsylvania Public Utility Commission
PFMC	Philadelphia Facilities Management Corporation
PGC	Philadelphia Gas Commission
PGW	Philadelphia Gas Works
PHMSA	United States Pipeline and Hazardous Materials Safety Administration
PJM	PJM Interconnection
PPP	Public Private Partnership
QST	QST Energy, Inc.
SMR	Single Mixed Refrigerant
Sunoco Logistics	Sunoco Logistics Partners
Tcf	Trillion cubic feet
TETCO	Texas Eastern Transmission LP
Transco	Transcontinental Gas Pipe Line Company, LLC
TRC	Total Resource Cost
UIL	UIL Holdings Corporation
ULSD	Ultra Low Sulfur Diesel
Union	Gas Works Employees Union Local 686

I. INTRODUCTION

Concentric Energy Advisors, Inc. (“Concentric”) was retained by the Philadelphia City Council (“City Council”) to prepare a “highest and best use” (“HBU”) study of Philadelphia Gas Works (“PGW”).¹ An assessment of the highest and best use of PGW examines the potential and credible use of this collection of natural gas local distribution company (“LDC”) assets to achieve maximum value for customers, employees, and for the community it serves: the City of Philadelphia. PGW’s assets include an underground network of distribution pipes and related facilities, Liquefied Natural Gas (“LNG”) facilities, an experienced workforce, customer relationships with a large proportion of Philadelphia households and businesses, and access to attractive energy product and service markets. PGW can also leverage the various strengths of the City of Philadelphia (“City”), including its location within a large and diverse Northeast/Mid-Atlantic metropolis, access to well-developed road, rail, and marine infrastructure, outstanding higher education and medical institutions, and most recently, proximity to the Marcellus Shale, one of the largest natural gas fields in the history of North America.

For purposes of this study, the “value” to be maximized includes safe, reliable and affordable natural gas service to PGW’s 512,000 customers, decent wages and benefits for its employees (nearly all of whom reside within the City limits) and compensation to its owner, currently the City. As a natural gas utility with exclusive rights to provide gas service within Philadelphia, PGW is integral to the welfare of the City including its contribution to certain “public benefits” such as service to low-income and elderly customers, a stronger local economy, and a cleaner environment.

Achieving the highest and best use requires first identifying what contributions are within PGW’s reach, then taking necessary actions, subject to legal, financial, operational, and all other execution requirements. Each of these efforts will require financial and organizational commitments and hard work by teams of PGW’s employees. PGW has an obligation to its many stakeholders to invest its

¹ Concentric was also retained to act as City Council’s financial advisor for City Council’s evaluation of the proposed sale of PGW to UIL Holdings Corporation (“UIL”) Concentric’s financial advisor assessment is presented in a separate report. City Council, through Concentric, also retained Claritas Energy Advisors, LLC to assist with the assessment of PGW’s LNG assets and their potential contribution to highest and best use.

finite organizational, financial and human resources wisely, focusing on efforts that provide the highest return at an acceptable risk. PGW and its customers stand to gain from increased utilization of existing distribution facilities by spreading the fixed costs of these assets over larger volumes and the City will benefit from an improved economy.

II. PGW TODAY

The starting point for a discussion of “highest and best use” is a description of PGW’s existing customer base, physical assets, revenues and cost basis, products and services, gas supply portfolio and regulatory oversight. Significantly, PGW’s opportunities to contribute to economic development in Philadelphia derive primarily from its core gas business, the marketing and pricing of gas supply and delivery services and from programs that help customers use less energy.

1. PGW Is the Largest Municipally-Owned Natural Gas LDC in the United States

PGW serves the fifth largest city in the United States, with over 1.5 million residents. It owns, operates and maintains a distribution system of over 3,000 miles of natural gas mains, approximately 500,000 service lines that connect customers to these mains and over 200 regulator stations throughout its system that maintain adequate pressures to meet customer demands.² PGW has an obligation to provide safe, reliable and affordable service to its sales and transportation customers. PGW has approximately 1,640 employees. Approximately 70 percent of those employees are members of the Gas Works Employees Union Local 686 (“Union”), while the remaining 30 percent are non-union employees.

PGW’s primary service is the sale and delivery of natural gas to Philadelphia residential and business customers on a “firm” basis, meaning that PGW is obligated to meet their demands throughout the year, including on the coldest days, and must plan its pipeline network and gas supply portfolio

² As of December 31, 2012. *See*, Philadelphia Gas Works Teaser, August 2013, at 3. The underground pipes are referred to as gas “mains”; the smaller facilities that connect a customer’s meter to the gas main are referred to as “services”.

accordingly. The delivered cost of natural gas that firm sales customers pay is comprised of three distinct components:

- (1) The commodity price of the natural gas purchased by PGW in a supply area;
- (2) The cost of pipeline transportation and storage associated with moving the gas from the supply basin to the interconnection between the interstate pipeline system and the PGW distribution system; and
- (3) The cost of distributing the gas through the PGW system, including the local delivery of natural gas, maintenance of the distribution network, billing and collection, and related customer services.

To provide some context, the first two components currently comprise approximately 40 to 45% of an average residential customer bill.

PGW also provides a transportation-only service where customers (mostly large industrial customers) choose to acquire their own natural gas from an unregulated natural gas marketer and rely on PGW to deliver it to their premises. Certain large customers have the ability to burn an alternative fuel and are able to contract for “interruptible” sales or transportation service from PGW. PGW is able to charge less for these services because it is not required to plan its gas supply portfolio or local distribution network to meet their demands throughout the year. PGW also sells natural gas in both vapor and compressed states that fuels natural gas vehicles (“NGVs”). All of these sales occur on a “tariffed” basis at regulated rates that are approved by the Pennsylvania Public Utility Commission (“PA PUC”).

Table 1 presents a breakdown of PGW customers and volumes for its sales and transportation services.

Table 1: Customers and Volumes³

Customer Class	Heating		Non-Heating	
	Customers	Volumes (Mcf)	Customers	Volumes (Mcf)
Sales Service				
Firm Sales				
Residential	370,254	28,101,309	26,024	552,418
CRP	75,141	9,420,038	503	29,964
Commercial	17,432	6,550,305	4,395	1,235,527
Industrial	408	369,412	161	139,679
Municipal	378	500,375	101	125,365
Housing Authority - GS	1,664	175,537	0	0
Public Housing Authority	832	615,027	0	0
NGV	0	0	1	1,270
Total Firm Sales	466,109	45,732,003	31,185	2,084,224
Interruptible Sales			15	897,901
Total Sales	466,109	45,732,003	31,200	2,982,125
Transportation Service				
Firm Transportation				
Residential	127	41,545	36	847
CRP	0	0	0	0
Commercial	1,630	2,271,840	484	458,267
Industrial	48	170,985	29	151,376
Municipal	196	397,541	217	109,727
Total Firm Transp.	2,001	2,881,911	766	720,218
Interruptible Transp.			415	23,588,301
Totals				
Firm Services	468,110	48,613,914	31,951	2,804,442
Firm and Interruptible Services	468,110	48,613,914	32,366	27,290,644

The data in the table also reveals the high saturation of residential (94.4%) and commercial (79.9%) customers that heat with natural gas.

³ PGW Proposed Operating Budget for Fiscal Year 2014-15 – Gas Costs and Purchasing Plans, Tables SR 12 (Customers as of February 2013) and SR 4 (Weather-Normalized Sales for the 2012-2013 fiscal year).

2. PGW's Engagement with the Community

PGW's engagement with the community it serves is extraordinary. PGW currently has approximately 70,000 low-income residential customers who are enrolled in the Customer Responsibility Program ("CRP") and approximately 23,000 customers in its Senior Citizen Discount ("SCD") program. Senior citizens who qualify for the discount program receive a 20% rate discount.⁴ CRP participants pay for natural gas service based on family size and their ability to pay, established as a percentage of their gross household income in relation to the Federal Poverty Level ("FPL"). In FY 2013 CRP customers had average annual usage of 125 Mcf/year as compared to 76 Mcf/year for other residential customers. This significant difference contributes to the level of funding for CRP that is provided by all other customers through the Universal Service and Energy Conservation component of PGW's distribution charge. However, they are required to participate in PGW's conservation programs and to apply for an energy assistance grant from the federally funded Low Income Home Energy Assistance Program ("LIHEAP"). PGW's Enhanced Low Income Retrofit Program ("ELIRP") has been specifically designed to help CRP customers conserve energy and avoid termination for non-payment, and also to reduce PGW's uncollectible expense. The annual costs of the two discount programs and ELIRP are recovered as part of the distribution charge and are projected to be over \$80 million or approximately 20% of the distribution charge in 2014.⁵ PGW also has a "Community Outreach" team that works with customers to inform them of programs that can help them save on their natural gas bills and apply for funds that are available to help defray the costs of using natural gas.

PGW's connection to the economic wellbeing of the City is further reflected by efforts to avoid termination of service and a policy of not foreclosing on property liens for non-payment for service. PGW has a significant number of liens associated with outstanding natural gas debt on properties within its service territory. Concentric understands that PGW defers collecting on the lien until the property is sold, rather than initiating foreclosure proceedings, a policy that helps to prevent housing abandonment and even homelessness. Additionally, PGW's Landlord Cooperation Program

⁴ The SCD program was closed to new participants in 2003, and customers that require assistance are directed to the CRP.

⁵ PGW June 2014 Budget Filing, Schedule SR 16

("LCP") works with landlords of residential properties to minimize liens due to tenant delinquencies. Moreover, PGW must make reasonable efforts to seek collection from delinquent customers before shutting off their service.

Finally, the exercise of control by the Mayor, City Council, Philadelphia Facilities Management Corporation ("PFMC"), and Philadelphia Gas Commission ("PGC") infuses PGW decision making with the public interest of the City and of its citizens. Although PGW is subject to oversight from the PA PUC through its ratemaking and other regulatory powers, the City exercises control over PGW's annual capital and operating budgets and various financial and business transactions.

3. PGW Efforts to Support Economic Development

PGW supports economic development in four primary ways:

- By encouraging customers to become natural gas customers and to convert existing end-uses to natural gas;
- By offering energy efficiency programs that help customers spend less on natural gas, freeing up funds that they can direct to other purposes;
- By promoting Combined Heat and Power ("CHP") as an efficient solution for customers that have significant electricity and thermal needs; and
- By funding a portion of PGW's pipeline construction if necessary to connect new loads.

The first two objectives are accomplished by PGW's "EnergySense" program that offers financial incentives to customers to convert from oil or steam to natural gas and to install more efficient gas equipment.⁶ EnergySense was designed to achieve five policy goals: (1) reduce customer bills, (2) maximize customer value, (3) contribute to the fulfillment of the City's sustainability plan, (4) reduce

⁶ The EnergySense program encompasses PGW's five-year Demand-Side Management ("DSM") program that was approved by the PA PUC on July 29, 2010. PGW would need to propose a new set of DSM programs to the PA PUC if they are to be continued beyond August 31, 2015.

PGW cash flow requirements, and (5) help the Commonwealth of Pennsylvania and the City of Philadelphia reduce greenhouse gas emissions.⁷

The six DSM programs are:

- 1) Enhanced Low-Income Retrofit: PGW's largest program provides heating system replacements, weatherization services, and customer education at no cost to participants in PGW's CRP, targeting high-use customers.
- 2) Residential Heating Equipment Rebates: cash rebates of up to \$2,000 to offset most of the incremental costs of installing high efficiency equipment.
- 3) Comprehensive Residential Retrofit Incentives: subsidized energy audits for single-family residential customers with rebates tied to first-year energy savings.
- 4) High Efficiency Construction Incentives (Residential & Commercial): provides technical assistance and financial incentives to new construction and gut rehab projects that go further than required by the building code. The financial incentive is provided at the end of the project.
- 5) Commercial and Industrial Retrofit Incentives: technical assistance, PGW financial incentives, and connections with third-party lenders for efficiency improvements including heating system replacements, improved system controls, and building improvements. Initially targeted to multi-family buildings, the program has recently focused on commercial and industrial customers as well.
- 6) Commercial and Industrial Equipment Rebate Incentives: rebates on high efficiency gas appliances and residential heating equipment for multi-family, commercial and industrial customers, including restaurants.

Program budgets have increased from year-to-year as programs have been ramped up. Spending on individual programs depends on market conditions and customer responsiveness and thus PGW retains the flexibility to shift spending among the programs, subject to an overall spending cap. PGW expects to spend approximately \$14.7 million in fiscal year 2015. Over 80% of the DSM budget has been targeted to low-income retrofit investments and other programs that focus on

⁷ Philadelphia Gas Works, Fifth Year Implementation Plan Fiscal Year 2015, May 2014, page 5.

residential customers, which is appropriate given the benefits to all customers of reducing energy use by CRP customers.

When designing and measuring the success of these programs, utilities estimate the benefits and costs, often including environmental benefits (avoided pollutant emissions) that accrue more broadly to society. As presented in the following table, PGW calculates the benefit-cost ratio using both a “total resource cost” (“TRC”) test which includes the value of environmental benefits that accrue more broadly to society and a “gas administrator” test that focuses more narrowly on utility benefits and costs. A value greater than 1 indicates that the program provides net benefits, with higher numbers indicating greater value. The results of these tests, along with the FY2015 and five-year projected spending levels, are presented in the following table.⁸

Table 2: DSM Program Spending and Benefit-Cost Test Results⁹

Program	Spending Levels (\$000)		Benefit Cost Test	
	FY 2015	Five-Year	TRC	Admin
Enhanced Low-Income Retrofit	7,600	31,701	1.23	1.03
Residential Heating Equipment Rebates	1,146	3,204	1.71	2.78
Comprehensive Residential Retrofit Incentives	1,400	2,350	0.44	0.50
High Efficiency Construction Incentives	298	580	0.70	0.57
Commercial & Industrial Retrofit Incentives	537	1,070	1.32	1.31
Commercial & Industrial Equipment Rebates	338	620	3.14	3.73
Administrative Costs	1,390	4,559		
Total	12,708	44,084	1.17	n/a

PGW coordinates many of its DSM programs with other government and community organizations including: (1) the Pennsylvania Department of Community & Economic Development (“PA DCED”) (Low-Income Retrofit); (2) Keystone HELP (provides low-interest loans to help participating customers finance their required contribution in order for them to take advantage of

⁸ PGW has consistently spent less than the targeted annual budget amounts and expects to spend only \$44.1 million of the \$63.7 million budgeted over the five-year period, including program management costs.

⁹ Data presented in PGW’s “Five-Year EnergySense Demand Side Management Portfolio, Fifth Year Implementation Plan, Fiscal Year 2015”, May 2014.

the Residential Heating Equipment Rebate and Comprehensive Residential Retrofit programs); and (3) the Pennsylvania Housing Finance Authority (provides funding assistance for multi-family building efficiency projects). In addition, Pennsylvania has several small business programs that might be used for energy efficiency improvements such as the DCED High Performance Building Incentives Program and DEP Small Business Advantage Grant Program. PGW became a sponsor of ENERGY STAR's Energy Efficiency Program and will be included on its registry of available rebates and incentives. PGW has also worked with the PA CareerLink to connect local unemployed workers with weatherization training programs and ultimately with jobs at firms that provide these services to PGW.

The Commercial and Industrial Equipment Rebates program includes rebates for Combined Heat and Power ("CHP") investments. CHP provides significant economic and efficiency benefits by generating electricity on the customer premises (thus avoiding purchases from the electric utility) while also producing thermal energy that is used for a second purpose such as heating, hot water or cooling. PGW also offers a Commercial Industrial Customer Incentive Program ("CICIP") whereby PGW will provide the up-front capital costs to install the CHP equipment and recovers its 5% financing costs through operating cost savings with an expected payback of three to five years. PGW demonstrated the CHP technology after receiving a \$465,000 grant in December 2009 from the Pennsylvania Department of Environmental Protection ("PA DEP") to install a 200 kW microturbine at its headquarters, matching a grant provided by the PA Green Energy Works! The gas-fueled microturbine generates electricity that could reduce PGW's electricity purchases while also generating heat that is captured and used to provide building cooling by applying absorption cooling technology. PGW has also installed CHP at the Four Seasons Hotel, and at six other locations that are projected to have a total annual natural gas demand of over 100,000 Dekatherms ("Dth").

PGW offers a cogeneration rate for customers that are determined by the FERC to be "qualifying facilities" under the provisions of the Public Utility Regulatory Policy Act of 1978, an act that promoted the development of efficient alternatives to utility-owned power plants. This is an interruptible service and PGW has the right to limit the number of customers that receive the service. However, PGW has only four customers that are currently receiving service under this tariff with sales of approximately 22,000 Mcf per year. Cogeneration is similar in many respects to

customer-sited CHP facilities but operates on a much larger scale and is designed to connect to and sell capacity and energy into PJM Interconnection (“PJM”) markets.¹⁰ PGW has considered leasing unused property to a developer to construct a gas-fired cogeneration project, providing a potential incremental source of revenues from the property lease and margin on the sale of natural gas.

PGW no longer offers a discounted rate to business customers for economic development purposes. However, it does offer financial support for the cost of main extensions to serve new residential and business customers under Section 10 of its Gas Service Tariff. PGW will cover the cost of a main and service extension in an amount equal to up to five years of the anticipated Delivery Charges for residential customers. PGW covers the main and service extension costs in an amount equal to up to three years of the anticipated base rate revenue for commercial and industrial customers as long as the total installation costs are less than \$10,000, with the customer contributing the balance. For installations whose costs exceed \$10,000, the amount of and method of recovery of the required customer contributions are negotiated with PGW.

4. PGW Actions to Replace Aging Gas Mains

The continuing reliance on cast iron and non-cathodically protected steel mains and services installed prior to 1970 when plastic pipe became the industry standard presents a challenge to PGW and many other older distribution systems in the United States. While these facilities continue to provide adequately reliable and safe service, they require more extensive survey and maintenance efforts, costs that are recovered from all customers. PGW and other LDCs facing similar circumstances are pursuing efforts to replace older mains and services, subject to operational, safety and customer rate impact considerations.

The Pipeline and Hazardous Materials Safety Administration (“PHMSA”), a division within the U.S. Department of Transportation (“U.S. DOT”), has primary responsibility for oversight of the safety of all distribution and interstate pipeline facilities. Since 2011, PHMSA has required all LDCs to file distribution integrity management programs (“DIMP”) that document the status of their system,

¹⁰ PJM plans and operates the regional electric transmission network that serves Pennsylvania and all or parts of 12 other states and the District of Columbia. It also operates the regional market for electricity.

identify risks, propose risk mitigation measures, and monitor the effectiveness of the program. PGW has been applying a risk-based methodology using a Main Replacement Prioritization model developed by Advantica in 2008 that recognizes that many factors, in addition to the age and materials of pipe, must be considered when determining whether replacement or an alternative approach should be employed to maintain the safety, reliability and integrity of a distribution system. These factors include recent evidence of pipe condition including leaks and inspection reports. PGW's Long-Term Infrastructure Improvement Plan ("LTIIP") approved by the PA PUC on April 4, 2013, presents PGW's current prioritization and primary focus on replacement of cast iron mains, followed by replacement of its unprotected coated steel and ductile iron mains. As of the end of 2013, PGW had 1,501 miles of cast iron mains or approximately one-half of its 3,024 miles of mains.¹¹

Many state legislatures, including Pennsylvania's, have authorized the use of surcharges that make it financially feasible for LDCs to accelerate their pipe replacement programs.¹² PGW collects the costs of the accelerated replacement components through its PA PUC-approved Distribution System Improvement Charge ("DSIC"). Collections through the DSIC are capped at 5% of the distribution component of the bill, although the PA PUC may grant a waiver of this provision "if necessary to ensure and maintain safe and reliable service".¹³ PGW collects approximately \$22 million per year through the DSIC, recovering the costs of an additional 7 miles of pipe replacement, increasing PGW's total annual pipeline replacement from 18 to 25 miles. PGW faces a multi-decade challenge to replace its 1,501 miles of cast iron mains and engaged Advantica in 2008 to perform a detailed analysis to develop a prioritization of replacement that reflects the most recent break, leak and incident experience associated with different categories of cast iron mains and the resulting impacts on the risk profile associated with various sizes and pressures of its remaining cast iron inventory. The results of this analysis were incorporated into PGW's PUC-approved five-year plan. Based on this plan, PGW's accelerated replacement program will eliminate all 12" and 30"

¹¹ PGW Annual Report for Calendar-Year 2013 Gas Distribution System, submitted to PHMSA. PGW also has 493 miles of lower priority unprotected coated steel mains and 132 miles of ductile iron mains.

¹² Pennsylvania Act 11 of 2012, which became law on February 14, 2012, provided utilities with the ability to recover certain incremental distribution infrastructure replacement costs through a surcharge.

¹³ Final Implementation Order in PA PUC Docket No. M-2012-2293611, dated August 2, 2012, pages 40-41.

high-pressure cast iron main within the next ten years and all of its 8" & smaller low or intermediate pressure cast iron main within the next 50 years. PGW will still have 20% of lower risk cast iron mains (243 miles) to replace at the end of this period as well as other lower priority ductile iron (132 miles) and unprotected coated steel pipe (493 miles) to replace.

PGW coordinates its pipeline replacement projects with other City agencies and with local businesses and residences in the affected neighborhoods but pipe replacement projects are unquestionably disruptive to the local neighborhood, and in particular, to local businesses that depend on customers arriving by vehicle. One potential synergy derives from the potential that new load can be connected while the street is open. There are other challenges to increasing the pace of main replacement, including safety-related challenges from a larger construction effort and the potential need to rely more on contractors that are not familiar with working on PGW's system. While all contractors need to be certified by the U.S. DOT, PGW's current Collective Bargaining Agreement ("CBA") places certain limitations on the use of outside contractors.

5. PGW Sources All of its Gas Supply from the Gulf Coast

PGW plans its gas supply portfolio to meet customer demands on the coldest "peak" days of the year (referred to as "design day" conditions), and to meet the daily demands of its firm sales customers throughout the year. PGW's mandated objective under both state and city law is to meet these requirements on a lowest reasonable cost basis, reflecting the fact that resources have different costs, contractual provisions, and operating characteristics. This approach, common to all LDCs, is achieved through a portfolio of contracts for gas supplies, interstate pipeline transportation, and underground storage facilities. Some cold-weather LDCs, including PGW, supplement these contracts with LNG facilities in their service area that provide for the liquefaction, storage, and vaporization of natural gas.

Although PGW is located close to the Marcellus Shale, all of its natural gas supply is acquired in the Gulf Coast and delivered to Philadelphia by two interstate natural gas pipelines: Texas Eastern Transmission LP ("TETCO"), and Transcontinental Gas Pipe Line Company, LLC ("Transco").

PGW's long-term contracts for capacity on both TETCO and Transco reflect the historical reliance of many LDCs in the Northeast and Mid-Atlantic on natural gas that is produced in the Gulf Coast and Southwest producing areas.¹⁴ For reasons discussed in detail in Technical Appendix A, the natural gas prices that PGW sales customers pay reflect the lower, less volatile pricing of Gulf Coast markets and compare favorably to the prices for supplies acquired near Philadelphia delivery (and pricing) points.¹⁵

For economic reasons, PGW reserves and pays for transportation capacity on both an annual and winter-only basis. Gulf Coast supplies are transported by either TETCO or Transco (i) to PGW's distribution system for redelivery to customers, (ii) to PGW's Richmond LNG facility to be liquefied and then stored in either the Richmond or Passyunk LNG facility; or (iii) to Gulf Coast or Western Pennsylvania underground natural gas storage fields for withdrawal and delivery to PGW's distribution system at a later date.

PGW contracts for underground storage service provided by both TETCO and Transco as a means of mitigating higher winter prices and achieving operational benefits.¹⁶ PGW is able to lower the annual cost of gas for its sales customers by purchasing and injecting gas into storage during periods when prices tend to be lower (*i.e.*, off-peak summer periods), and withdrawing the gas when prices are usually higher (*i.e.*, peak winter periods). PGW's market area storage contracts also reduce the amount of pipeline capacity that would otherwise be required to transport natural gas from the Gulf Coast, again lowering the overall cost of the portfolio and utilizing long-haul transportation capacity more efficiently. In addition, from an operational perspective, storage provides PGW with the ability to enhance the diversity and reliability of supply, and to more accurately balance forecasted and actual demand.

¹⁴ Interstate pipeline transportation rates are regulated by the FERC, and are based on the underlying costs of providing the transportation service ("cost-based rates").

¹⁵ PGW's transportation customers purchase their supplies from gas marketers and are more likely to pay prices that are based on the TETCO M3 or Transco Zone 6 Non-NY indices. As discussed in Technical Appendix A, such market area prices can be more volatile and, as experienced this past winter, significantly higher than production area prices, even after accounting for the cost of transportation to Philadelphia.

¹⁶ Underground natural gas storage facilities exist throughout the United States, but are predominantly located along the Gulf Coast, western Pennsylvania, upstate New York, Michigan and south central Ontario. PGW contracts for storage both in the Gulf Coast and in western Pennsylvania. Similar to interstate pipelines, natural gas storage service is also regulated by the FERC.

6. PGW's LNG Assets Are Relied On To Serve Winter Peak Demand

PGW's two LNG facilities (Richmond and Passyunk) serve as a supplemental peaking supply source on the coldest days of the year when its sales customers' requirements exceed the aggregate delivery capability of less expensive pipeline and underground storage gas. They also help PGW meet varying intra-day, daily and seasonal supply needs. LNG serves similar roles to underground storage, although LNG is used to serve peak demands for relatively short durations (e.g., typically less than 15 days). This is because on a per unit cost basis, the cost of liquefying, storing and re-vaporizing the gas is a significantly more expensive way to meet customer demand over a longer period than injecting and withdrawing natural gas from an underground storage field. The two facilities have a combined storage capacity of approximately 4.3 billion cubic feet ("Bcf") of LNG, the ability to liquefy up to 16 MMcf/day of natural gas and eight vaporizers with over 550 MMcf/d of LNG vaporization capacity.

PGW has a design day demand requirement of approximately 674 million cubic feet per day ("MMcf/day")¹⁷ which represents approximately 1% of the total design year demand of approximately 64,465 MMcf. To meet projected customer demands, PGW's portfolio of pipeline transportation and storage contracts combine for a total deliverability into PGW's distribution system of 472 MMcf/day.¹⁸ As discussed in more detail below, PGW relies on its ability to vaporize LNG stored in its Richmond and Passyunk facilities to meet its projected design day demand that cannot otherwise be served by its pipeline transportation and storage assets. PGW has significantly more daily vaporization capability than required to meet its current need of approximately 200 MMcf/day.

¹⁷ The "design day" assumes weather at 0° F (PGW, 2014/2015 GCR Pre-Filing, Item 53.64(c)(13)).

¹⁸ Informational Postings for Transcontinental Gas Pipe Line and Texas Eastern Transmission, LP.

Table 3: Summary of PGW’s Existing Design Day Demand and Peak Supply Strategy

Description	Amount (Mcf/d)
<u>Demand</u>	
Design Day Demand (FY2013)	673,531
<u>Peak Supply</u>	
TETCO (pipeline transportation)	173,319
Transco (pipeline transportation)	167,179
TETCO (bundled transportation/storage)	64,965
Transco (bundled transportation/storage)	66,758
Subtotal	472,221
LNG Vaporization Required to Meet	
Design Day Demand	201,310

PGW’s Richmond plant is centrally located within its service area on a 30-acre lot in the Port Richmond neighborhood near the Delaware River. It began operation in 1974. The Richmond plant has both liquefaction and vaporization capabilities and is one of the largest LDC-owned LNG facilities in the United States with the capacity to store 4 Bcf of LNG in its two storage tanks.

The Richmond plant has two truck-loading bays; however, only one truck-loading bay is presently operational and modifications would be required to activate the second truck bay. PGW’s Passyunk plant is located in the southwestern portion of its service area on a 72-acre lot in southwest Philadelphia along the Schuylkill River. The Passyunk plant is much smaller than Richmond and has a 0.253 Bcf storage capacity. Passyunk lacks liquefaction capability and depends on LNG that is trucked from the Richmond plant. Table 4 presents key operational data for the two facilities.

Table 4: LNG Facility Capacities¹⁹

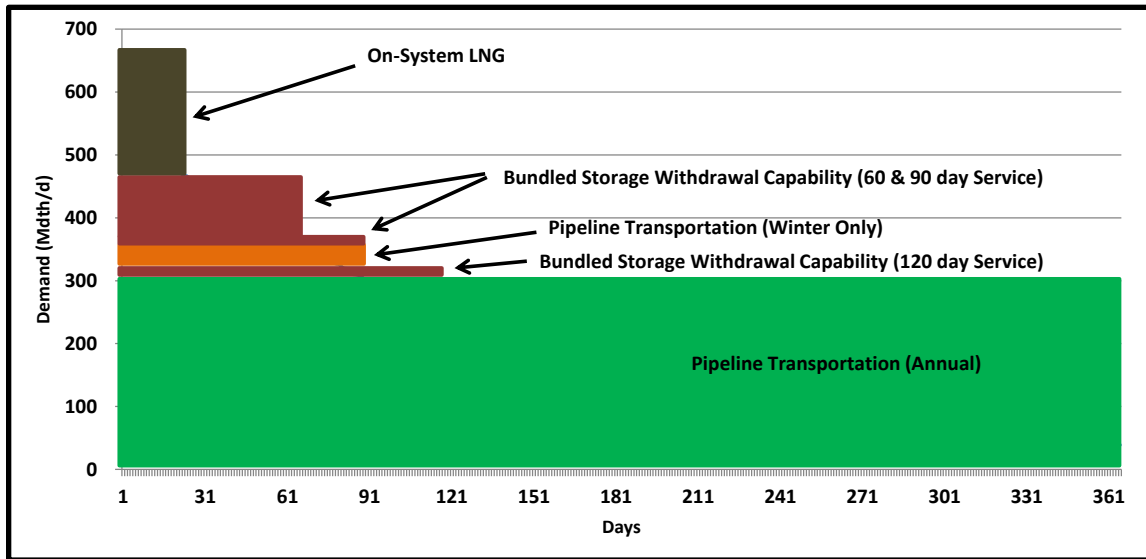
Capacity	Richmond	Passyunk
Storage (Mcf)	4,045,800	253,000
Liquefaction (Mcf/d)	16,000	n/a
Vaporization (Mcf/d)	463,000	90,000
LNG Pumping (Mcf/d)	776,000	135,000
Truck Loading (Mcf/d)	9,600	4,800
Truck Bays	2	1

Although Richmond’s storage capacity is slightly in excess of 4 Bcf, its annual liquefaction capacity is only 2 Bcf, a suboptimal configuration that results from the particular liquefaction technology and its dependence on adequate pipeline flows. Thus, PGW can only liquefy natural gas from September through November and then again from March through mid-June when the volume of gas flowing on PGW’s distribution system produces sufficient pressures to enable liquefaction. Although this is an efficient technology that reflects PGW’s particular system configuration, it differs from technologies employed by most LDCs that can operate from April through October when natural gas prices tend to be lower. The imbalance between PGW’s storage and liquefaction capacity is discussed in more detail in Technical Appendix B.

Since PGW’s LNG assets are the most expensive resource, they are relied upon for only the highest demand days as illustrated in the diagram in Figure 1. This figure depicts PGW’s gas supply portfolio “load duration curve,” a visual presentation of the distinct roles served by transportation, storage and LNG resources in meeting demand at the lowest reasonable cost. It is constructed by arranging PGW’s daily demand for all 365 days from the highest value to the lowest value (represented by the line on Figure 1 below). The supply resources required to serve system demand are stacked and arranged with the lowest cost at the bottom and the highest cost at the top.

¹⁹ Information provided by PGW in response to Concentric information requests.

Figure 1: PGW Design Day Load Duration Curve and Maximum Daily Transportation and Storage Capabilities²⁰



It should be noted that a significant portion of the annual pipeline capacity at the bottom of the supply stack is used during off-peak periods to transport gas to refill underground storage that will be needed in the coming winter. With that caveat, PGW should be able to utilize existing available transportation, storage and LNG capacity (i.e., the portion of each shaded rectangle representing a supply resource that is above the demand curve line) to meet at least some on-system growth in firm sales, depending on the type and amount of such demand, before it would have to contract for new pipeline capacity.

7. PGW Sells Surplus LNG to “Off-System” Customers

Since PGW must plan to meet the periods of highest demand, there are periods in which it has more interstate pipeline capacity and on-system LNG capacity than it needs to get through the winter. Recognizing that there is an opportunity for more efficient utilization of natural gas infrastructure throughout the country, federal and state policy makers have implemented policies over the last 30 years that make the system more efficient by establishing “secondary” markets for pipeline

²⁰ Information provided by PGW in response to a Concentric information request.

transportation capacity and the natural gas commodity in vapor, compressed, and liquid form. Like any prudent operator, PGW takes advantage of these opportunities and shares the benefits with its customers.

Due to mild temperatures over the 2011/12 and 2012/13 winters that resulted in lower than anticipated heating demand, PGW was able to build its inventory of stored LNG above typical levels. Capitalizing on this opportunity, in April 2013 PGW began selling surplus LNG that is not needed to meet the needs of its own sales customers at unregulated, market prices to “off-system” customers, thus taking advantage of the current differential between PGW’s cost to acquire and liquefy natural gas and the price that customers are willing to pay for LNG. PGW has executed six contracts for LNG sales (five remain active through 2016), with total contractual volumes of 3.23 Bcf. PGW must husband its on-system LNG in order to meet emergencies so caution must be taken to ensure that efforts to take advantage of off-system sales opportunities are not overly aggressive and do not place reliable service to firm sales customers at risk. Thus, the service provided under each of these contracts is interruptible, i.e. PGW can withhold deliveries at its sole discretion when they might threaten PGW’s ability to provide service to its firm on-system customers. The customers include heavy-duty trucking fleets, drilling and fracking operations, and other Mid-Atlantic LDCs. Actual sales and revenues to date as well as projections through fiscal year 2016 are summarized in Table 5.

Table 5: Off-System LNG Sales²¹

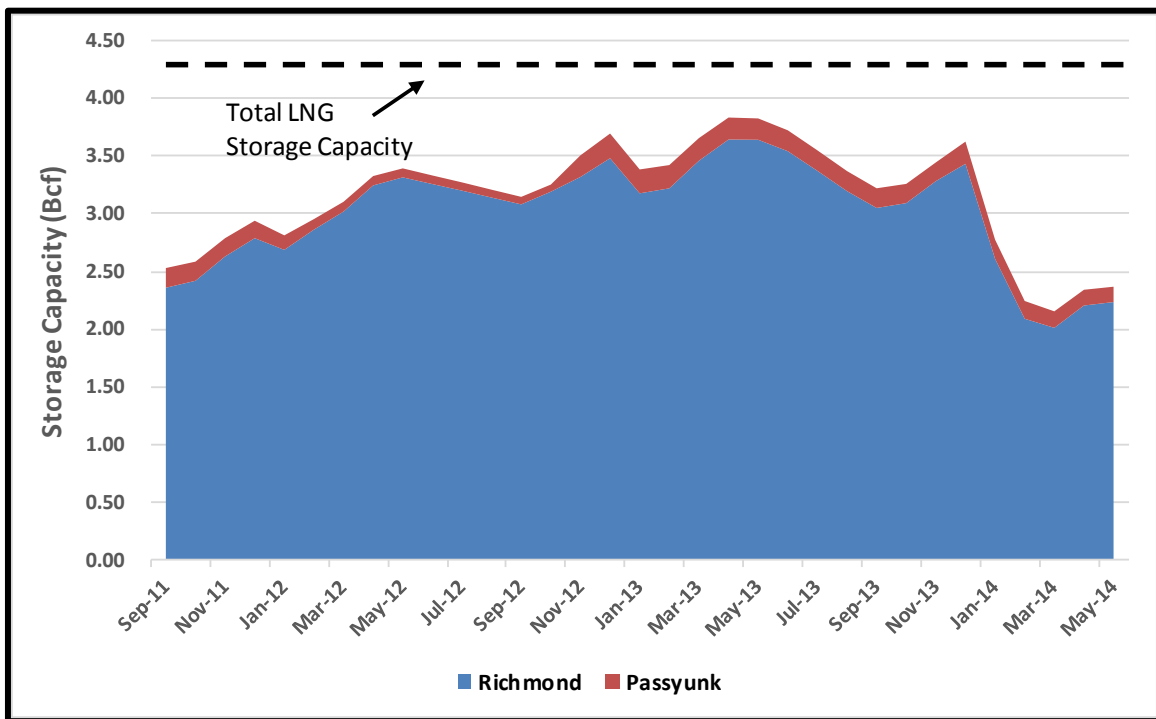
Year	Sales (Mcf)	Total Revenue (\$000)
2012/13	239,254	2,265
2013/14	1,057,391	10,880
2014/15	991,498	9,720
2015/16	662,000	6,456

²¹ Response to Informal Discovery Data Request, Fiscal Year 2015 Operating Budget, OB-ID-1, July 1, 2014. Sales and revenue totals for 2013/14 consist of 7 months of historical data (September-March) and five months of projections (April-August). *See Also:* PGW Fiscal Year 2015 Operating Budget and Five-Year Forecast Fiscal Years 2016 through 2020.

The margins from each of PGW’s off-system LNG sales contracts, calculated as the difference between revenues and the cost of acquiring and transporting the natural gas vapor, are confidential. PGW has assumed a margin of \$3.68 per Mcf to forecast revenue from LNG sales for fiscal years 2014 and 2015 in its most recent operating budget.²² Applying this to the actual and projected sales volumes in the table above indicates margin revenues of approximately \$3.6 million for fiscal years 2014 and 2015, and approximately \$2.4 million in FY2016.

As noted above, the existing liquefaction capacity at the Richmond plant is approximately 2 Bcf. PGW’s combined use of LNG to serve either its firm sales customers or off-system markets cannot exceed 2 Bcf without drawing down inventory levels. Inventory levels can be partially restored in future years if the combined on-system and off-system requirements are less than 2 Bcf per year. Figure 2 presents the combined inventory level in PGW’s LNG facilities since September 2011.

Figure 2: PGW’s LNG Inventory Levels



²² Response to Informal Discovery Data Request, Fiscal Year 2015 Operating Budget, OB-ID-1, July 1, 2014.

As shown in this figure, the amount of PGW's unused storage capacity has fluctuated between 500 MMcf and 1.8 Bcf over the last 18 months. The limitations on PGW's liquefaction capability prevent it from taking full advantage of its storage capacity and restrict the sustained level of vaporization/LNG off-system sales to 2 Bcf per year.

III. PGW AND THE PHILADELPHIA ECONOMY

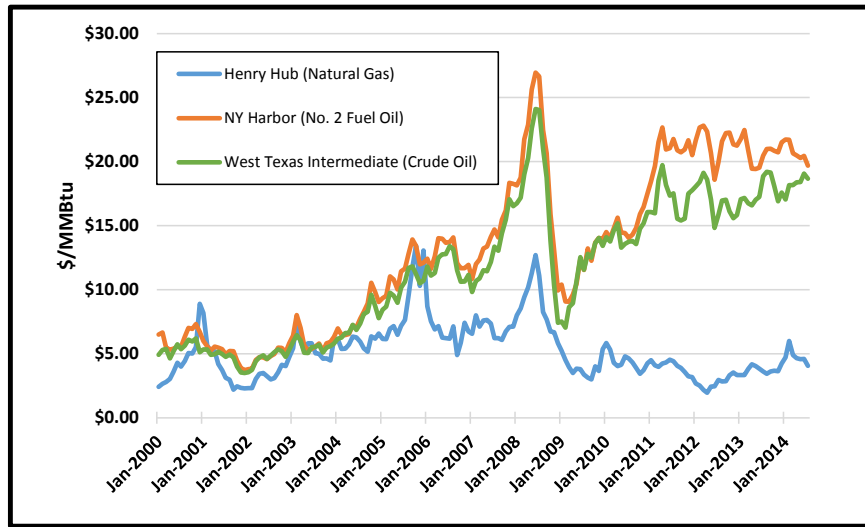
PGW's contribution to the local economy begins with providing safe, reliable and affordable service to existing residential and business customers. PGW can also help existing businesses expand and attract new businesses, particularly those that rely on natural gas as a primary factor in their business. The current climate of low natural gas prices presents a unique opportunity for PGW to leverage their core strengths to support economic growth.

1. PGW Has a Unique Opportunity to Take Advantage of Historically Low Natural Gas Prices

Domestic natural gas prices are expected to remain low and maintain a significant advantage over oil-based products for the next several years due to the extraordinary development and importance of Marcellus and other shale fields.

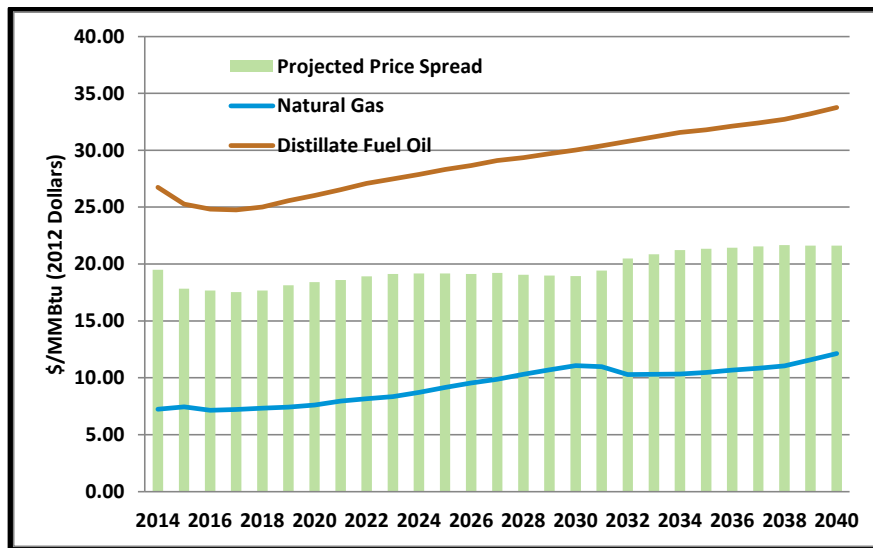
Historically, natural gas and fuel oil competed with each other for many uses and generally moved in parallel with global crude oil prices. However, beginning in 2006, natural gas and oil prices began to decouple from one another, and since 2009, there has been a fundamental separation in the prices of these commodities due in large part to extraordinary shale development. Domestic natural gas prices have also been constrained by the limited access of natural gas supply to higher-priced export markets. As shown in Figure 3, natural gas prices are currently trading at approximately four times lower than the price of distillate fuel oil, the oil product used to serve the heating needs of some homes and small businesses.

Figure 3: Historical Natural Gas, Distillate (No. 2) Fuel Oil and Crude Oil Spot Prices²³



The United States Energy Information Administration (“US EIA”) projects this price spread will continue well into the future, as shown in Figure 4.

Figure 4: Projected Natural Gas and Fuel Oil Prices for the Mid-Atlantic Region



Source: U.S. Energy Information Administration, Annual Energy Outlook 2014.

²³ U.S. Energy Information Administration, Monthly Spot Prices, 2000-July 2014.

PGW's customers are currently benefitting from these low prices, even though PGW sources all of its gas from the Gulf Coast rather than from the nearby Marcellus Shale. As discussed in Section IV, there may be an opportunity for PGW to reconfigure its gas supply portfolio in the future to secure some of its supplies directly from the Marcellus, diversify its supplies, and lower its gas supply costs further, with the resultant savings passed on directly to residential and business customers.

2. Natural Gas has a Role to Serve as Philadelphia Pursues Economic Development

While low natural gas prices contribute to economic development, they represent only part of the opportunity. The City of Philadelphia has many advantages as a place to live, work, and locate new businesses. Economic development is a source of construction and permanent jobs for residents of Philadelphia and the surrounding area, including high-paying service, technical, and manufacturing jobs. These jobs result in both direct and indirect expenditures, contributing to economic vitality as workers spend a portion of their incomes on goods and services within the City. Economic development also increases tax revenues to support education and other City services that help attract a trained workforce.

The City has clearly been focused on economic development in recent years, including actions to reduce the costs of locating a business within the City limits. In December 2013, a Manufacturing Task Force formed by the City produced a report entitled, "Manufacturing Growth Strategy for Philadelphia". The report noted that while manufacturing employment has declined steadily over the past several decades throughout the United States, the declines in the City of Philadelphia have exceeded the national average since 1990.²⁴ This report addressed several issues that are directly relevant to attracting manufacturing to Philadelphia including worker education and training, innovation, access to capital, collaboration, and taxes. Two of the report's eleven recommendations focused directly on energy:

#7 Increase the supply of natural gas and NGLs (Natural Gas Liquids) available to manufacturers in the City & Region by increasing the pipeline capacity. Additional natural

²⁴ "Manufacturing Growth Strategy for Philadelphia," December 2013, page 6.

gas and NGL pipeline capacity to Philadelphia will provide a strong competitive advantage to the chemical and petrochemical clusters.²⁵

#8 Promote the use of energy efficient technology, distributed energy systems, and smart grid technology to improve energy efficiency of large manufacturing operations.

The “Manufacturing Growth Strategy for Philadelphia” report presented an analysis of existing Philadelphia industries and identified industries that are either “energy-intensive” or are otherwise “competitively advantaged.”²⁶ Both sets of industries are potentially attractive targets for a coordinated set of City/PGW programs that would help existing businesses expand their Philadelphia presence or solicit new businesses. The industries identified by the Task Force are presented in Table 6.

Table 6: Energy-Intensive and “Competitively Advantaged Industries”

Energy-Intensive Industries	Competitively Advantaged Industries
<ul style="list-style-type: none"> • Food • Primary and Fabricated Metals • Nonmetallic Minerals • Chemicals • Petrochemicals • Refining 	<ul style="list-style-type: none"> • Pharmaceutical & Medicine • Pulp, Paper & Paperboard Mills • Sugar & Confectionary Product • Dairy Product • Fruit & Vegetable Preserving, Specialty Food • Other Wood Product • Other Nonmetallic Mineral Product • Glass & Glass Product • Bakery & Tortilla • Animal Slaughtering & Processing • Converted Paper Product • Beverage • Resin, Synthetic Rubber & Artificial Synthetic Fibers

²⁵ The NGL opportunity is addressed in Section V as an opportunity for PGW to provide service to energy hub related businesses that locate in Philadelphia and in Section VI with respect to the viability of PGW taking a more active role as a transporter or seller of NGLs.

²⁶ The Task Force consultant, IHS Global Inc., performed “shift-share” analysis to identify the “competitively advantaged industries.” They are characterized as having (a) an above average energy intensity, and (b) employment which is growing faster than employment in the industry in the rest of the country.

Philadelphia is also interested in attracting industries that provide high quality jobs and are most likely to generate local economic activity, particularly if it considers offering financial incentives. For example, North Carolina screens applicants for economic development grants by considering job quality, industry quality, and state and local economic impacts. Further, cost-benefit assessments look beyond direct economic benefits such as employment and income and consider quality of life benefits. Some states take a more holistic view, targeting economic development programs to poorer counties.²⁷

3. Some Caution Applies to Utility Economic Development Programs

Many natural gas and electric utilities offer programs that contribute to economic development within their service areas. These programs are typically funded by customers based on an implicit assumption that retained and expanded load will retain or add a contribution towards the LDC's fixed costs that otherwise would have been paid by the existing customers. Clearly, the LDC must strike a balance between promoting economic development and the near-term rate impacts assumed by other customers, and state regulators typically review these programs. LDCs are typically required to justify their initial program design, particularly if the program is implemented through a tariff. Since other customers foot the bill, the LDC may also be subject to an after-the-fact review of decisions to discount rates or infrastructure costs to attract business, particularly if the program provides flexibility with respect to the amount of the discount. The review takes place when the LDC requests approval to recover the costs of the discount program from other customers.

There is extensive academic literature on the role of government in economic development that offers insights into the potential focus and design of PGW business development incentives. In general, these studies have shown that broad-based incentives such as tax breaks are not particularly efficient because business relocation decisions are driven by many other factors including the existence of a trained labor force, proximity to other production inputs and to markets, local and regional infrastructure, and the quality of educational institutions. A more targeted incentive that reduces the price of a major input factor (e.g., labor costs or natural gas costs for an energy-intensive

²⁷ "Business Incentives Reform", published by the Corporation for Enterprise Development, December 15, 2009

business) often dwarfs the value of a tax-based incentive. The clustering of similar businesses is also an important determinant of firm location and represents the presence of success factors for an industry or set of related industries.²⁸

Philadelphia's Office of the City Controller recently published a report that assessed the Keystone Opportunity Zone Program, finding that industrial tax policies are too diffuse to be effective.²⁹ Based on its finding of a relatively high cost per new job and lengthy payback periods, the report concluded that a cluster approach to economic development, "building upon local strengths and trends", is strategic and more likely to be successful than tax breaks. A cluster approach aligns with targeted public policy initiatives that train workers to meet the labor needs of a particular industry set. Pennsylvania has been a leader in such training programs.³⁰

States and communities should foster real and lasting sources of competitive advantage as the primary drivers of relocation, and use government policies to supplement these advantages. Failure to objectively account for this reality may lead to ineffective and inefficient apportionment of limited economic development funds. One study observed that, "[t]he most fundamental problem is that many public officials appear to believe that they can influence the course of their state or local economies through incentives and subsidies to a degree far beyond anything supported by even the most optimistic evidence."³¹ However, one positive outcome of the competition among states as well as their past failures to realize economic development goals is increased attention to the need to conduct cost-benefit analyses *prior to* awarding incentives. In order to improve accountability, incentive payments should be subject to contractual provisions that tie payments to achievement of

²⁸ The clustering concept, introduced and popularized by Harvard Business School Professor Michael Porter, posits that a concentration of related companies, organizations and institutions will foster individual firm productivity and innovation. Policies can also be designed to create a trained work force and infrastructure that helps attract related businesses and thus promote local and regional economic growth. Silicon Valley is an example of a technology cluster.

²⁹ "An Analysis of the Keystone Opportunity Zone Program, 1999-2012: The Benefits and Costs to Philadelphia", issued on March 19, 2014.

³⁰ "Growing Pennsylvania's High-Tech Economy: Choosing Effective Investments," by Greg LeRoy with Leigh McIlvaine, Peter Fisher, Alan Peters, Doug Hoffer, Stephen Herzenberg, Mark Price, Merrill Goozner and Philip Mattera, Good Jobs First, January 2010, page 81.

³¹ "The Failures of Economic Development Incentives", by Alan Peters and Peter Fisher, Journal of the American Planning Association, Winter 2004, Vol. 70, No. 1, page 35.

specified goals, such as new local hires. Some states have even instituted “clawbacks” of incentives that are applied when companies fail to live up to their end of the bargain.³²

4. Implications for PGW’s Economic Development Role

This background has several potential implications for an expanded role that PGW might serve in economic development:

- PGW’s ability to influence economic location will be greatest for industries and firms that rely significantly on natural gas as an input to production such as those cited in Table 1 above;
- Efforts to develop a natural gas hub or similar “cluster” of economic activity may contribute to a larger pool of trained labor that can migrate among related businesses as individual company economic fortunes vary;
- Cost reductions in inputs that directly affect the bottom line, including natural gas costs, will have a much greater impact than tax breaks and will benefit all firms that use such inputs, not only those firms that are profitable enough to benefit from tax breaks;
- Programs that benefit all customers such as those that lower gas costs, enhance the integrity of PGW’s distribution infrastructure, or increase margins from off-system sales benefit all of PGW’s customers and are therefore likely to have broader and more sustainable benefits than programs that offer time-limited economic development rate discounts to individual PGW customers (particularly during periods of economic dislocation when affordability of utility costs has increased importance);
- Major infrastructure investments, such as a new pipeline project or LNG expansion, may lower the gas commodity portion of customer bills for all customers and provide a hedge against price volatility during periods of peak demand or deliverability interruptions; and
- Programs that improve the efficiency of the building envelope will also benefit successor businesses that occupy the same buildings.

IV. SPECIFIC PGW OPPORTUNITIES TO ACHIEVE ITS HIGHEST AND BEST USE

Concentric has identified six opportunities for PGW to contribute to the City of Philadelphia’s economic growth and general welfare, while enhancing its own financial strength. Significantly, all of these opportunities derive from its core gas business: the sale and delivery of natural gas and related

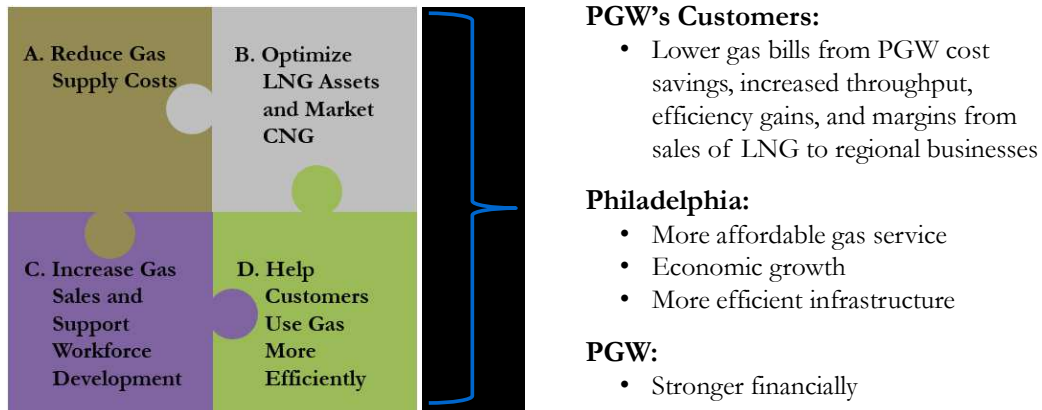
³² “Business Incentives Reform”, published by the Corporation for Enterprise Development, December 15, 2009.

products and programs that help customers use less energy. PGW is already engaged in several of these activities and Concentric is proposing that it either continue or expand these efforts. While the opportunities can be considered individually or in subsets, Concentric has crafted them as an integrated collection that can work together to achieve the following goals:

- Minimize PGW’s gas supply and delivery costs over the long-run;
- Contribute to Philadelphia’s economy by retention and attraction of businesses and by providing employment opportunities to its citizens;
- Grow top-line and net revenues from traditional regulated services and emerging competitive market opportunities and thereby enhance PGW’s financial position;
- Increase energy efficiency of PGW customers in the near term, and improve the efficiency of buildings in Philadelphia over the long-run; and
- Support Philadelphia’s economic and social policy goals.

As shown in Figure 5, there are four categories of opportunities that form a highest and best use strategy.

Figure 5: PGW Opportunities



Six HBU Opportunities => \$27 - \$33 Million/Year for PGW

- | | |
|---|---|
| <p>A. ① Diversify the Gas Supply Portfolio</p> <p>④ Pursue CHP, Help Businesses Grow and Convert Customers to Gas</p> <p>C. ⑤ Support Energy Industry Workforce Training Programs</p> | <p>B. ② Optimize LNG Assets</p> <p>③ Support Development of a Regional NGV Market</p> <p>D. ⑥ Invest in Customer Premises to Lower Energy Bills</p> |
|---|---|

These opportunities are closely related. Considered as a group, they have the potential to reduce the natural gas bills of PGW's customers over the medium to longer-term, particularly if PGW is able to achieve additional efficiencies in acquiring gas supply or in performing its distribution function. PGW customers can apply these saving to improve their own finances, invest in their businesses, or spend on goods and services within and outside of the City. It may also be appropriate for PGW to reserve a portion of these savings and redirect them to programs that help attract new businesses to Philadelphia, help existing customers use less natural gas, and invest in the integrity of the distribution network. A healthier local economy, with job training for Philadelphia's workforce, can potentially improve the quality of life of many families and reduce the number of customers that have to depend on financial assistance to heat their homes. Finally, select investments in new competitive business opportunities that are closely related to PGW's core business, such as growth of LNG and compressed natural gas ("CNG") sales, can provide substantial incremental margins that can be passed on to PGW's customers or used to defer increases in their rates.

A. Opportunity to Reduce Gas Supply Costs

Diversifying PGW's gas supply portfolio could potentially lower the cost of gas to PGW, resulting in lower customer gas bills. The City will benefit from increased affordability of natural gas for customers, especially for those who struggle to pay their bills. Residential customers will benefit from savings that can be redirected to other priorities, a portion of which is likely to be spent in Philadelphia. Business customers will improve their profitability with benefits accruing to owners and employees. PGW will benefit from lower CRP costs and a reduction in bad debt expense, as well as from any increased sales in response to lower gas prices. Finally, while many load growth programs (the next set of opportunities) and energy efficiency programs tend to benefit a subset of customers disproportionately, a reduction in the delivered cost of natural gas benefits all customers.

Opportunity 1: Diversify PGW's Gas Supply

As described in Section II, PGW currently sources all of its supply from the Gulf Coast, a strategy that has served it and its sales customers well. PGW's sales customers have benefited significantly from the development of the Marcellus and other shale fields, even without PGW's sourcing any supply directly from the Marcellus Shale, as shale development has reduced natural gas prices throughout the country. However, as discussed in Technical Appendix A, PGW's transportation

customers, which include some of Philadelphia’s largest businesses and employers, have not fared as well to the extent that they acquire their supplies from third-party marketers at prices tied to the two Philadelphia pricing points, “TETCO Zone M3” and “Transco Zone 6, Non-New York”.

The existing price (or “basis”) differentials among the Gulf Coast (Henry Hub), Marcellus (Dominion Point South and Leidy), and the two Philadelphia pricing points indicate that there is inadequate pipeline transportation capacity to deliver Marcellus supplies to market, including the Philadelphia market area.³³ Natural gas prices within the Marcellus have been lower than prices in the Philadelphia market, and they have been significantly lower during the winter months due to inadequate pipeline capacity connecting the Marcellus to Philadelphia. These existing basis differentials, if sustained, will attract interest from pipeline developers.³⁴ However, PGW’s sales customers will benefit if and only if the transportation rate that PGW would have to pay for this new, more expensive capacity (relative to the inexpensive TETCO and Transco capacity) is less than the anticipated future basis differential.³⁵ This appears to be the case currently, as shown in Table 7.

³³ As described in Technical Appendix A, price differentials between regional natural gas trading and pricing location points are referred to in the industry as “basis differentials”.

³⁴ In August 2014, two major pipeline projects were announced that would, if constructed, create additional pipeline capacity connecting Marcellus production to Mid-Atlantic markets. On August 12th, UGI Corp. and partners unveiled plans to construct a 100-mile pipeline, PennEast, with a capacity of up to 1 Bcf/d to deliver Marcellus gas from northeast Pennsylvania to an interconnection with the Transco pipeline in Mercer County, New Jersey, less than 50 miles northeast of Philadelphia. On August 26th, Williams Cos. Inc., announced a competing project, Diamond East, which would expand a section of the Transco pipeline to similarly add up to 1 Bcf/d of additional capacity from Marcellus production fields in northeast Pennsylvania to Mercer County, New Jersey (again northeast of Philadelphia). Both projects are holding open seasons—a standard practice in the pipeline industry to gauge customer interest before making capital investments—in August/September of 2014 and both projects could provide substantial incremental access to Marcellus gas for customers in northeastern Pennsylvania and New Jersey.

³⁵ Concentric has not estimated the potential cost of a new pipeline from the Marcellus to Philadelphia, as this requires a site-specific engineering analysis.

Table 7: Delivered Cost Comparison of Gulf Coast v. Marcellus Supplies to PGW³⁶

<u>Delivery Cost Component</u>	<u>Cost</u> <u>(\$/MMBtu)</u>
Delivered Cost From the Gulf Coast to PGW	
Average Futures Price at Henry Hub	\$ 4.43
Pipeline Transportation	\$ 0.50
Pipeline Fuel	\$ <u>0.08</u>
Total Delivered Cost	\$ 5.01
New Pipeline Capacity "Cost-to-Beat":	
For Gas Sourced from Marcellus at Dominion Point South	
Total Delivered Cost from Henry Hub	\$ 5.01
Average Futures Price of Dominion Point South	\$ <u>(3.48)</u>
	\$ 1.53
For Gas Sourced from Marcellus at Leidy	
Total Delivered Cost from Henry Hub	\$ 5.01
Average Futures Price of Leidy	\$ <u>(2.84)</u>
	\$ 2.17

As shown in this table, if the rates for a new pipeline remain within the \$1.53 to \$2.17 range, then the project would be cost neutral from the perspective of a PGW sales customer, without considering the benefits of a more diverse supply. If the rates remain lower than these levels, the project would clearly have a positive cost benefit for PGW customers.

There are several caveats to Opportunity 1. First, even though current futures prices indicate that Marcellus prices are likely to remain low, as new pipeline capacity is developed that allows Marcellus gas to reach new markets, the Marcellus prices are likely to eventually increase (and basis differentials relative to the Gulf Coast decrease). This will decrease the potential benefits to PGW's sales customers from a new pipeline that connects the Marcellus to the Philadelphia market area.

³⁶ Commodity costs reflect futures prices from Table A-1. Transportation costs and associated fuel reflect the existing maximum tariff rates on Transco for Rate Schedule FT (non-incremental) service from Zone 3 to Zone 6. Note that numbers in the table have been rounded for convenience of presentation.

Second, it is possible that Gulf Coast prices will increase if new LNG export facilities are developed. As noted in Technical Appendix B, most of the proposed facilities are located in the Gulf of Mexico.

Third, PGW cannot exercise control over the development of new pipeline capacity from the Marcellus to the Philadelphia market area. Rather, this will depend on the actions of a pipeline development firm and the commitments of other potential shippers to acquire the capacity needed to secure the economic viability and customer benefits of a new pipeline project. Pipeline developers gauge market interest by conducting an “open season” and inviting interest from potential shippers. However, as the largest potential customer in the Philadelphia area, PGW can potentially serve as an “anchor” customer, an industry term used to refer to a customer that is large enough to make a new project worth seriously considering.³⁷ Under this scenario, the developer would work with PGW to plan the pipeline project in-service date to closely correspond with the termination of one or more of PGW’s existing TETCO/Transco pipeline transportation contracts.³⁸ PGW should expect to sign an initial contract of at least ten years in order for the developer to secure the contractual commitments necessary to finance the project.

Finally, PGW should by no means abandon the Gulf Coast as a significant source of natural gas supply. Given recent experience with the impact of shale development on basis differentials, it is clear that diversity of supply remains an important portfolio objective for an LDC because it provides some protection against supply disruptions in any single production area. It is likely that overall supply flows will continue to change over time in response to shale development and new

³⁷ The concept of an “anchor” customer is also used when an LDC is considering extending its main. A large industrial customer considering a conversion to natural gas can serve to prompt marketing inquiries to other business and residential customers along the route to determine if enough volumes can be secured to make the project viable.

³⁸ PGW’s long-haul transportation contracts with TETCO and Transco are currently in an “evergreen” status, meaning that they can be terminated with notice periods that range from one to three years. The TETCO contracts have either 12-month or 24-month notice requirements and the Transco contracts have 36-month notice requirements.

pipeline projects that respond to sustained basis differentials. Diversity of supply offers a hedge against these supply and transportation uncertainties.³⁹

New pipeline capacity to the Philadelphia market area would also benefit PGW's existing and potential new large transportation customers, significantly so if new capacity lowers prices at the two Philadelphia pricing points. These customers utilize PGW to deliver third-party supply to their facilities and thus contribute to the recovery of the fixed costs of the distribution system. Transportation customers tend to be large employers and a significant reduction in their cost of natural gas would provide a meaningful boost to the Philadelphia economy.

Ironically, PGW can also exploit the current price differentials and price volatility that is caused by the lack of adequate pipeline capacity serving Philadelphia. As noted in Technical Appendix A, natural gas prices in the Mid-Atlantic market areas have been characterized by greater volatility than production area prices over the past two years and, in particular, this past winter. Henry Hub spot prices have traded within a range of \$3.28/MMBtu⁴⁰ to \$8.15/MMBtu over the past year, although trading above \$7.00/MMBtu on only four days. In contrast, Philadelphia area prices reached highs of \$90/MMBtu and \$120/MMBtu during the 2013/14 winter on the TETCO M3 and Transco Zone 6 Non-New York pricing indices respectively.⁴¹ Because PGW sources all of its gas from the Gulf Coast production area, it is insulated from the gas price volatility experienced at Philadelphia trading points. By contrast, many large industrial and electric generation customers in the Mid-Atlantic (including PGW transportation customers) rely on interruptible pipeline transportation service or purchase their supplies at a market area trading point and are exposed to price spikes at these points.

This creates an arbitrage opportunity for PGW to exploit market inefficiencies and infrastructure constraints and resulting spikes in natural gas prices that may only last for periods of a few hours,

³⁹ Potential increased reliance on natural gas as a fuel for electric generation to replace capacity and energy from retiring coal plants, the location of these new plants, and evolving electricity market rules are additional sources of natural gas pricing uncertainty.

⁴⁰ MMBtu or million British thermal units is a standard unit of measurement of the energy content of a fuel, which is closely equivalent to the volume measurement, Mcf.

⁴¹ SNL Financial.

days, or weeks. This would involve PGW relying more on its LNG vaporization capacity to serve on-system customers during these periods (if such actions are consistent with LNG operating guidelines that ensure reliability) and then either releasing pipeline and storage capacity to customers in constrained markets or selling a bundled supply service into these markets by combining supply and pipeline capacity. The precise timing and size of the arbitrage opportunities are difficult to predict in advance but if PGW were in a position to respond opportunistically and quickly, the resulting margins could far exceed the current LNG off-system sales margins, even if the volumes are much lower. There were several such opportunities this past winter as pipeline constraints out of the Marcellus and into certain markets contributed to price spikes. While this opportunity exists presently, it would likely dissipate if new pipeline capacity is developed. It should also be noted that expansion of PGW's LNG liquefaction capacity, and more efficient use of its LNG storage capacity (Opportunity 2) would increase PGW's ability to perform these activities.

The potential economic benefit to PGW's firm sales customers of shifting a portion of their supply to the Marcellus could be significant. For example, a relatively modest reduction in the cost of gas delivered to PGW for firm sales customers (or \$0.20/Mcf) would yield savings of approximately \$11 million per year. PGW's transportation customers would also benefit from increased pipeline capacity from the Marcellus to the Philadelphia market. These transportation customers would save an additional \$6 million if they were to achieve the same \$0.20/Mcf in savings.

PGW may have arbitrage opportunities before new pipeline capacity is developed that would increase the margins that might otherwise be achieved through off-system LNG sales, but it would be speculative to estimate these benefits.

Summary Conclusion: PGW should signal its interest to the market and respond to requests for interest by pipeline developers (“open seasons”) that are considering developing pipelines to serve the Philadelphia market. During the interim, PGW should also explore opportunities to exploit arbitrage conditions that derive from sourcing its gas supply from the Gulf Coast.

Potential Benefits to PGW’s Customers: Lower costs for PGW’s sales customers, a reduced cost burden attributable to the CRP, lower commodity costs for PGW’s transportation customers, lower delivery costs to the extent that PGW’s transportation customers are able to grow or new customers are attracted by lower Philadelphia market area prices, increased diversity of PGW’s supply portfolio as a hedge against future basis differential trends and production area/market supply disruptions.

Potential Benefits to the City of Philadelphia: Economic benefits from savings to all business and residential customers, reduced customer uncollectibles associated with non-CRP customers resulting from lower bills, increased profitability for existing and potential new industrial customers that will contract for their own supplies from third-party marketers.

Potential Risks: It can take a few years to develop a pipeline project, particularly if it encounters siting challenges. Basis differentials are subject to changing supply and demand conditions and there is no guarantee that this strategy will yield benefits to PGW’s customers and to the City. However, it will clearly mitigate these same risks as compared to the existing sourcing of all supply from the Gulf Coast.

B. Optimize the Value of PGW’s LNG Assets and Expand PGW’s Participation in the LNG and CNG Sales Markets

In Section II, we described the current underutilization of PGW’s LNG storage capacity (4 Bcf versus 2 Bcf annual liquefaction capacity), which restricts its ability to take advantage of the opportunity to sell LNG at current high margins to customers that use it for transportation and other purposes. PGW also has an opportunity to further support the development of lighter natural gas vehicles that run on CNG.

Opportunity 2: Optimize the Value of PGW’s LNG Assets

PGW can expand its liquefaction capacity to improve the overall design of its LNG facilities, support on-system sales growth, and increase its ability to serve emerging off-system LNG markets.

The potential expansion of PGW's LNG facilities has been cited as an element of a strategy to transform Philadelphia into an "Energy Hub".⁴² An expansion of liquefaction driven primarily by growth in firm on-system sales would represent a significant investment but would be most closely aligned with PGW's primary natural gas sales function. The existing capacity is adequate to serve PGW's firm sales customers, although PGW has indicated that a near-term expansion of liquefaction capacity would enhance their security of supply. Regardless, such an expansion would also have to be supported by sales of LNG to off-system customers. The LNG market is not price-regulated and thus, PGW would be investing in facilities to support sales in a competitive market, where supply, demand and price are all impacted by market forces beyond PGW's control. This represents a different risk profile than associated with PGW's core regulated sales and transportation business. As a result, PGW may want to consider partnering with a private entity that can bring capital and marketing competencies to the opportunity, while also accepting a portion of the risks. An additional consideration is whether a municipally-owned PGW would be constrained from entering into certain forms of public-private partnership to mitigate the risks of expanded participation in competitive off-system sales markets.

As mentioned above, PGW's current liquefaction technology is efficient, but restricts the periods during the year in which PGW can liquefy natural gas primarily to the Spring and Fall months. These limitations prevent PGW from taking full advantage of its 4 Bcf of storage capacity and also restrict the sustained level of annual combined vaporization for delivery to sales customers and LNG off-system sales to 2 Bcf per year. Any combination of annual vaporization to meet the needs of on-system firm sales customers and off-system LNG sales that exceed 2 Bcf will result in a drawdown of inventory levels that would need to be replaced in a subsequent year.

Despite these limitations, PGW has been able to exploit the differential between its cost to acquire and liquefy natural gas and the price that customers are willing to pay for LNG. As discussed in Section III and in Technical Appendix A, the Marcellus and other shale developments have created a wide price spread between LNG and competing oil-based products (primarily diesel and residual

⁴² See, by way of example, <http://www.forbes.com/sites/michaelkrancer/2013/11/19/houston-we-have-a-problem-profs-say-philly-to-become-global-energy-hub/>

fuel oils). This price advantage is expected by most analysts to be sustained, leading many traditional users of diesel and residual fuel oil to seriously consider making the investments necessary to convert from their existing fuel to LNG. In certain markets, more stringent environmental regulations are reinforcing favorable conversion markets. This combination of circumstances creates a sound market opportunity for PGW to take greater advantage of its existing LNG storage capacity, but only if it is able to address its current liquefaction constraints.

A. Emerging LNG Markets

The liquefaction expansion decision will depend in large part on an assessment of emerging LNG markets. Concentric has analyzed the Mid-Atlantic LNG fuel conversion markets, as presented in Technical Appendix B. The most promising of these markets are conversion of heavy-duty vehicles (“HDV”) and the Marcellus drilling/fracking market, followed by the marine vessel market. Rail transportation markets for LNG are still in the incubation stage, but represent potential longer-term opportunities for PGW. PGW is already targeting some of these markets, consistent with the recommendations of a study prepared for PGW by Pace Global in 2012.⁴³

The heavy-duty vehicle market is projected to grow from 0.01 Bcf/day in 2012 to 4 Bcf/day by 2035⁴⁴ and there is a significant opportunity for LNG to displace diesel in the Mid-Atlantic region because the payback to convert trucks to burn LNG can be as short as three years. In addition to the current price differential between LNG and diesel, U.S. Environmental Protection Agency (“EPA”) regulations provide additional motivation to HDV fleet owners to consider conversion to LNG. Since 2005, all diesel used by HDVs must be ultra-low sulfur diesel (“ULSD”), and the EPA recently began directly regulating CO₂ and Greenhouse Gas (“GHG”) emissions from HDVs, starting with the 2014 model year.⁴⁵ Philadelphia is strategically located in close proximity to numerous major interstate highways that are heavily trafficked by HDVs including I-95, I-76, and I-676, making it a likely location for future LNG fueling infrastructure that PGW could supply and/or develop and own. As of August 2014, there were only three operational LNG fueling stations in the

⁴³ Pace Global, *Small-Scale LNG Market and Strategic Approach to Market Penetration*, April 2012.

⁴⁴ IHS CERA, *Fueling the Future with Natural Gas: Bringing It Home*, January 2014.

⁴⁵ American Clean Skies Foundation, *Natural Gas for Marine Vessels: U.S. Market Opportunities*, April 2012.

northeastern U.S.; however, a number of additional fueling stations are in development in the Mid-Atlantic region and will require LNG fuel supplies. Incremental LNG production and new fueling stations will be needed for LNG to reach its market potential as a fuel for HDVs.⁴⁶

The second most promising near term market is fuel-intensive drilling and hydraulic fracturing (or “fracking”) processes that typically use diesel fuel oil. Conversion economics are outstanding with LNG fuel costs running at about one-half of diesel costs and yielding payback periods for the equipment investment of 2 to 4½ years.⁴⁷ According to one industry executive, natural gas (including LNG) is currently fueling approximately 7 percent of horizontal drill rig fleets in the U.S., but could rise to 50 percent within two years.⁴⁸ As with the other fuel conversion opportunities, the greatest obstacle to the use of LNG as a fuel source for drilling and fracturing is the shortage of LNG. Currently, there are no liquefaction plants located within the Marcellus production basin, providing a potential opportunity for PGW to take advantage of its proximity to the Marcellus to build market share. PGW is not alone in identifying this opportunity, however. UGI Corp. has recently begun marketing LNG to Marcellus drilling operations from its Temple plant in Reading, PA. At some point, a Marcellus-based liquefaction plant or smaller mobile liquefaction units that can move with drilling/fracking equipment may become competitors. The window of opportunity to supply LNG to drilling and fracking operations in Pennsylvania may also be short-lived as it is likely that infrastructure will eventually be built allowing producers to use lower cost field gas to fuel these processes.

The market for LNG as a marine fuel is still in the earliest stages and should be approached as a longer-term opportunity. Marine vessels typically run on liquid petroleum fuels - either residual fuel oil or low-sulfur diesel. The marine vessel market is promising because of the conversion economics and pending environmental regulations that would restrict the sulfur content of marine

⁴⁶ Zeus Intelligence website, <http://member.zeusintel.com/LNGFuel/Fuelstation/Index.aspx>, accessed August 5, 2014; Powered by LNG website, <http://poweredbylng.com/>, accessed on August 5, 2014.

⁴⁷ Journal of Petroleum Technology, “Displacing Diesel: The Rising Use of Natural Gas by Onshore Operators”, December 2013; Global Hunter Securities, LLC, Thought of the Day: Converting diesel powered drilling rigs to natural gas, April 23, 2012.

⁴⁸ Journal of Petroleum Technology, “Displacing Diesel: The Rising Use of Natural Gas by Onshore Operators”, December 2013.

fuels. The EPA has adopted rules imposed by the International Maritime Organization (“IMO”) that establish limits on the sulfur content of marine fuel to 1.0 percent in designated Emission Control Areas (“ECA”)—which include all U.S. territorial waters—and in 2015 the limit on sulfur content in ECAs will be further reduced to 0.1 percent. This is an emerging market with the number of LNG-fueled vessels bunkering (i.e., refueling) in U.S. ports projected to increase modestly from zero today to approximately 30 vessels by 2018.⁴⁹ The equivalent amount of LNG that would be required throughout the U.S. for refueling marine vessels is 2.5 Bcf per day, with 10 percent of this in the region that includes Philadelphia. PGW’s LNG Facilities are located near some of the largest ports in the country including Philadelphia, New York/New Jersey, and Baltimore. This market may develop more slowly, however, as it most likely requires new infrastructure to be constructed at port locations. Thus, penetration levels in the U.S. are expected to develop slowly, with LNG usage in domestic shipping markets increasing from inconsequential levels in 2013 to two percent in 2040.⁵⁰ The paybacks are also more modest than the HDV market at approximately 10 to 12 years for the most promising vessels (tugboats, ferries, and bulk carrier vessels). If and when this market matures, liquefaction and storage facilities will likely be constructed at the port facilities themselves to enhance efficiencies which may reduce the advantage of PGW’s location.⁵¹

B. PGW’s Ability to Grow Off-System Sales with Its Existing LNG Facilities

As shown in Table 8, PGW’s existing sales program is already approaching the limit of what can be accomplished without drawing down inventory levels below those required to meet on-system obligations.

⁴⁹ NGV Today, “Special Report: Vehicle grade LNG production capacity inventory growing”, April 15, 2014.

⁵⁰ U.S. Energy Information Administration, Annual Energy Outlook 2014, Transportation Sector Energy Use by Fuel Type within a Mode.

⁵¹ LNG produced at a location other than the port facilities would have to be delivered to the ports either by numerous cryogenic tank trucks or via a cryogenic pipeline, adding incremental capital and/or operating costs.

Table 8: Recent and Projected LNG Vaporization and Sales (Mcf)

	Historical		Forecast		
	FY2012	FY2013	FY2014	FY2015	FY2016
Balance - Beginning of Year	2,592,730	3,208,450	3,348,454	2,164,619	2,323,861
Less: Vaporization/Boil-off	(974,238)	(1,298,010)	(2,190,031)	(1,251,653)	(1,370,000)
Less: LNG Sales		(239,254)	(1,057,391)	(991,498)	(662,000)
Plus: Liquefaction	1,589,958	1,677,268	2,063,588	2,402,393	1,964,529
Net Change	615,720	140,004	(1,183,835)	159,242	(67,471)
Balance - End of Year	3,208,450	3,348,454	2,164,619	2,323,861	2,256,390

PGW's fiscal year runs from September 1 to August 31 and the modest FY2013 sales reflect that PGW began selling LNG to off-system markets in April 2013. End-of-year inventories grew in each of the two historical years since liquefaction exceeded the sum of LNG uses: vaporization to support on-system customer requirements, boil-off that occurs during storage and liquefaction, and off-system sales.⁵² There were no off-system LNG sales in FY2012, and Philadelphia experienced a relatively mild winter, allowing inventories to increase by 615 MMcf. Inventories increased by a more modest 140 MMcf in FY2013 as PGW began its off-system LNG sales program and Philadelphia experienced a colder winter.

The data for FY2014 reflects 7 months of actual and 5 months of forecast data. This past winter was relatively and consistently cold, and the expected amount of vaporization or boil-off is much larger than the two preceding years. PGW has projected that it will increase liquefaction in FY2014, but this is also the first full year of off-system LNG sales. However, the net impact on end-of-year LNG inventories is likely to be significantly negative (approximately 1.2 Bcf reduction from the prior fiscal year-end inventory of 3.3 Bcf).

⁵² Boil-off is evaporation of LNG which results from the process required to maintain minimum temperature in the tank and during the liquefaction process. This vapor is captured and also injected into the distribution network.

The two fully forecasted years in Table 8 reveal lower off-system sales as PGW is challenged to maintain end-of-year storage inventories at a level necessary to meet on-system needs if PGW were to experience another cold winter. PGW may be able to rebuild its storage inventories depending on weather conditions but inventory levels will still remain well below the FY2013 levels and further below PGW's 4 Bcf of storage capacity. This also assumes that PGW is able to liquefy at or near capacity levels. PGW's off-system sales will be lower if Philadelphia experiences a cold winter or if PGW is successful in attracting new load, particularly weather-sensitive load. In fact, should Philadelphia experience a "design winter", PGW may not be able to make any off-system sales.⁵³

In summary, aggressive pursuit of the emerging off-system LNG market is not viable under the current circumstances. An expansion in liquefaction capacity would most likely be required to maintain current off-system LNG sales levels, and will definitely be needed to target the emerging LNG markets. Moreover, without additional liquefaction capacity, PGW's existing 4 Bcf of storage capacity will continue to be substantially underutilized.

C. Potential Expansion of PGW's LNG Liquefaction Capacity

Concentric assumes that PGW would undertake a significant, yet prudent, financeable expansion of its LNG liquefaction capability that accomplishes the following objectives:

- Maintains the primary role of LNG facilities to meet the peak demands of PGW's on-system firm sales customers, while also accommodating successful efforts to attract new load (see Opportunity 4);
- Allows PGW to aggressively pursue off-system sales and higher-margin opportunities by responding to customer interest in longer-term and/or firmer commitments;
- Addresses the underutilization of PGW's LNG storage capacity, relative to its liquefaction capacity; and
- Enables PGW to liquefy LNG during the summer months, if not year round.

These objectives can be efficiently achieved by adding liquefaction and truck-loading capacity at the Richmond LNG facility. The most important financial assumptions pertain to the size, cost,

⁵³ Design winter conditions are defined as those that existed during the coldest winter in the past 30 years.

operations and technology of the new liquefaction unit and the margins to be realized from off-system sales. Concentric has not prepared a rigorous business case for the LNG expansion option because this would require detailed site-specific engineering analysis.⁵⁴ However, for purposes of providing a sense of whether such a study might be warranted, Concentric has made some simplifying assumptions. The assumptions are as follows:

- PGW adds 12,000 Mcf/day of liquefaction capacity employing nitrogen expansion technology capable of liquefying natural gas during the non-winter months.⁵⁵
- The cost of adding this liquefaction capacity could be between \$40 and \$60 million (indicating that a detailed site-specific engineering study is clearly appropriate to develop a more precise cost estimate).⁵⁶
- Richmond's second truck loading bay will be placed back in service to accommodate a significant increase in off-system LNG sales while maintaining deliveries to the Passyunk LNG storage facility, at an estimated cost of \$650,000.
- The liquefaction capacity would be operated from April through October, for a total of 214 days, relying on PGW's existing interstate pipeline capacity to deliver supplies that approximate 13,500 Mcf/day (accounting for gas used during the liquefaction process) during this period while avoiding liquefaction during the winter months when the existing pipeline capacity is dedicated to delivering supplies for PGW's firm sales customers. This would also accomplish the objective of allowing for liquefaction during the summer months when natural gas prices are typically at their lowest points during the year.
- PGW is able to sell 7,000 Mcf/day of LNG, assuming an even level of LNG sales over all twelve months of the year. This would double PGW's LNG liquefaction capacity, increasing it by more than 2.5 Bcf/year, and would resolve the imbalance between the liquefaction and storage capacities.

The current liquefaction unit at the Richmond plant is sufficient to support almost the entirety of the shortfall between PGW's combined pipeline transportation and storage capacity and its firm customer demand, should Philadelphia experience a design winter. Therefore, for purposes of

⁵⁴ Concentric is not an engineering consultancy and is not able to confirm that the technology configuration that serves as the basis of this analysis is either a viable or the best configuration.

⁵⁵ In a response to a Concentric information request, PGW has indicated that a nitrogen expander liquefaction unit capable of producing 10,000-12,000 Mcf per day of LNG could be added to the Richmond facility without the need for additional storage or pumping capacity. Refer to Appendix B for a brief discussion of the most common liquefaction technologies.

⁵⁶ This cost projection is based on a survey of industry information on the capital costs associated with installing new liquefaction capacity as well as communications with PGW management.

estimating the payback of the second liquefier, we assume that the incremental costs of this capital investment should be compared to the revenues generated from any off-system sales. Concentric has assumed that the margin revenue from LNG sales ranges from \$3.00 to \$4.00 per Mcf, after accounting for commodity, pipeline and storage, and operating costs.

Our preliminary assessment of the LNG expansion option indicates it could result in \$7.7 million to \$10.0 million of margin revenues each year, which translates into a payback period in the range of four to eight years, depending on the actual cost to construct the second liquefaction unit and the actual margin generated from LNG sales.

D. Impact on Risk, Risk Mitigation, and Regulatory/Legal Authorities

While the development of 12,000 Mcf/day of LNG liquefaction capacity may not be required to securely serve PGW's existing firm sales customers, the new capacity would enhance security of supply while providing a cushion to address potential load growth. The new capacity would also resolve the underutilization of the existing 4 Bcf of storage capacity. However, to the extent that the additional liquefaction capacity primarily supports PGW's efforts to sell LNG to emerging markets, PGW would be engaging with a competitive market. However promising this market may be, this would change PGW's risk profile and thus raises several questions.

The most fundamental question is how this change in risk will be allocated between PGW's owner (currently the City), and PGW's customers. Under PGW's current approach to off-system LNG sales, PGW is exploiting surplus conditions, as they vary throughout the year, to sell LNG on an interruptible basis without adversely impacting its ability to meet its primary obligation to serve firm sales customers. This clearly benefits existing sales customers as they are absorbing little or no incremental risk and benefit from the margins generated by off-system LNG sales. The market outlook for LNG and PGW's competitive position appear to be strong enough to merit detailed engineering cost and market studies for the expansion of PGW's liquefaction capabilities. Since this is a major capital project that will likely need to be funded through a PGW bond offering, it will require City Council budgetary and financing approvals. Properly informed, City Council can make a determination as to whether the business case makes sense for the City, PGW, and PGW's

customers and whether there would be any limitation on the use of bond proceeds for this purpose.⁵⁷

One approach to mitigate the risk of an expansion of PGW's liquefaction capacity would be for PGW to enter into a Public-Private Partnership ("PPP"), joint venture or other form of operations agreement with a private entity that could bring financial, operational, and marketing competencies to the venture.⁵⁸ It should be noted that pursuit of LNG off-system sales by a privately-owned PGW would likely face challenges from the PA PUC.⁵⁹

Summary Conclusion: PGW should perform a detailed site-specific engineering analysis of an optimally sized expansion of its LNG liquefaction capacity as well as a more detailed market study and provide the PGC and City Council with a business case to consider, supported by any necessary legal opinions if a PPP is contemplated.

Potential Benefits to PGW's Customers: Capacity to support continued growth of both on-system firm sales and off-system LNG sales, and associated financial benefits such as possible deferral of rate increases or reduced reliance on debt financing.

Potential Benefits to the City of Philadelphia: Contribution to the City's efforts to transform itself into an Energy Hub, and associated employment opportunities.

Potential Risks: Risks that the market for LNG will not develop as anticipated in terms of both sales volumes and margins, and the risk that the LNG expansion project will either cost more than projected or not perform as designed.

Opportunity 3: Support the Development of a Regional NGV Market

CNG is used primarily in vehicles, ranging from small passenger cars to heavy trucks and busses. These vehicles are either newly constructed or converted from standard gasoline vehicles to run on

⁵⁷ Concentric offers no opinion on this and other legal questions referenced in this Report.

⁵⁸ Concentric understands that more than 15 years ago, the City authorized PGW to enter into a joint venture agreement with QST Energy, Inc. ("QST") in order to participate in PECO's electricity pilot program. The legality of this alternative was addressed by a 1997 City Solicitor legal opinion

⁵⁹ A privately-owned PGW may require approval from the PA PUC, which will be interested in how the costs, revenues, and risks associated with a dual-purpose LNG liquefaction facility will be allocated between sales customers and shareholders.

CNG. While more expensive to purchase than gasoline-fueled vehicles, they have lower operating costs as a result of the price differential between CNG and gasoline products and reduced maintenance requirements. NGVs emit approximately 20% less greenhouse gases, significantly less smog-inducing Nitrous Oxide gases and almost no fine particulate matter (one of the most harmful pollutants to human health when ingested into the lungs). However, despite Federal Government tax incentives, the national NGV market is not yet sufficiently developed to support the development of a regional or cross-country network of filling stations that would be required to encourage conversions, especially among long-distance travelers.

The Federal Government is providing tax credits for the establishment of refueling stations and grants for refueling stations that serve buses and shuttles.⁶⁰ The PA DCED Alternative and Clean Energy Program is also providing matching grants for the establishment of CNG and LNG refueling stations. PGW has an opportunity to support the development of the regional NGV market by converting its own fleet to CNG where cost-effective and working with the City to convert other City-owned fleets. Municipal fleets and other fleets that travel within a smaller geographical area are an ideal target because CNG vehicles have only half the range of conventional gasoline vehicles. PGW is targeting approximately a dozen firms that own and operate fleet vehicles in the Philadelphia area with a total potential natural gas market of almost 1,000,000 Mcf/year by 2020.⁶¹

PGW views the CNG market as a means of increasing non-weather sensitive year-round gas sales and earning margins on these sales and is developing a private CNG refueling station on PGW property.⁶² PGW has made its own commitment to the NGV market with the purchase of 24 fleet sedans, as described in a June 18, 2014 announcement.⁶³ By taking these actions, PGW is demonstrating support for development of a new natural gas market and its commitment to wider

⁶⁰ “Growth of CNG in the Philadelphia Market”, draft presentation prepared by PGW’s Marketing Department, July 2014.

⁶¹ Ibid.

⁶² Ibid. For security reasons, it would not be appropriate to allow non-PGW vehicles to refuel at PGW sites that are also dedicated to other uses.

⁶³ “PGW Unveils Natural Gas Vehicles, Supports Expansion of Philadelphia Natural Gas Vehicles Market”, PGW News Release, June 18, 2014.

use of a clean-burning fuel. In so doing, PGW takes a leadership role as an environmentally conscious corporate citizen, while fostering potential opportunities for additional local employment.

A preliminary business plan, developed by a consulting firm with expertise in the NGV vehicle and fueling station market, concluded that PGW is unlikely to achieve a payback on investments in fueling stations and vehicles within a seven-year period if its market is limited to its own vehicles.⁶⁴ Nonetheless, PGW's relatively modest initial foray into this market, as recommended by the PGC and approved by City Council,⁶⁵ will provide additional experience to assess whether this is a viable long-term market opportunity for PGW. PGW is currently focused on increasing throughput by providing natural gas sales and transportation service at high pressures to public and private refueling stations that decide to locate within Philadelphia. In other words, while PGW can demonstrate support for this market by converting its own vehicles, the highest and best use opportunity depends on conversion of other City-based fleet vehicles that are refueled at public and private stations located within Philadelphia that receive sales or transportations service from PGW. In addition to providing uncompressed gas to a refueling station that is owned and/or operated by a third party, PGW could possibly develop, own and operate its own refueling stations although this would require a substantial capital investment and confidence that the market will support entry into this competitive business.

⁶⁴ Business Case for the Assessment of the Market for Natural Gas Vehicles and Equipment (NGVE) in the Philadelphia Gas Works (PGW) Service Territory, Draft Report prepared by Gladstein, Neandross & Associates, May 1, 2014.

⁶⁵ Bill No. 130583 (approved by City Council on October 17, 2013 and signed by the Mayor on October 30, 2013).

Summary Conclusion: PGW should aggressively pursue arrangements to help convert other City fleets to natural gas and continue to market to third-party fleet owners while it gains experience from its initial participation in the NGV market and monitors the evolution of the regional and national market to inform its long-term strategy.

Potential Benefits to PGW's Customers: Increase in throughput on PGW's network and additional margins that can be flowed back to PGW's customers.

Potential Benefits to the City of Philadelphia: Improvements in the local environment from the much cleaner fuel; lower fuel and operating costs for fleet vehicles which recover the cost of investing in NGVs.

Potential Risks: Financial risks attributable to the return on investment required to participate at this relatively early stage in the development of the NGV market.

C. Increase Gas Sales and Train Workers to Support Economic Growth

While the first two categories of opportunities contribute to the Philadelphia economy by lowering costs to all customers either through lower natural gas supply costs (Category A) or by generating new margins from off-system LNG sales and an expanded CNG market (Category B), this third category focuses more directly on efforts to help existing businesses expand and attract new businesses to Philadelphia. It includes promotion of CHP, increased sales and transportation service to “energy hub” customers and other businesses that decide to locate in Philadelphia, conversions of customers to natural gas, and training programs to put Philadelphia citizens to work.

Opportunity 4: Promote CHP, Help Businesses Grow, and Convert Customers to Natural Gas

PGW can contribute to economic growth in the City by providing financial support to customers that are considering installing CHP or other gas-burning equipment, and by working collaboratively with industry and government to support businesses that are considering expanding their existing operations or locating new operations within the City. The first such opportunity, CHP, appears to be particularly timely as many large customers that also have thermal loads are looking for ways to reduce and manage their electricity and overall energy costs.

These incremental loads provide economic value to the participating customers as they reduce their energy bills by lowering the cost of energy and using fuel more efficiently. They also provide benefits to PGW and other customers by making a contribution to the recovery of distribution system fixed costs that would otherwise be borne by these customers, net of any incremental investment that may need to be required by PGW to provide the service. Finally, they benefit the Philadelphia economy by helping customers and businesses spend less for energy and by supporting an expansion in business (and associated employment) in Philadelphia.

a. Promote Combined Heat and Power

Approximately 70% of existing CHP installations in the country are fueled by natural gas.⁶⁶ CHP installations vary significantly in size ranging from small microturbines to large industrial installations that generate in excess of 100 MW. CHP is considerably more efficient than purchasing electricity produced by the electric utility while also producing on-site thermal energy using a furnace or boiler. This technology has been available for some time, but many regulators are now encouraging electric generation from equipment located on customer premises as more environmentally friendly, while avoiding the need to build additional central power stations and invest in additional electric distribution infrastructure. Customers that install CHP save money on both their electricity consumption and thermal uses while creating CO₂ emissions reductions from the increase in overall efficiency.

As a backup source of electric generation, CHP can also improve system resiliency when there is a major outage. CHP is an option for some of PGW's largest customers including hospitals, hotels, prisons, manufacturers, and universities, whose demand for electricity is round-the-clock. An April 2011 study commissioned by the Commonwealth of Pennsylvania noted that CHP equipment is produced by multiple Pennsylvania based firms and also creates consulting opportunities for local engineering firms.⁶⁷ The report concluded:

⁶⁶ "CHP Market in Pennsylvania", presentation by Anne Hampson of ICF International at the RPA Energy Symposium, April 8, 2014.

⁶⁷ "Pennsylvania Combined Heat and Power Market Assessment", prepared by the DOE Mid-Atlantic Clean Energy Application Center, April 2011.

CHP addresses energy issues important to Pennsylvania by effectively using Marcellus gas, lowering consumer power costs, increasing power reliability, creating jobs and stimulating private investment while also providing a low cost means of reducing greenhouse gas (GHG) emissions.

PGW is aggressively pursuing CHP opportunities throughout its service area. As described in Section II, PGW has installed CHP at its headquarters, at the Four Seasons Hotel, and at six other locations with a total annual projected load of over 100,000 Dth, and offers financial support for new CHP installations through its CICIP.⁶⁸ These installations utilize microturbines, relatively small (30 to 200 kW) generating units that can be packaged together to increase output. PGW has an active marketing campaign with proposals to over 25 other customers with a total load of over 2.5 million Dth/year.⁶⁹

CHP may be the most promising and immediate opportunity that PGW has to add load and create momentum among its commercial and industrial customers. This program can be combined with technical advice from PGW's experts, additional funding from the Commercial and Industrial Equipment Rebate energy efficiency program, and funding that may be available from government sources. The expertise component is important because many customers need help understanding the technology and economic advantages of CHP, particularly because they are mainly focused on their primary business. While appreciative of the opportunity to save money, management can be reluctant to make investments in energy technology that is beyond their core business. PGW addresses these concerns by structuring contracts in a way that credits the customer's up-front investment against savings over the first few years of operation.

PGW's CHP strategy is consistent with its core business, contributes to more efficient energy use, and will secure new load that generates margin. The contribution to margin is site-specific and contract-specific and will depend on the size of PGW's investment to make the sale and connect the customer. However, even at a relatively modest \$1/Mcf in margin revenues and assuming a 40%

⁶⁸ "Growth of CNG in the Philadelphia Market", draft presentation prepared by PGW's Marketing Department, July 2014.

⁶⁹ Ibid.

success rate, the CHP opportunity would generate approximately \$1 million per year to offset PGW's fixed costs that would otherwise be borne by other customers.

b. Help Attract New Businesses or Expand Existing Businesses

There are numerous economic development programs offered by LDCs throughout the country. They rely on economic incentives such as discounted service, rebates for equipment and other investments, and grants. Regulatory approval of economic development rates is usually required because these rate discounts or other forms of financial incentives to one subset of customers are funded by the remaining customers.

Most LDC programs fall into one of the following categories:

- Business Attraction: discounted distribution rates for a pre-defined period of time for start-up firms or firms relocating to the LDC service area; demonstration of a viable alternative location may be required. Discount may also be tied to degree of energy-intensity. Programs often coordinated with area economic development efforts.
- Business Expansion: discounted rates based on the number of jobs created or for significant increases in demand relative to a baseline energy usage. May also include capital contributions to offset the costs of expansion investments incurred by the expanding business where private financing is unavailable.
- Business Retention: discounted rates based on verifiable financial and other documentation that they are required to prevent a firm from relocating outside of the LDC's service territory. May be coupled with state/local government incentives to retain the business.
- Vacant Buildings/Enterprise Zones: discounted rates for businesses relocating to designated areas or buildings.
- Building Repurposing: grants to repurpose the existing utility infrastructure to accommodate repurposing of an industrial building.

While PGW offers support for installation of new mains and services where cost-beneficial and also incentives for installation of DSM measures for commercial and industrial customers, it does not

currently provide discounted rates to retain or attract businesses.⁷⁰ As discussed in Section III, incentive rates have the potential to contribute directly to the bottom line of a business and are a strong financial motivator. However, there are many other reasons that contribute to business location and expansion that are just as important as or more important than a time-limited rate discount and which may drive the firm's business decision. Certainly, PGW should approach these opportunities with appropriate caution if a significant rate discount is entailed. Rate discounts are absorbed by other customers and thus cannot be justified without a cost-benefit analysis to assess the value of new business from a PGW perspective. The incentive can also take the form of a loan by PGW to reduce the subsidy that would otherwise be borne by other customers. PGW may have to require a customer commitment to take service at minimum levels in order to justify the loan or rate discount, given the calculated payback period for recovery of any incremental costs necessary to serve the new load.

PGW efforts to retain, attract, and expand businesses in Philadelphia are more likely to lead to successful outcomes if they are coordinated with other public and private actions that either support the same opportunity or improve the overall business climate. There will be certain opportunities that have a higher hurdle rate than can be met alone by either a PGW or other economic development benefit. The value of a coordinated program is also greater than the sum of its parts for businesses that need help navigating relocation or expansion challenges. A teamed approach may make the difference for certain opportunities. Under these circumstances, PGW and government entities that are providing financial support to a business should estimate the cost per job attracted or retained and impose "clawback" provisions that would require customers to repay a portion of the financial incentive if their economic commitments are not fulfilled.

The Commonwealth of Pennsylvania and the City of Philadelphia each have organizations and many programs to promote economic development, alternative energy or DSM efforts that could be combined with a PGW program. The Pennsylvania programs include the Keystone HELP Energy

⁷⁰ PGW offered an economic discount rate in the 1990s that offered a 15% discount off of the PGW rate, including gas costs for any new or expanding customers on Rate BPS that were making a significant capital investment and would add at least 1,500 Mcf per month of load. The cumulative amount of the discount was capped at the amount of the investment.

Efficiency Loan Program, the Keystone Innovation Zone Tax Credit Program, the High Performance Building Incentives Program, the Jobs Creation Tax Credits Program, the Tax Increment Financing Guarantee Program and the Pennsylvania Capital Access Program. The City also offers financial support for energy efficiency improvements through the Mayor's Office of Sustainability and in the form of PGW's energy efficiency programs.

PGW can contribute to business attraction without necessarily providing rate discounts to new businesses that relocate to Philadelphia by placing increased importance on the marketing and sales functions. PGW increased the number of employees in this function by approximately 20% in 2012.⁷¹ The new business function can work with prospective high gas-consuming businesses and serve in a technical advisory capacity to help businesses understand PGW's service options, including CHP and programs to help them use natural gas more efficiently, a function that is already being performed by PGW. PGW's business development team can help businesses identify and apply for energy-related funding from State and City sources and navigate any unique siting approvals required for the installation of energy equipment or removal of existing equipment. PGW can also make enhancements to the local network if necessary to serve the particular site or sites under consideration. Concentric understands that PGW has recently begun providing incentive-based compensation to select members of the marketing group, tied to success in exceeding annual goals for attracting new loads. Given the unique opportunity faced by PGW and other LDCs, and the importance of adding profitable load to the system in order to restrain costs for all customers, PGW should continue these efforts and increase its marketing activities.

There is one business growth opportunity that deserves special mention. This relates to the potential that Philadelphia could take advantage of its proximity to low-cost Marcellus Shale natural gas and transform itself into a regional "Energy Hub", with the natural gas industry acting as an engine for economic growth. Although the subject of considerable discussion, this concept remains loosely defined. It has been referenced at various times in connection with (1) efforts to transport NGLs from the Marcellus Shale to the Philadelphia area for redistribution to domestic and export markets, (2) location or expansion of businesses that either rely on natural gas or NGLs as a factor

⁷¹ PGW's FY 2013 Operating Budget Filing, SD-3.

of production or that support Marcellus Shale development efforts, and (3) potential increased sales of LNG to be made possible by an expansion of PGW's existing LNG facilities, including the potential to export LNG. The Philadelphia Energy Hub concept has also been linked to support for the establishment of a local energy policy "think tank".⁷² The Philadelphia business community has expressed support for efforts to transform Philadelphia into an energy hub.

NGLs (i.e., propane, ethane, butane, and natural gasoline) are extracted along with natural gas in the western portion of the Marcellus Shale. NGLs are separated from natural gas by processing plants that are located in production areas and are transported to markets where they are used for several purposes including as a feedstock for petrochemical plants and as an additive to vehicle fuel. Efforts that enhance the ability of these products to be extracted and sold increase the return to Marcellus Shale producers, thereby supporting development of the Marcellus Shale and the substantial economic benefits to Pennsylvania and other Marcellus Shale states.

For purposes of this report, it is important to clearly distinguish among these three concepts, as they refer to distinct product markets and therefore present distinct opportunities for PGW. The potential for increased sales of LNG, a market that PGW already serves, is discussed as Opportunity 2. The ability of PGW to lower the cost of its supplies by potentially acquiring natural gas directly from Marcellus Shale producers is discussed as Opportunity 1. PGW is also a participant in this market, both as a purchaser of the natural gas commodity but also as a contracting party for interstate pipeline capacity necessary to transport the commodity to Philadelphia. In contrast, PGW does not currently participate as a buyer, transporter or seller in the global NGL market. Concentric views participating as an active market participant in NGLs as being beyond PGW's core business and thus, not a viable opportunity for PGW. (See Section V for a discussion of non-viable opportunities.) However, there is an opportunity for PGW to provide natural gas sales and transportation services to NGL market participants.

Given its proximity to the Marcellus Shale and transportation infrastructure, Philadelphia is an attractive location for firms that will either use NGLs as a feedstock in their industrial processes or

⁷² "Penn Receives \$10 Million to Open Center for Energy Policy", Philadelphia Magazine, July 17, 2014.

store and redeliver NGLs to other markets via ship, rail, or truck. It is certainly conceivable that a cluster of such businesses could develop in the Philadelphia area and that this would serve as a source of economic vitality. Thus, growth of the NGL-related industries provides a growth opportunity for PGW to the extent firms that either use NGLs as a feedstock or serve in some capacity along the NGL supply chain located within PGW's service territory and become large industrial natural gas sales or transportation customers. This opportunity is entirely consistent with PGW's core business.

This opportunity will contribute to Philadelphia's economic growth by helping existing businesses be more profitable and expand, and by helping to attract new businesses. If these efforts are successful, PGW's load will grow, providing benefits to all PGW customers by spreading the fixed costs of the distribution network over larger volumes, net of any investment required to connect new load. Existing pipeline capacity serving the Philadelphia market is sufficient to serve the current demands and may accommodate some growth. However, if PGW is successful in converting the remaining oil customers to natural gas or helping to attract new gas-intensive businesses to Philadelphia, new pipeline capacity from the Marcellus or some other production area will need to be developed. By entering into contracts to use and pay for (and thus finance) incremental pipeline capacity, PGW can help ensure a reliable, competitively priced supply of natural gas to meet a growing demand.

c. Natural Gas Conversions

Although PGW has a high saturation of businesses and homes (86% according to a 2008 report⁷³) that use natural gas, the current price advantage provides an opportunity to convert customers who continue to rely on other energy sources, particularly customers located on streets that already have gas service (referred to as "on-the-main" customers) and require only the construction of a service line from the street to the property. There is also an opportunity to convert non-heating customers who already have gas service but have an oil furnace or boiler that is ready to be replaced. The

⁷³ "The Philadelphia Gas Works: Challenges and Solutions", October 2008, Economy League, Greater Philadelphia, page 31.

economics of connecting a customer to the main make sense from both the customer and PGW perspectives when the load is large enough to warrant the capital investment that each incurs. The customer incurs capital expense to remove existing appliances and/or heating systems and install new natural gas equipment; PGW incurs the capital cost of adding a service line and a meter.

Timing is a key determinant of the potential of the conversion market. Customers are most willing to convert to natural gas when their equipment fails and when the price of natural gas is significantly lower than their current fuel (as it is now). PGW's infrastructure costs and sales hurdles are lowest when the customer's property is located on an existing main or if it is not, when the street is open or will be opened for other purposes (e.g., a pipeline replacement project).

LDCs have standard cost-benefit thresholds to minimize the impact on existing customers of attaching new customer load and PGW is no exception. The test is often expressed as generating a return that is equal to the cost of capital within some reasonable time period (e.g., ten years). Part 10 of PGW's Tariff provides for PGW to pay for extensions of mains and services in an amount equal to up to five years of anticipated delivery charges for a residential customer and up to three years for a commercial customer, with some flexibility depending on the size of the load that is connected. If these PGW investments are not sufficient to cover the cost of the main and service extension, the customer will need to make a contribution to bring the payback period to a term that is acceptable to PGW.

PGW is currently able to serve incremental sales load in whole or in part with its existing pipeline transportation, storage and LNG resources depending on the type and amount of new or added load. For new PGW customers who elect transportation service, this is not a consideration as they are obligated to secure their own natural gas supply and pipeline transportation capacity, and rely on PGW solely to distribute this gas supply to them, or pay a penalty if their supply is not delivered to PGW's distribution system.

However, at some point PGW would need to contract for additional pipeline and storage capacity and/or make modifications to its existing LNG facilities in order to enable growth. New pipeline projects can take a few years to obtain necessary siting and regulatory approvals followed by construction. Thus, PGW will need to align its marketing programs with its ability to contract for

new capacity that may be required. Another option is to obtain additional capacity from a shipper that no longer needs it. However, the feasibility of this option would depend on such factors as the size and load profile of PGW's incremental demand, the number of days during the year for which the capacity could be obtained, the duration of the period in which the capacity would be available, and the degree to which it could be obtained on a firm (i.e., permanent) basis.

Summary Conclusion: PGW should aggressively pursue CHP installations where they provide an efficient solution to customers with electricity and thermal needs and actively contribute to broader City efforts to attract new businesses to the City. However, PGW should emphasize technical advisory and customer support services over rate discounts. PGW should also continue efforts to grow its Marketing Department and broaden employee incentive programs that reward successful load additions, and pursue proactive outreach directly to customers and by working collaboratively with other government and community organizations. PGW should pursue opportunities to connect new "on-the-main" load and convert existing non-heating customers to heating customers when their heating equipment needs to be replaced.

Potential Benefits to PGW's Customers: Increased throughput and recovery of fixed costs that would otherwise be borne by existing customers. Electricity and thermal cost savings for CHP customers.

Potential Benefits to the City of Philadelphia: Lower energy costs for residential and business customers, and improvements to the environment.

Potential Risks: Monetary loss if PGW made an investment to serve a new customer or to add new load and the anticipated load did not materialize.

Opportunity 5: Support Energy Industry –Workforce Training Programs

Like many utilities, PGW has an aging workforce but requires trained, certified, and experienced workers to perform many jobs. Many of these functions are essential to maintain the safety and reliability of the distribution network and other gas facilities. The certification requirements for jobs such as pipeline operators, welders, and pipe joiners for plastic pipe are regulated by the U.S. DOT. Training of existing and new workers is part of a comprehensive solution to these issues. Perhaps more significantly, Philadelphia's ability to attract energy-related businesses in its efforts to become

an Energy Hub will be greatly enhanced if businesses are able to draw from a larger pool of trained workers.

These workforce requirements are also evolving with technology, customer service needs, and stakeholder involvement in utility activities. While PGW will need to continue to maintain a trained operational workforce to replace, maintain and operate its distribution facilities, it must also attract and train members of emerging “grey-collar” and “green-collar” workforces. “Grey-collar” refers to workers that have aspects of their jobs that are characteristic of blue-collar and other aspects that are characteristic of white-collar jobs. These jobs require technical skills but do not always require a four-year college degree. These workers can staff many support functions throughout a natural gas utility including customer-facing jobs. A “green-collar” worker, as the name implies, works in an industry that contributes to a cleaner, more sustainable economy. Green-collar workers run the gamut from highly skilled professionals to trades people who install energy efficient equipment. PGW will need these workers as part of its marketing efforts and to deliver energy efficiency measures.

These varying needs, including the traditional and new economy jobs, extend beyond PGW to other energy-focused businesses. Philadelphia has both workers that require additional skills to be employed in the energy industry and educational institutions at all levels from high school through college and beyond, that can participate in this opportunity. Several training programs have already emerged to meet the demand for trained workers to support Marcellus Shale development efforts. A large proportion of Marcellus workers are Pennsylvania residents.⁷⁴ Pennsylvania College of Technology has partnered with Penn State Extension to offer training under a program called ShaleTEC. Many of its programs are supported by grant funds, including funding from the Federal Government. One program, ShaleNET (which targets the unemployed, veterans, dislocated and low-income workers), received a \$4.9 million grant from the US Department of Labor’s Employment and Training Administration. A recent two-year grant to the Pennsylvania College of

⁷⁴ “Workforce Development in the Natural Gas Industry”, published by America’s Natural Gas Alliance (“ANGA”).

Technology from the National Science Foundation focuses on two-year majors that develop technical competencies such as welding and electronics.⁷⁵

PGW can serve in a sponsorship role, working with other local businesses, City government, and local educational institutions to design and develop training programs that target City residents. These programs can be developed in coordination with Philadelphia-based vocational/technical high schools, trade schools, community colleges and four-year colleges to provide greater access to Philadelphia residents. By contributing to the design and development of programs, PGW can lend its support to make internships and permanent job placement an integral part of new training programs. This is consistent with and would reinforce Philadelphia's goal of taking advantage of its location and infrastructure to expand energy businesses. It is conceivable that PGW could sponsor training for new or existing PGW employees and/or provide instructors to train participants. PGW and its customers will benefit from a trained workforce, as will other energy businesses. The City will benefit by helping citizens gain the training that they need to secure energy industry and related employment. These efforts will enhance PGW's relationships with other large businesses (and customers) and increase PGW's standing in the community.

Summary Conclusion: PGW should develop and support workforce training programs targeting City residents that address a broad spectrum of energy jobs to help make Philadelphia an attractive location for energy businesses.

Potential Benefits to PGW's Customers: Training programs will help to address PGW's aging workforce challenges.

Potential Benefits to the City of Philadelphia: Increased employment and a more attractive business environment for energy firms that are considering relocating to or expanding in Philadelphia.

Potential Risks: Limited risks can be mitigated by collaboration with other energy businesses and by selecting the right educational institution(s).

⁷⁵ "Built on a Legacy", Publication of the Pennsylvania School of Technology, Winter 2012.

D. Help Customers Use Gas More Efficiently

PGW's efforts to improve the energy efficiency of Philadelphia's buildings, residential equipment, and business operations should be continued and expanded. To the extent that more resources are directed to commercial and industrial customers (without taking resources away from the ELIRP), this will improve the competitiveness of Philadelphia and provide another tool that can be used to help existing PGW business customers expand and attract new businesses to the City.

Opportunity 6: Invest in Customer Premises to Lower Energy Bills

There is almost no scenario in which investing in energy efficiency does not make sense. It helps business and residential customers hedge their risk against higher prices, a weakening economy, and more stringent environmental regulations. For customers who may struggle to pay their energy bills, energy efficiency programs provide direct savings while also reducing the burden of uncollectible accounts that are recovered from all customers.⁷⁶ Service terminations and reconnections are expensive, and add to the personal stress of being without gas service for any length of time.

As with lowering gas supply and delivery costs, energy efficiency provides bill savings that flow directly to the customer's bottom line, and are thus available for economic or financial growth or for other expenditures, with benefits flowing to the Philadelphia economy. Many LDCs also offer "services-in-kind" including energy audits, engineering services, and program management/coordination that help customers save money, whether to serve their existing demands or expand their business.

Energy efficiency has other benefits as well. Once efficiency investments or retrofits are made to a residential or business structure, energy savings will also accrue to subsequent owners and tenants. There are also meaningful environmental and economic benefits. The design of a large commercial or industrial energy efficiency project requires technical competencies and the installation of energy efficiency measures provides local construction jobs to carpenters and trained craftspeople, and

⁷⁶ PGW forecasts approximately \$40 million of bad debt expense in the 2014-2015 fiscal year, declining to approximately \$35 million for FYs 2016 to 2020. PGW Fiscal Year 2015 Operating Budget & Five Year Forecast, August 19, 2014.

enhances other businesses that support these endeavors. For example, PGW collaborates with Philadelphia Works Inc. to train unemployed workers to perform weatherization services increasing the likelihood that they will be hired by local conservation installation firms. Local firms can supply energy efficiency building materials. Finally, energy efficiency can increase property values and make buildings more attractive to potential buyers.

As described in Section II, PGW is already investing in energy efficiency through its suite of programs branded as EnergySense. However, the overwhelming majority of the funds to date have been either directed to residential markets or to the multi-family subset of commercial and industrial customers. The largest program, ELIRP, is directed to CRP customers and effectively reduces energy costs that would otherwise be borne by other customers. It is imperative that PGW make efforts to reduce CRP customers' usage since their bills are based on their income level, rather than on the amount of natural gas they use. In part reflecting that low-income customers are more likely to live in substandard housing stock or to have older, inefficient furnaces, CRP customers' annual usage is more than 50% higher than other residential customers'. This contributes to the approximately \$70 million annual CRP discounts subsidized by PGW's other customers. Reflecting the direct interest of both PGW and its customers in improving energy efficiency among CRP participants, PGW has been focused on providing these programs through its ELIRP. PGW has identified several improvements to the delivery of the ELIRP, including increasing participation rates and directing spending more effectively, once access to the home is gained. Since the ELIRP has benefit-cost ratios that are not much above 1 (see Table 2), these enhancements are essential. PGW's multi-family programs are equally important and should be maintained.

However, PGW spent less than one-third of its overall DSM budget on its Commercial and Industrial Equipment Rebates Program even though it has the highest benefit-cost ratio by a considerable margin (over 3 as compared to the other programs in Table 2 which have ratios close to 1). To date, PGW has devoted a much smaller portion of its energy efficiency budget to programs that benefit business customers. While some of this lower level of spending is due to a lack of customer interest in the programs, this suggests that there is an untapped potential to improve the profitability of existing Philadelphia businesses, as well as the potential to add energy efficiency to the toolkit when PGW is working with the City to help existing businesses expand and encourage new businesses to relocate to Philadelphia. To the extent that these businesses offer the prospect of

high quality jobs for Philadelphia residents, these benefits should be recognized and reflected in the evaluation of the applicable PGW program. In these cases, pursuit of energy efficiency goals is directly connected to PGW's goal of adding more load, contributing to the overall HBU objective.

Moreover, business customers do not often require a grant to pursue efficiency opportunities that have a reasonably short payback period. They will invest in energy efficiency equipment if they properly understand the opportunity and the range of solutions that are available to them. PGW can expand its audit programs and provide other "services-in-kind" by increasing the size of its team of energy efficiency experts within its Marketing Department, which is already providing these services. Small business customers may require financing support that is available from existing government-sponsored programs.⁷⁷ It is also conceivable that PGW could establish a budget item and use these funds to provide on-bill financing to business customers.⁷⁸

Energy efficiency also provides longer-term benefits to PGW by reducing gas demand during peak periods. Programs that target the efficiency of heating systems certainly contribute to this outcome. Lower peak demands also contribute to PGW's ability to sell surplus LNG (Opportunity 2). To the extent that PGW is successful in connecting new load (the objective of the prior set of opportunities), energy efficiency gains can translate into serving that load growth without adding more costly incremental pipeline and storage capacity.

A more recent trend in energy efficiency is the development of energy usage databases that enable benchmarking of energy use against similar buildings within a city or state or on a broader regional scale. Benchmarking data is particularly valuable because it creates competition among building owners and because it provides the insights necessary to target both building infrastructure improvements and other energy efficiency programs more effectively. The benchmarking data also

⁷⁷ The Pennsylvania DCED offers grants and loans for energy efficiency and other "clean energy" projects through its Alternative and Clean Energy Program. The Pennsylvania DEP also offers a grant program (the Small Business Advantage Grant Program) for small businesses that can demonstrate 25% savings in energy consumption or pollution emissions.

⁷⁸ On-bill financing is increasingly being offered by utilities to help customers finance energy efficiency investments, with the utility effectively providing a loan that the customer pays back through monthly payments that appear on their utility bill.

provides the information necessary to analyze the effectiveness of the improvements made and to refine program designs.

On June 21, 2012, City Council passed an ordinance that provided for benchmarking of the energy and water usage of large commercial buildings (50,000 square feet or more).⁷⁹ Philadelphia is one of several cities across the United States that has recognized the value of benchmarking energy usage against buildings of similar size and characteristics. Early studies indicate that these efforts can result in total energy savings (electricity and natural gas) of as much as 25% or more. PGW has indicated that the Ordinance benchmarking data will be publicly available in 2015 and that this may generate interest in retrofit investments among PGW's commercial and industrial customers.⁸⁰ PGW has performed initial outreach to these customers and plans on further outreach based on the published benchmarking data. While this may not be a new program, the success of similar initiatives in other cities supports the importance of PGW's proactive follow-up and efforts to work with building owners to identify and implement efficiency improvements.

PECO Energy Company is supporting this effort by making benchmarking data available in a way that protects the privacy of customer information, one of the key concerns that has held back similar initiatives. New York City and Boston have committed to similar programs, with New York addressing multi-family buildings as well as commercial buildings. The early multi-family building data reveal variations in energy usage of three or four times the amount of the highest performing buildings.⁸¹ A recent report by the California Public Utility Commission indicated that, in response to such benchmarking, 62% of buildings took actions to control their energy usage and 82% either planned or implemented energy efficiency improvements.⁸²

⁷⁹ Bill No. 120428-A (signed by Mayor Nutter on August 27, 2012).

⁸⁰ Philadelphia Gas Works Five-Year EnergySense Demand Side Management Five-Year Implementation Plan Fiscal Year 2015, Page 64.

⁸¹ "Building Energy Benchmarking: An Overview of City and Utility Programs", presentation by Andrea Krukowski of the Institute for Market Transformation at the NECPUC Conference, June 17, 2014.

⁸² Ibid.

Summary Conclusion: PGW should maintain its focus on the ELIRP and continue to pursue improvements to program delivery, and any other steps that can be taken to increase energy efficient usage among CRP customers. However, an effort should be made to spend up to the budget for programs that target business customers, particularly if gas supply and energy delivery efficiencies can support an increase in the overall DSM budget. Energy efficiency in large buildings can be pursued when the benchmarking data mandated by City ordinance is available in 2015.

Potential Benefits to PGW's Customers: Lower costs for participating customers and potential longer-term benefits for all customers from lower gas supply costs, increased throughput, lower bad debt costs, and increased margins from off-system LNG sales. Energy efficiency savings by CRP customers translate directly into savings for other PGW customers.

Potential Benefits to the City of Philadelphia: Increased competitiveness of participating business customers potentially contributing to business expansion and attraction; increased affordability of service for participating residential customers.

Potential Risks: None, as long as PGW is able to identify and execute on cost-effective energy efficiency opportunities.

V. NON-VIABLE OPPORTUNITIES

PGW is a public utility providing essential services to customers that are depending on it to provide safe, reliable and affordable gas supply and distribution service, and related services such as energy efficiency. Each of the opportunities in Section IV is either a core service (i.e., a service provided as part of PGW's core business) or is closely integrated with core services. Indeed, PGW is already providing many of these services to varying degrees. They each rely on existing PGW competencies.

However, Concentric considers any opportunity that is either clearly outside of PGW's core business, relies primarily on competencies that it does not currently possess and cannot be easily acquired, or would impose unacceptable financial risk on PGW such that it might threaten its ability

to meet its public utility obligations to be a non-viable opportunity.⁸³ There are two such opportunities that warrant review in this report because they have been a topic of discussion in the context of transforming Philadelphia into an Energy Hub. These are opportunities that would have PGW either (1) develop an LNG export facility, or (2) become a transporter and/or seller of NGLs. As discussed below, each of these markets is a well-developed global market dominated by large corporations that possess the resources necessary to finance infrastructure and absorb the market risks.

1. NGL Markets

NGLs are extracted along with natural gas in the western portion of the Marcellus Shale and are separated from natural gas by processing plants that are located in production areas. They are then transported to markets where they are used for several purposes including as a feedstock for petrochemical plants and as an additive to vehicle fuel. This presents an opportunity for PGW to provide its core gas supply, distribution, and energy efficiency to firms that are locating or expanding their business in Philadelphia.

However, participating as a buyer, transporter or seller of NGLs is beyond PGW's core distribution and liquefaction businesses. In that sense, NGLs are not directly relevant to PGW. Further, participants in the NGLs market, like Sunoco Logistics Partners ("Sunoco Logistics"), are large well-capitalized firms that have the financial resources to participate in this very competitive and mature market. In short, the NGLs market is not close enough to PGW's core business and competencies to realistically support its entry into this market, even though it may be a source of growth for Philadelphia and a central element of an Energy Hub concept.

⁸³ This conclusion is not related to the form of ownership of PGW as it is likely that a public utility regulator would take a similar view if an investor-owned public utility were to propose engaging in an activity with any of these characteristics and conducting the business within the regulated utility. To the extent such a business were to be conducted by an unregulated business, regulators would adopt policies that were designed to ensure that there was no impact on the ability of the regulated utility to perform its functions, including its ability to finance utility investments.

Sunoco Logistics' efforts to develop this market are instructive regarding the risks of the portion of the business that is perhaps closest to PGW's core competencies: the proposed development of a pipeline to transport NGLs from the Marcellus to the Philadelphia area. Certain natural gas products can be trucked from the Marcellus to markets including NGLs, CNG and LNG. However, ethane and propane can be most efficiently transported through pipeline facilities. In 2010, Sunoco Logistics proposed developing the 300-mile East pipeline to transport these products from the Marcellus to the Marcus Hook Refinery complex located less than 15 miles southwest of Philadelphia on the Delaware River, where the NGLs would be stored and subsequently redelivered to domestic (propane) and export (ethane) markets. The project involves repurposing of an existing oil-products pipeline and the addition of new pipeline facilities. Providing a commercial outlet for these NGL products enhances the value of natural gas production in the Marcellus Shale, a result that the PA PUC has determined will provide public benefits to the Commonwealth of Pennsylvania.⁸⁴ However, the Mariner East project will require approval of the construction of 18 pump stations and 17 valve control stations along its route and this has become a battleground for the project's opponents.⁸⁵ While this matter is far from resolved, this example provides a sense of the risk involved in this one segment of the NGL market.

2. LNG Export Market

Liquefied natural gas—or LNG—is produced by cooling pipeline natural gas to minus 260°F, and is stored in secure tanks. LNG storage tanks are filled in one of two ways: natural gas can be delivered by pipeline to the LNG site and then liquefied and injected into storage tanks, or it can be delivered in its liquefied state by truck from another tank or from a large regional storage facility that may also serve as an LNG import or export facility.⁸⁶

⁸⁴ Opinion and Order in Docket No. A-2013-2371789, issued August 29, 2013 and amended November 14, 2013.

⁸⁵ Sunoco Logistics has sought “public utility corporation” status from the PA PUC that would effectively shift zoning authority from each of the affected communities to the PA PUC. On July 30, 2014, a preliminary decision issued by two administrative law judges assigned to the case recommended that the PA PUC reject Sunoco Logistics' request.

⁸⁶ LNG facilities that rely on truck deliveries of LNG and are owned by LDCs are often referred to as “satellite” LNG facilities. PGW's Passyunk facility is an example of a satellite LNG facility.

It was not long ago that the United States was issuing licenses to LNG import facilities in response to declining production from traditional supply sources. With the development of Marcellus and other shale fields, the natural gas industry has changed dramatically and there have been numerous proposals to reconfigure existing import terminals or develop new terminals that would export LNG to Asia and other markets, allowing producers to take advantage of much higher global prices for natural gas. The global demand for LNG is forecast to grow from 32 Bcf/d,⁸⁷ in 2012 to approximately 66 Bcf/d by 2030.⁸⁸

It has been suggested that PGW could develop an LNG export facility that would take advantage of Philadelphia's proximity to the Marcellus Shale and the availability of port facilities. An engineering consultancy, CH-IV International ("CH-IV") was retained by PGW to assess the feasibility of its expanding its LNG facilities and exporting LNG. CH-IV reported that such a project would likely require an investment in excess of \$2 billion.⁸⁹ CH-IV concluded that LNG exports from the Passyunk facility are not feasible due to a number of issues including the small site acreage, the requirement to construct a new larger storage tank and marine facilities, and difficulties with delivering incremental high pressure feed gas to the Passyunk site. CH-IV also concluded that exports from the Richmond facility might be feasible under certain conditions, but identified numerous potentially "fatal flaws" that could preclude transitioning this facility to support LNG exports, including:

- The ability of LNG vessels to navigate the Delaware River to the Richmond site;
- Alterations to in-tank pumps could affect the grandfathered status of the storage tanks;
- Expanded infrastructure may require larger exclusion zones; and
- Uncertainty regarding ability to acquire or lease property necessary for a larger export project (e.g., the Tioga Marine terminal).

⁸⁷ Canadian Association of Petroleum Producers, *An Overview of the World LNG Market and Canada's Potential for Exports of LNG*, January 2014.

⁸⁸ IHS CERA, *Global Liquefied Natural Gas: New Supplies Ahead*, Presented to the IHS Forum, May 22, 2013 in Amsterdam.

⁸⁹ CH-IV International, *Export Facility Feasibility*, Prepared for Philadelphia Gas Works, January 2013.

Perhaps more importantly, even if the potential “fatal flaws” identified by CH-IV can be overcome, an LNG export project located at the Richmond site would still face myriad obstacles and would subject PGW to considerable development and market risks. As discussed at length in Technical Appendix B, an LNG export facility in Port Richmond would face robust competition from an already crowded field of development projects. This competition includes numerous proposals for projects located in the U.S., as well as development projects in Australia and Western Canada that can reach Asian markets in approximately half the time of a project that would be located in Philadelphia. It is possible that only a handful of U.S. export projects will be developed and these are likely to be the projects with superior economics, solid financial strength, strategic geographic locations, and which have been quick to mobilize support.

The process of developing an LNG export facility takes several years, and the projects that can bring their LNG to market the fastest will benefit from a first mover advantage, including greater access to customers in premium markets and creditworthy investors. Most of the proposed projects have already commenced the development process and are working toward obtaining necessary permits and financing. In fact, a number of the proposed U.S. projects will already be making final investment decisions by the end of 2014, and are scheduled to come on-line in the 2017-2019 timeframe. These projects require multiple approvals at the federal level, and may also require state or local action.⁹⁰ Significantly, seven of the nine domestic projects that have received DOE approval as of September 10, 2014 involve the conversion of existing LNG import facilities to export facilities.⁹¹ This gives them a cost advantage that derives from the ability to repurpose some of the existing infrastructure. For example, they can utilize existing and partially depreciated storage tanks,

⁹⁰ At the federal level, an onshore LNG export project based in the U.S. would require the following approvals: (1) approval from the Department of Energy for exports to non-Free Trade Agreement countries (DOE approval is automatic for exports to countries with which the U.S. has a Free Trade Agreement); (2) approval from FERC for the siting, construction and operation of the LNG export facility; and (3) a Letter of Recommendation from the U.S. Coast Guard on the suitability of domestic waterways to safely accommodate LNG tanker traffic to and from the export facility.

⁹¹ Of the nine projects that have been approved, only three—Cheniere Energy Inc.’s Sabine Pass project, Sempra Energy’s Cameron LNG project, and the Carib Energy LLC project—have received final approval; the remaining six projects have been granted conditional approvals and will have to complete an environmental review process before receiving final approval. On August 15, 2014, the DOE implemented a revised policy, under which it will skip the conditional approval step and will now only review projects that have completed the environmental review process at FERC.

ship-loading facilities, and other supporting infrastructure. Many of these projects also have access to unutilized interstate pipeline capacity, alleviating the need for costly pipeline expansions and lowering their operating costs.

There are numerous challenges to locating an LNG export facility at the Richmond site, which apply equally to a municipally-owned or a privately-owned PGW. Unlike competing sites, a Richmond export facility would be located in an urban and densely populated area and would require that LNG vessels transit past the Philadelphia International Airport, multiple sports stadiums, and numerous refineries. The consequence of an accident or terrorist attack at this location, however remote the potential, would be catastrophic. PGW or another developer would have to prove to the U.S. Coast Guard that the Richmond site is capable of being protected from a terrorist attack, including the use of the Delaware River by LNG vessels.⁹² Additionally, several bridges span the section of the Delaware River that would be used to transport LNG, and these bridges would have to be closed to traffic each time an LNG vessel passed through the harbor.⁹³ There has also been public opposition to the siting of an LNG terminal in the City of Philadelphia. In 2006, 12 of the Philadelphia City Council's 17 members voted to pass a non-binding resolution in response to a proposed LNG import terminal in Philadelphia expressing:

Unqualified opposition to any project that would create an LNG shipping terminal within the City of Philadelphia or that would cause loaded LNG tankers to regularly traverse the Delaware River alongside the City of Philadelphia.⁹⁴

There is substantial business risk associated with the development of an LNG export facility at the Richmond site. A U.S. LNG export project can expect to spend tens of millions of dollars in development costs before a final investment decision is made. The FERC National Environmental Policy Act ("NEPA") permitting process alone can cost \$10-\$15 million.⁹⁵ Given the level and

⁹² "U.S. Coast Guard Spells Out New Guidelines for Tankers", Alexander's Gas and Oil Connections, <http://www.gasandoil.com/news/2005/07/ntn52753>.

⁹³ The Distrigas LNG import facility located in Everett, Massachusetts just outside the City of Boston is located in a similar urban setting. Due to the extensive security measures taken and logistical issues such as bridge closures, it costs the City of Boston approximately \$80,000 for each LNG tanker trip through the harbor. See <http://www.actionpa.org/lng/2006-01-18.html>

⁹⁴ Resolution No. 060123 of the Council of the City of Philadelphia, February 16, 2006.

⁹⁵ CH-IV International, Export Facility Feasibility, Prepared for Philadelphia Gas Works, January 2013.

caliber of competition in the LNG export market, and the resultant unlikelihood that a Port Richmond LNG export project would come to fruition, this would likely leave millions of dollars in development costs to be absorbed either by the City, a partner, or a private owner of PGW. A project of this complexity and magnitude, with the associated construction challenges and potential for cost overruns, should be managed by an entity with prior experience with similar multi-billion dollar construction projects. To put this in a different context, the \$1.9 billion cost estimate in the CH-IV report for an export facility at the Port Richmond site is more than one and a half times the value of PGW's net utility plant or more than 25 times its capital expenditures in 2013.⁹⁶

Building on the conclusions from the CH-IV feasibility study, it is Concentric's conclusion that the Richmond site is not a viable LNG export site and would involve extraordinary development risk for *any* owner/developer. Moreover, it appears likely that the proposal will be vigorously opposed due to its location and the development process will take years as a result. This conclusion would appear to apply to any PGW owner.

VI. CONCLUSION

Concentric has identified six opportunities for PGW to contribute to the City of Philadelphia's economic growth and general welfare. Significantly, all of these opportunities derive from its core gas business: the sale and delivery of natural gas and related products and programs that help customers use less energy. It should be noted that PGW is already pursuing several of these opportunities. However, enhancement or further development of these opportunities may allow PGW to increase its revenue and accordingly its financial health.

The opportunities are clearly interconnected, particularly if there is an opportunity for PGW to achieve savings from either the sourcing of natural gas (Opportunity 1) or non-fuel operating expenses. For example, a relatively modest 2% decrease in gas supply costs would generate approximately \$10 million annually that could be used to reduce customer bills and also support an expansion in energy efficiency programs, expansion of the marketing and sales department, and

⁹⁶ Philadelphia Gas Works, Audited Financial Report for Fiscal Years 2012 and 2013.

development of training programs for Philadelphia citizens. It should be recognized however, that none of the opportunities will be easy to accomplish. They will all require commitment and execution.

The potential impact of each opportunity on PGW's customers, PGW the City of Philadelphia, and the environment are summarized at the conclusion of each opportunity. They are also summarized in a qualitative manner in the following table, using the following three criteria:

- (1) Impact on PGW's Rates: whether the opportunity is likely to have a significant favorable impact on the rates paid by all PGW customers – or whether it will contribute to higher rates in the intermediate to longer term (as indicated by a negative symbol);
- (2) Impact on PGW's Financial Strength: the degree to which the opportunity is likely to contribute to a stronger PGW in the intermediate to longer term (as indicated by a positive symbol); and
- (3) Impact on the Philadelphia Economy: the degree to which the City and its citizens will benefit from the opportunity (again, as indicated by a positive signal).

All of the criteria are measured with a long-term perspective in mind.

Table 9: Impacts of Potential Opportunities

	Viable Opportunities	PGW Rate Levels	PGW Financial Strength	The City	Potential Annual Value	Comments
1	Diversify Gas Supply Portfolio	+	+	+	\$17 M	Savings passed on; some spending increases possible
2	Optimize LNG Assets	+	+	+	\$8 to \$10 M	Viable business, but not without risk
3	Support Development of a Regional NGV Market	Neutral	Neutral	+	Minimal Until Market Develops	Modest business benefits at this time
4	Pursue CHP, Help Businesses Grow, Convert Customers to Gas	+	+	+	\$1 to \$3 M	Participating customers benefit, supporting the economy
5	Support Energy Industry Workforce Training Programs	–	Neutral	+	Value Accrues to City	Increases job opportunities, Business Attraction
6	Invest in Customer Premises to Lower Energy Bills	+	+	+	\$1 to \$3 M from CRP	Most valuable if CRP Demands are Reduced
	Non-Viable Opportunities					
	NGL Market Participant	Neutral	–	Neutral		Too big a play for PGW
	LNG Exports	–	–	–		Too big, too risky, too late

Collectively, the six opportunities identified by Concentric will make significant strides toward achieving the highest and best use for PGW. Opportunities 1, 2, and 4 have the potential to generate \$27 million to \$33 million of cost savings or incremental revenues per year, contributing to lower customer bills and a stronger PGW. To the extent that some portion of these savings are either spent or invested in Philadelphia, this would increase the benefits. Although more difficult to quantify, Opportunities 3, 5, and 6 can also provide substantial benefit to PGW and its customers, and more broadly to the City of Philadelphia. There is at least one viable opportunity that merits close study because, while promising and the second largest potential value, it is likely to increase PGW’s risk profile unless deliberate actions are taken to mitigate the risk (Opportunity 2).

There are two other opportunities that have been a topic of discussion in the context of transforming Philadelphia into an Energy Hub. These would either have PGW (1) develop an LNG export facility, or (2) become a transporter and/or seller of NGLs. Each of these markets is a well-developed global market dominated by large corporations that possess the financial resources necessary to finance infrastructure and absorb the market risks. Concentric views the LNG export market as being non-viable under any ownership structure. PGW is too late to the competition, and in any event, does not have either an advantaged location or existing LNG import infrastructure. Concentric views the Marcellus/NGL opportunity as a potential source of new customer load but taking on an active role as a buyer, transporter, or seller of NGLs is beyond PGW's core business.

TECHNICAL APPENDICES

A: NATURAL GAS PRODUCTION AND PRICES

This Technical Appendix will describe natural gas production in the United States, and how it is impacting pipeline flows and pricing in producing and consuming regions, including the Philadelphia market area.

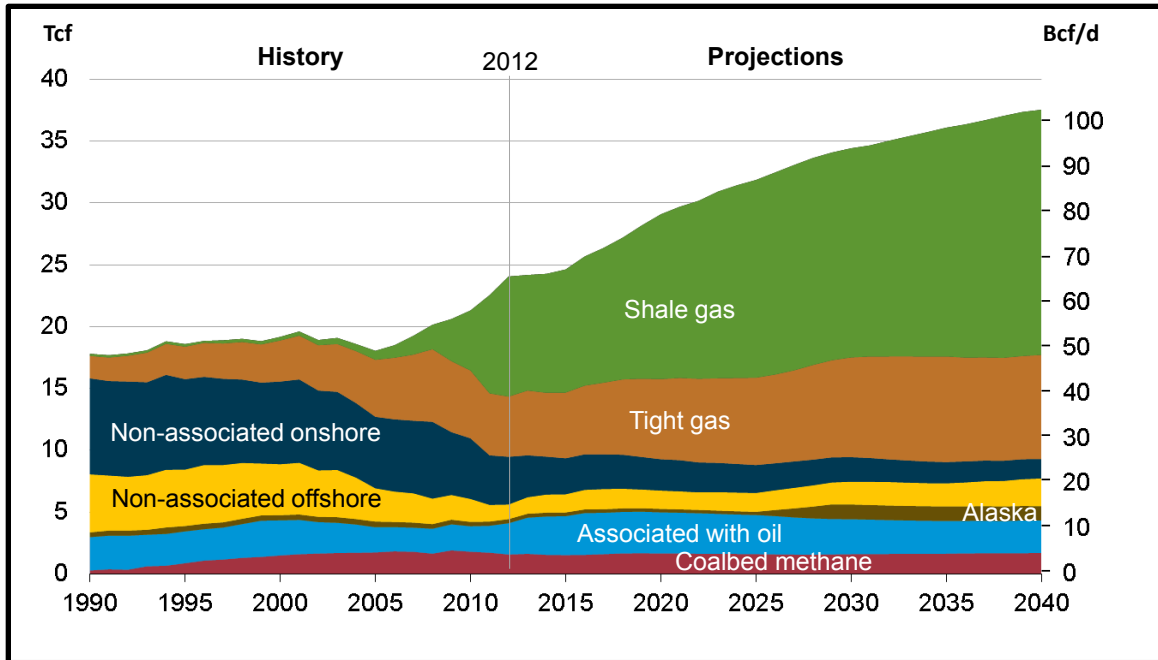
A. Natural Gas Production

Natural gas has been conventionally produced (*i.e.*, extracted) from underground geologic formations or “supply basins” with most production concentrated in two regions: the Gulf Coast/Southwest (*i.e.*, Texas, Louisiana, Oklahoma, New Mexico, and offshore Gulf of Mexico) and more recently, the Rockies (*i.e.*, Wyoming, Colorado, Utah). The United States supplements its own natural gas production with imports of natural gas from producing areas in Western Canada.⁹⁷ An extensive network of transmission pipelines has developed since the 1950s to connect these producing areas to markets throughout the country. These historical flows are changing dramatically with nonconventional production from approximately twenty-five shale formations that are dispersed throughout the United States. In contrast to traditional natural gas production, shale gas is extracted from very small gaps within horizontal layers of sedimentary shale formations made economically viable by advances in hydraulic fracturing and horizontal drilling technologies. As shown in Figure A-1, production from shale formations is projected to grow dramatically over the next twenty-five years. United States production has increased 35% since 2005, from 18 trillion cubic feet (“Tcf”) per year to approximately 24 Tcf per year currently.⁹⁸ On a daily basis, this equates to an increase in natural gas production levels from approximately 49 Bcf/d to approximately 68 Bcf/d. Concerns regarding declining reserves in traditional producing areas had led to several applications in the first decade of the century to develop multi-billion dollar facilities to import LNG. The shale developments have now led to proposals to convert existing LNG import terminals to export terminals as well as proposals for the development of new LNG export terminals.

⁹⁷ The United States has also met a relatively small percentage of its gas demand by importing LNG.

⁹⁸ In 2013, dry gas production totaled 24.3 Tcf (Energy Information Administration).

Figure A-1: United States Natural Gas Production



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2014 Early Release*.

Two of the largest shale formations, the Marcellus and Utica Shale formations, cover large portions of Pennsylvania, New York, West Virginia and Ohio as well as portions of several neighboring states⁹⁹. They are currently producing approximately 16 billion cubic feet (“Bcf”) per day (“Bcf/d”) of natural gas, representing over 20% of total domestic gas production, and are projected to reach over 22 Bcf/d by 2019.¹⁰⁰

Natural gas that is extracted from the southern and western portions of the Marcellus-Utica Shale formation often contains significant NGLs (*i.e.*, propane, ethane, butane, isobutane and natural gasoline). NGLs have many uses, including as feedstock for petrochemical plants and additives to vehicle fuel. NGLs, whose pricing is more closely related to crude oil prices than natural gas prices,

⁹⁹ The Utica Shale lies a few thousand feet under the Marcellus Shale and extends over a much broader area, extending into Quebec and Ontario to the north and Ohio and Tennessee to the west and southwest. Given this geography, they are often referred to as the Marcellus-Utica Shale formation.

¹⁰⁰ Gas Daily, “NYMEX below \$4.50; Northeast cash spikes,” June 24, 2014; RBN Energy, “They Long to be Close to You – Moving Marcellus/Utica Natural Gas South and West”, May 15, 2014.

provide incremental revenue sources to producers once they are separated from natural gas in processing plants that are designed for that purpose. NGLs are becoming a larger driver of production economics in the liquid-rich portions of the Marcellus-Utica basin. As a result, infrastructure is being constructed in the Marcellus to separate the NGLs from the natural gas and then transport those NGLs to markets, including to the Marcus Hook facility in eastern Pennsylvania that will process, store and distribute propane and ethane. It should be stressed that NGLs are distinct from natural gas and have a separate processing and transportation infrastructure.¹⁰¹

B. Natural Gas Pricing Fundamentals

The price of natural gas is established on a daily basis at multiple trading/pricing points across the United States. There are two primary categories of pricing points: production area pricing points and market area pricing points. Production area pricing points represent the price of the natural gas commodity in a region in which there is significant natural gas production, *i.e.*, the wellhead, or at a point of aggregation of production from multiple producing areas. The Henry Hub pricing point is perhaps the most important production area pricing point in the United States and is the pricing point used for natural gas futures contracts traded on the New York Mercantile Exchange (“NYMEX”). Henry Hub is a point of interconnection among 13 interstate and intrastate pipelines located in Louisiana. Market area pricing points represent the price of the natural gas commodity in the area in which it will be consumed, and reflect not only the cost of the commodity itself, but also the cost of transportation and other value drivers based on circumstances in that particular market.

The “basis differential” concept is the difference between the price of natural gas at two pricing points at a given point in time and is important in the natural gas industry because it is an indicator of pipeline constraints between two pricing points. Prices at a particular trading point are commonly compared to the price at Henry Hub and expressed as a basis differential. Basis differentials reflect the value (but not necessarily the cost) of transportation between two pricing

¹⁰¹ As discussed in Section VI, the proposed iEast pipeline is encountering siting opposition from several communities along the route.

points at a particular time. To the extent that basis differentials are substantially higher than the cost of transportation, and that differential is sustained over a reasonably longer period, this indicates that there are pipeline constraints between those points, and provides a signal to pipeline project developers that there may be sufficient demand to contractually support the construction of new pipeline capacity to alleviate those constraints.

The level of production from shale gas has been so significant that it has lowered natural gas prices throughout much of the United States, and has also dampened volatility in natural gas pricing, benefitting customers throughout much of the United States. The dispersion of shale gas throughout the country has also had a dramatic impact on natural gas flows and on basis differentials. Thus, certain regional pricing points that have historically traded at a premium to Henry Hub (i.e., a positive basis differential) are now trading below Henry Hub prices. These flow changes have in turn caused natural gas production located in other regions to find markets elsewhere, creating a cascade effect of changing flow patterns on pipelines across the United States, and reducing the basis differentials between many pricing points compared to where they have been historically.

For example, Northeast market area prices have traditionally traded at a premium to Henry Hub reflecting the fact that flows of natural gas on the interstate pipeline system have consistently been in one direction: from the Gulf Coast region to the Northeast. While natural gas continues to flow in this direction, development of the Marcellus-Utica Shale basin has created significant changes in pipeline flows, and in turn, natural gas pricing, across the United States. Because natural gas supply in the Marcellus region currently exceeds demand within that region, natural gas flows are now beginning to be bi-directional, that is, gas is also now flowing from the Marcellus to markets in the Southeast and Midwest, as well as north into New York, New England and eastern Canada, in response to demand/supply conditions.

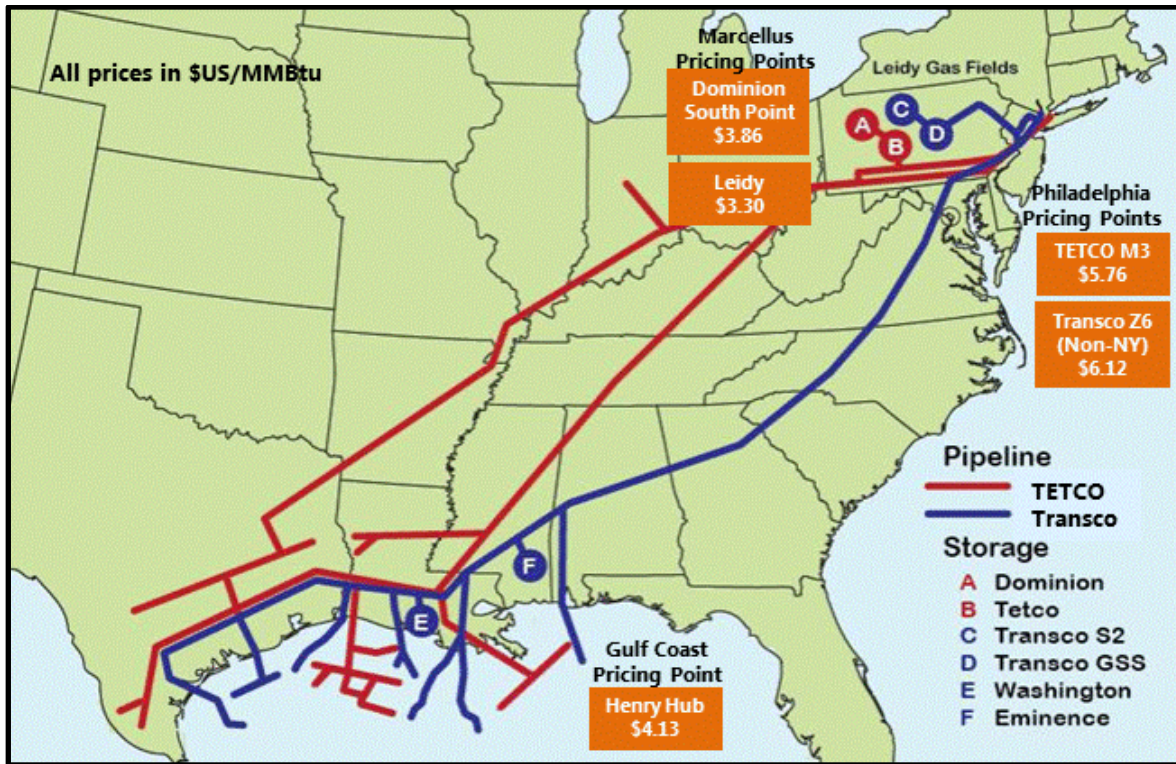
C. Natural Gas Prices in Philadelphia

Historically, since there was relatively limited natural gas production in the Northeast, the major market centers in the eastern United States, including Philadelphia, have been served from natural gas produced from the supply basins in the Gulf/Southwest producing areas and transported to the

Northeast on long-haul pipelines. Philadelphia is directly served by two such interstate natural gas pipelines: Texas Eastern Transmission Co. (“TETCO”) and Transcontinental Pipeline Co. (“Transco”). As shown in the map in Figure A-2 below, both of these pipelines originate in south Texas and terminate in the metropolitan New York City region.

The pricing points that are most relevant to PGW and its customers are also presented in Figure A-2 and are the prices in the Gulf Coast (Henry Hub), within the Marcellus-Utica Shale area (Dominion Point South and Leidy), and for deliveries to Philadelphia (TETCO Zone M3” and “Transco Zone 6, Non-New York”).

Figure A-2: Map of Pipeline Systems and Storage Facilities Serving PGW and Average Annual Spot Natural Gas Prices (April 1, 2013 – March 31, 2014)



The Henry Hub pricing point is particularly relevant for PGW’s sales customers because PGW sources all of its supply from the Gulf Coast under contracts that are tied to Henry Hub prices. The two Philadelphia pricing points are particularly relevant to PGW’s transportation customers that acquire supplies from third-party markets with pricing tied to these points. The Marcellus prices are relevant because they offer both sales and transportation customers the potential of a lower cost

alternative, if pipeline capacity were to be developed to deliver natural gas from the Marcellus to Philadelphia.

The pricing relationship between Henry Hub and the Marcellus pricing point has reversed over the past three years. Marcellus annual average prices have switched from trading at a premium to Henry Hub, to trading at a discount to Henry Hub. As can be seen in Figure A-2, Marcellus basin prices (as represented by the Dominion South Point and Leidy prices) averaged approximately \$3.86/MMBtu and \$3.30/MMBtu, respectively over the twelve-month period ending March 31, 2014, while the Henry Hub price averaged \$4.13/MMBtu. Within the past year, prices within the Marcellus have been below (and sometimes significantly below) other production area pricing points, reflecting that there are pipeline constraints getting gas out of the Marcellus basin. Since the growing natural gas supply within the Marcellus is competing for limited pipeline capacity to reach consuming markets, this has the effect of suppressing the Marcellus prices.¹⁰²

These historical pricing relationships are presented in Table A-1. The impact of existing pipeline constraints on prices of natural gas that was bought and sold at Philadelphia pricing points over this past winter is also apparent in this table. While Philadelphia prices traded close to the Henry Hub prices and at a modest premium to Marcellus prices during the summer months, they traded at average prices that were approximately twice the production area prices during this past winter. There are a number of reasons for the spikes in spot natural gas prices that were experienced this past winter in and around Philadelphia, as well as in other major demand centers along the East Coast. They include: (i) colder than normal weather that increased peak demands; (ii) reductions in the availability of natural gas supply and pipeline transportation attributable to these weather conditions; (iii) lower than expected storage inventories; and (iv) increased reliance on natural gas for

¹⁰² There have been several pipeline projects that have been completed, are currently under construction, or are proposed to increase the pipeline takeaway capacity from the Marcellus to market areas to serve customers that have signed long-term contracts for that pipeline capacity. Nearly all of the existing pipelines serving this region have expanded, and additional new “greenfield” pipelines have also been constructed and proposed to meet the growing production. Despite these new pipeline projects, production increases in the Marcellus Shale has exceeded the pace of new pipeline construction and constraints continue to restrain gas from getting to markets.

power generation in competitive wholesale electric markets.¹⁰³ As noted above, these price spikes have been particularly relevant for PGW’s transportation customers that acquire supply at the two Philadelphia pricing points.

Table A-1: Average Historical and Futures Natural Gas Prices for Pricing Indices Relevant to PGW¹⁰⁴

	Production Area			Market Area	
	Henry Hub	Dominion South Pt.	Leidy	TETCO M-3	Transco Z6 Non-NY
Historical Actual Prices (April 2013 - March 2014)					
Summer	\$ 3.77	\$ 3.58	\$ 3.06	\$ 3.80	\$ 3.85
Winter	\$ 4.63	\$ 4.25	\$ 3.63	\$ 8.53	\$ 9.32
Annual	\$ 4.13	\$ 3.86	\$ 3.30	\$ 5.76	\$ 6.12
Futures Prices (August 2014 - July 2019)					
Summer	\$ 4.33	\$ 3.27	\$ 2.67	\$ 3.46	\$ 3.63
Winter	\$ 4.57	\$ 3.77	\$ 3.08	\$ 5.85	\$ 6.31
Annual	\$ 4.43	\$ 3.48	\$ 2.84	\$ 4.46	\$ 4.75

Although not shown in this table, Philadelphia market area natural gas prices have also been more volatile. For example, over the past year, Henry Hub spot prices traded within a range of \$3.28/MMBtu to \$8.15/MMBtu (with only four days trading over \$7.00/MMBtu) with spot prices at Dominion South and Leidy also never trading above \$9.00/MMBtu (although Leidy did trade well below \$2.00/MMBtu at times). In contrast, the market area prices in and around the Philadelphia area were significantly more volatile in the winter of 2013/2014, with prices reaching a high of over \$120/MMBtu for the Transco Zone 6 Non-New York index price and over \$90/MMBtu for the TETCO M3 index price. These points experienced 15 days and 13 days, respectively, this past

¹⁰³ Natural gas-fired electric generators do not have an electricity market mechanism to recover fixed demand charges associated with reserving capacity on interstate pipelines and thus rely on interruptible pipeline transportation, a circumstance that can cause increased competition for natural gas, and thus cause an increase in the price of natural gas and electricity.

¹⁰⁴ SNL Financial; forward prices as of July 1, 2014.

winter where prices exceeded \$20/MMBtu. These price spikes, as noted above, have primarily affected PGW's transportation customers and other customers that purchase natural gas at these two points. PGW acquires all of its natural gas to serve its sales customers from the Gulf Coast.

It is important to emphasize, as discussed in Section III, that PGW's customers have benefited significantly from the natural gas production in the Marcellus-Utica Shale even though PGW currently sources its gas supplies from the Gulf Coast. Thus, an important question to be addressed is whether there are further benefits that can be realized by PGW for its sales customers by sourcing gas directly from the Marcellus-Utica basin either in lieu of or in addition to PGW's existing natural gas supply and pipeline transportation contracts. The futures prices in Table A-1 indicate that the market expects these pricing trends and relationships to continue, with modest premiums during the summer months and much higher prices during the winter months.

This is significant for PGW in at least two respects. First, since PGW acquires its supplies from the Gulf Coast, the differential between Henry Hub and Marcellus future prices suggests that it may be possible to achieve gas supply savings by re-contracting a portion of the portfolio from Gulf-sourced supplies to Marcellus-sourced supplies. As discussed in Section IV.A, this depends on new natural gas pipeline capacity being developed to deliver these supplies from the Marcellus to Philadelphia and on the cost of this new pipeline transportation capacity relative to PGW's existing transportation contracts.

Second, if natural gas continues to trade at a substantial premium during the winter months over the next few years, this will support PGW's ongoing efforts to market LNG in Philadelphia and other northeast markets that experience higher (and more volatile) winter prices, even if those price differentials are not as high as experienced this past winter. As long as prices from PGW's traditional supply sources do not increase to near the same degree during the winter months (as reflected in current future prices), PGW can liquefy natural gas acquired from the Gulf Coast that is not needed for sales customers and sell it to LNG customers.

B: DOMESTIC AND GLOBAL LNG MARKETS

A. Three LNG Markets

Liquefied natural gas—or LNG—is produced by cooling pipeline natural gas to minus 260°F, and is stored in secure tanks. LNG storage tanks are filled in one of two ways: natural gas can be delivered by pipeline to the LNG site and then liquefied and injected into storage tanks, or it can be delivered in its liquefied state by truck from another tank or from a large regional storage facility that may also serve as an LNG import or export facility.¹⁰⁵ Some evaporation or “boil-off” occurs during the liquefaction and storage processes but this vapor is captured and also injected into the distribution network.¹⁰⁶

There are three primary LNG uses that are relevant for PGW’s purposes. First, PGW liquefies, stores and vaporizes LNG in order to economically meet the demands of its sales customers on the coldest days of the year. Many LDCs with significant heating loads utilize LNG as part of their overall supply portfolio.

Second, there is a vibrant and competitive global market for LNG in which natural gas producing countries liquefy natural gas at export terminals and transport the LNG on specially designed ocean-worthy tankers to international markets throughout the world. To the extent that PGW considers either the importation or exportation of LNG, it is competing as a buyer or seller in this global market.

Third, there are several emerging markets for LNG in the United States, particularly as a transportation fuel. These markets are developing in response to the separation between the prices of gasoline and other oil-derivative commodities and natural gas. To the extent that PGW has LNG inventory during certain periods of the year that is surplus to the volumes

¹⁰⁵ LNG facilities that rely on truck deliveries of LNG and are owned by LDCs are often referred to as “satellite” LNG facilities. PGW’s Passyunk facility is an example of a satellite LNG facility.

¹⁰⁶ Boil-off results from the process required to maintain minimum temperature in the tank.

required to meet its obligations to serve sales customers, it can compete as a supplier to these markets.

B. LDC LNG Facilities

Many LDCs own and operate LNG facilities. The facilities vary by LDC requirements, but often include liquefaction, storage, and vaporization capabilities. Many facilities also include trucking docks to facilitate storage tank refills and transfers of LNG to other LDC facilities and, as discussed below, to serve emerging end-use markets.

When needed to serve peak demand, LDCs “vaporize” (i.e., re-heat) the LNG into its gaseous state and inject it directly into their distribution network where it is commingled with pipeline gas and delivered to customers. LNG may also be pumped into trucks and transported to other LNG facilities or to customers that use LNG to power engines and gas turbines.

Every LNG facility that is owned and operated by an LDC has a unique design that reflects the requirements of the LDC and the role LNG serves in the overall supply portfolio. Generally, the storage and vaporization facilities are designed to enable the LDC to vaporize large quantities of LNG over a relatively short number of days to meet increased demand during an extended cold snap. However, the liquefaction facilities are designed to accommodate LNG production over a much longer period of time due to economic and operational considerations. On a typical LDC distribution system, there is little demand for LNG during the summer months (in the gas industry defined as April through October) during which natural gas prices also tend to be lower due to the lack of heating demand. Because an LDC can rely on relatively lower gas prices throughout these months, it can install a smaller, less expensive liquefaction unit and gradually refill its LNG storage tanks over the course of the summer for the coming winter. As a consequence, LDCs typically establish prudent operating guidelines that are intended to preserve their ability to meet late winter season cold snaps.

There are presently three widely used liquefaction technologies: a nitrogen expander cycle, a methane (or open) expansion cycle, and a single mixed refrigerant (“SMR”) cycle. LDCs will

select the technology that best fits their particular circumstances based on factors such as site-specific requirements, operational efficiency, operating and maintenance costs, and the availability of pipeline pressure.

The Richmond plant employs the methane expansion process that relies on large flows of natural gas and a significant drop in pressure as it transfers from Transco's high-pressure pipeline system to PGW's low-pressure local distribution network. This technology is an option where an interconnection to the interstate pipeline is located adjacent to or on the LNG facility site. The LNG is produced by an "expander liquefier" that is located at the point of pressure transfer. While PGW's expander liquefier and the overall liquefaction process is extremely fuel-efficient, one drawback compared to other liquefaction technologies is that it may not be possible to economically liquefy natural gas during the off-peak summer months when flows on PGW's distribution system and pressures are relatively low. Whereas most LDC liquefaction units are run from April through October in order to take advantage of lower natural gas costs during off-peak periods, PGW's expander liquefier is typically operational from September through November and then again from March through mid-June when the volume of gas flowing on PGW's distribution system results in sufficient pressure. In the winter, PGW requires its full pipeline capacity and associated gas supply to meet heating load and the liquefier is typically inactive. This limits the amount of LNG that PGW can produce each year. Table B-1 presents the daily and monthly gross liquefaction rates used in PGW's most recent annual supply planning process.¹⁰⁷

¹⁰⁷ PGW's fiscal year runs from September 1st through August 31st of the following calendar year.

Table B-1: PGW Daily and Monthly Liquefaction Rates¹⁰⁸

Month	Mcf/d	Days	Mcf
March 1 - March 31	12,500	31	387,500
April 1 - April 30	12,145	30	364,350
May 1 - May 31	8,722	31	270,382
June 1 - June 30	5,166	30	154,980
July 1 - July 31			0
August 1 - August 31			0
September 15 - September 30	5,200	16	83,200
October 1 - October 31	9,797	31	303,707
November 1 - November 31	13,347	30	400,410
TOTAL			1,964,529

In contrast, the nitrogen expansion and SMR technologies require larger volumes of feed gas, but do not rely on pressure flows to liquefy natural gas, enabling an LDC to liquefy natural gas during the summer months when natural gas prices tend to be lower.

In the Northeast, many LDCs have liquefaction facilities connected to their distribution systems in order to economically meet the requirements of their sales customers on the coldest days of the winter. Alternatively, LNG can be offloaded into tank trucks and shipped to another tank, or sold as LNG to large customers or to wholesale LNG operations that serve large customers. PGW currently relies on its LNG facilities to perform both of these functions.

C. The Global Market for LNG

It was less than a decade ago that the United States was issuing licenses to LNG import facilities in response to declining production from traditional supply sources. With the development of Marcellus and other shale fields, the natural gas industry has changed dramatically. Domestic producers of natural gas now support the development of LNG

¹⁰⁸ Information provided by PGW in response to a Concentric information request.

export facilities to access global markets that are willing to pay much higher prices. Many of these markets are located in Asia, led by Japan, China and South Korea. Japan has been importing significant quantities of LNG to replace shuttered nuclear capacity in the wake of the Fukushima disaster. Figure B-1 provides data regarding the price that is being paid for LNG delivered in several major international markets.

Figure B-1: Global LNG Prices¹⁰⁹



The global demand for LNG is forecast to grow from 32 Bcf/d¹¹⁰ in 2012 to approximately 66 Bcf/d by 2030.¹¹¹ United States projects will be competing against approximately 40 Bcf/d of proposals from other countries that are anxious to serve Asian markets, including Canada and Australia. Certain Australian projects are expected to come on-line over the next few years, with up to 16 Bcf/d of export capacity online by 2018.¹¹² Western Canada is the proposed location for at least nine LNG export projects with a total capacity of 18

¹⁰⁹ Federal Energy Regulatory Commission, World LNG Estimated June 2014 Landed Prices.

¹¹⁰ Canadian Association of Petroleum Producers, *An Overview of the World LNG Market and Canada's Potential for Exports of LNG*, January 2014.

¹¹¹ IHS CERA, *Global Liquefied Natural Gas: New Supplies Ahead*, Presented to the IHS Forum, May 22, 2013 in Amsterdam.

¹¹² Canadian Association of Petroleum Producers, *An Overview of the World LNG Market and Canada's Potential for Exports of LNG*, January 2014.

Bcf/d, most of which have already received export licenses from the Canadian government.¹¹³ Compared to foreign export projects, U.S. export project costs are considered to be in the mid-range of global development projects.¹¹⁴

Export projects based in the U.S. will require approvals from both the Department of Energy (“DOE”) and the FERC, as well as a Letter of Recommendation from the Coast Guard that any waterways used could safely sustain LNG tanker traffic to and from the export facility. As of September 2014, 35 applications have been filed with the DOE for export authority to Non-Free Trade Agreement Countries with a total export capacity of more than 37 Bcf/d and, of these, nine have been approved.^{115, 116} To date, three LNG export projects have been approved by FERC. Figures B-2 and B-3 depict the number and location of proposed and potential LNG export projects in North America. These maps do not include two Louisiana projects and one Texas project that have already received FERC approval.

¹¹³ Ibid.

¹¹⁴ IHS CERA, *Fueling the Future with LNG: Bringing It Home*, January 2014.

¹¹⁵ U.S. Department of Energy, *Long-Term Applications Received by DOE/FE to Export Domestically-Produced LNG from the Lower 48 States* (September 10, 2014). As of September 10, 2014, applications for an additional 3.36 Bcf/d of export capacity had been filed with the U.S. Department of Energy for export authority to countries with whom the U.S. does have a Free Trade Agreement.

¹¹⁶ Of the nine projects that have been approved, only three—Cheniere Energy Inc.’s Sabine Pass project, Sempra Energy’s Cameron LNG project, and the Carib Energy LLC project—have received final approval; the remaining six projects have been granted conditional approvals and will have to complete an environmental review process before receiving final approval. On August 15, 2014, the DOE implemented a revised policy, under which it will skip the conditional approval step and will now only review projects that have completed the environmental review process at FERC.

Figure B-2: Proposed LNG Export Projects¹¹⁷

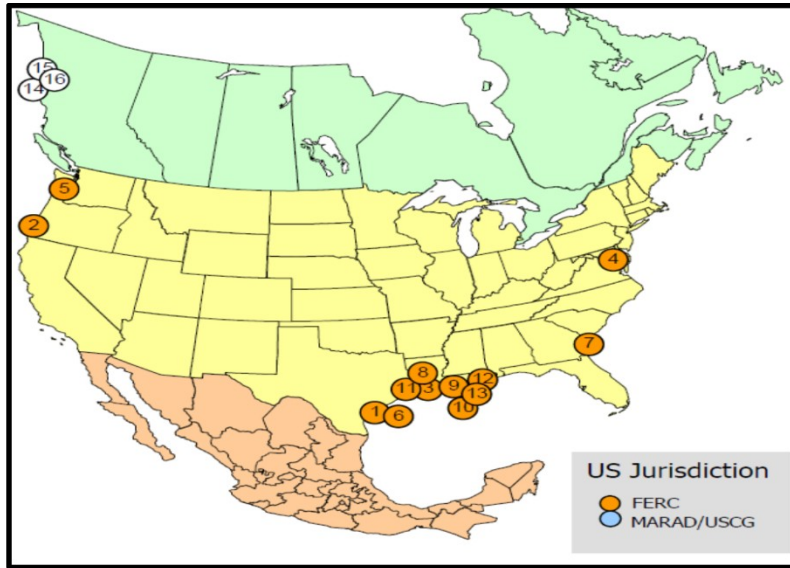
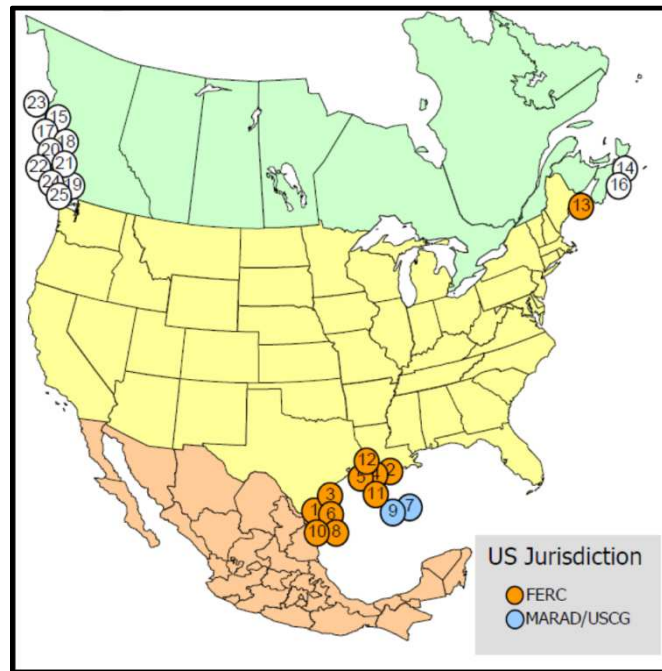


Figure B-3: Potential LNG Export Projects¹¹⁸



¹¹⁷ Federal Energy Regulatory Commission, July 31, 2014.

¹¹⁸ Ibid.

These projects are competing with Canadian and Australian projects as well as with each other and only a small portion of the proposed export capacity in the U.S. is likely to be constructed. A 2012 LNG export study conducted by NERA Economic Consulting on behalf of the DOE posited several scenarios of U.S. LNG exports ranging from 6 Bcf/d to 12 Bcf/d and industry consensus is that the eventual level of exports will fall somewhere within that range.¹¹⁹

The winning projects are likely to be those with superior economics, solid financial strength, a strategic geographic location, and which have been quick to mobilize support. Certainly, projects that are conversions of existing import facilities will have an advantage as they already have ship-handling, storage and pipeline interconnection facilities in place.

Since the process of developing an LNG export facility takes several years, the projects that can bring their LNG to market the fastest will also benefit from a first mover advantage, including greater access to customers in premium markets and creditworthy investors. Most of the proposed projects in the United States and Canada have already commenced the development process and are working toward obtaining necessary permits and financing. In fact, a number of the proposed U.S. projects will already be making final investment decisions by the end of 2014, and are scheduled to come on-line in the 2017-2019 timeframe. Many of the United States projects have already signed long-term off-take agreements, limiting and weakening the pool of remaining counterparties.

The capital and operating costs of the export projects that are in various stages of development will play a large part in determining which projects make it across the finish line. U.S. export project costs are considered to be in the mid-range of global development projects.¹²⁰ Seven of the nine U.S. projects that have received DOE approval involve the conversion of existing LNG import facilities to export facilities. This gives them a cost

¹¹⁹ NERA Economic Consulting, *Macroeconomic Impacts of LNG Exports from the United States*, December 2012. In May 2014, the DOE announced it would conduct an additional study on the potential economic impacts of 12 to 20 Bcf/d of LNG exports, but this study has not yet been released.

¹²⁰ IHS CERA, *Fueling the Future with LNG: Bringing It Home*, January 2014.

advantage that derives from the ability to utilize some of the existing infrastructure for LNG exports -- for example, existing and partially depreciated storage tanks, ship-loading facilities, and other supporting infrastructure. Many of these projects also have access to unutilized interstate pipeline capacity, alleviating the need for costly pipeline expansions and lowering their operating costs.

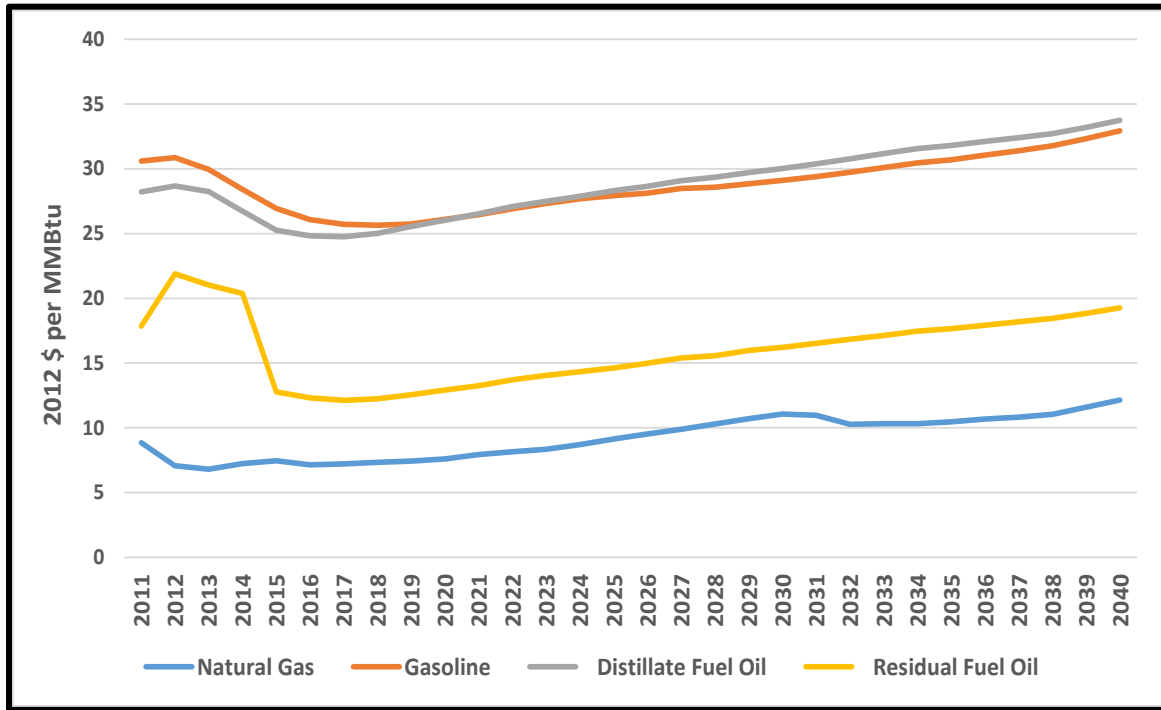
D. Emerging LNG Fuel Conversion Markets

As discussed in Chapter IV and Technical Appendix A, the Marcellus and other shale developments have created a wide price spread between natural gas and crude oil, with the latter trading at three or four times the price of natural gas. This price advantage is expected by some analysts to continue for the next 25 years.¹²¹ Retail price spreads are also strong and expected to be sustained, leading many traditional users of oil and petroleum-based products to seriously consider making the investments necessary to convert from their existing fuel to LNG.

Figure B-4 presents a recent 25-year projection of Mid-Atlantic prices for natural gas and petroleum products.

¹²¹ Ibid.

Figure B-4: Projected Fuel Prices in the Mid-Atlantic¹²²



These petroleum products currently serve several distinct transportation markets. Gasoline is the dominant fuel for light duty, on-road vehicles such as cars and smaller trucks. Distillate fuel oil, including diesel, is used in higher horsepower applications such as heavy-duty trucking and freight rail transportation. Residual fuel oil is a common fuel source for marine vessels.

Due to its relatively low energy density, natural gas must be compressed or liquefied for use as a transportation fuel. CNG has a greater energy density than natural gas, making it a viable alternative to gasoline for powering most light-duty vehicles, but CNG still lacks sufficient energy density to power high horsepower engines like those in heavy-duty vehicles, rail, drilling/fracking and mining equipment where LNG is a more suitable alternative to diesel and residual fuel oil.

¹²² U.S. Energy Information Administration, Annual Energy Outlook 2014, Energy Prices by Sector and Source (Reference Case), Mid-Atlantic region.

One of the challenges that will need to be addressed on a regional and national basis is an increase in the supply of LNG that can serve emerging markets as they develop. Existing LNG liquefaction and storage capacity is either dedicated as its primary use to the LDC market or, in the case of new export facilities, designed to operate at high load factors in order to recoup enormous capital investments. While these facilities can support development of emerging markets, it is likely that new liquefaction and storage capacity will need to be developed and primarily dedicated to these new markets. For example, the existing liquefaction capacity in the U.S. is concentrated in peak-shaving facilities owned by LDCs that have been designed to serve the needs of their firm sales customers, and typically have excess capacity during parts of the year. State and/or FERC approvals may be required to enable sales from these facilities to serve emerging markets.

The most promising of these emerging markets are discussed below.

a. Heavy-Duty Vehicles

The HDV or trucking market is currently reliant on diesel, and fuel costs account for a substantial portion of a heavy-duty truck fleet's operating costs. Conversion to LNG fuel offers the potential for substantial savings to fleet operators. While there has been very limited penetration by LNG into the domestic HDV market to date, LNG as an HDV fuel is projected to grow from 0.01 Bcf/day in 2012 to 4 Bcf/day by 2035¹²³ and there is a significant opportunity for LNG to displace diesel in the Mid-Atlantic region. On-highway diesel sales in the PADD 1B (Central Atlantic) district - consisting of Delaware, District of Columbia, Maryland, New Jersey, New York, and Pennsylvania - were approximately 3.9 billion gallons in 2012, which is the equivalent of 541 Bcf of LNG.

The cost of retrofitting an existing HDV diesel engine to burn either diesel or LNG is approximately \$30,000. A new Class 8 HDV that runs on LNG costs approximately \$40,000-\$100,000 more than one that runs on diesel. Yet, based on the LNG-diesel price

¹²³ IHS CERA, *Fueling the Future with Natural Gas: Bringing It Home*, January 2014.

differential and the fact that many HDVs travel as much as 130,000 miles per year, the investment payback period can be as short as three years.¹²⁴

The lack of both LNG fuel supplies and fueling infrastructure are major impediments to the greater usage of LNG in the HDV market. There are currently only six LNG production facilities in the Northeast, with a total production capacity of approximately 130 MMcf/d, offering LNG fuel supplies to HDVs.¹²⁵ None of these six plants are dedicated to providing LNG fuel supply for transportation, and the majority are peak-shaving plants owned by LDCs and typically only have spare capacity in non-winter months. Additional liquefaction capacity dedicated to serving transportation sector demand will be required for meaningful penetration by LNG in the HDV market to occur.

As of August 2014, there were also only 3 operational LNG fueling stations in the northeastern U.S.¹²⁶ Only one of these fueling stations—located in Bridgeport, Connecticut—is within 300 miles of Philadelphia, with the other two stations located in Ohio, more than 400 miles away. While this lack of LNG fueling infrastructure currently inhibits the growth of LNG as a transportation fuel, there are 8-10 additional LNG fueling stations either planned or under construction in the Mid-Atlantic region.¹²⁷ HDV traffic relies on major highways so new LNG stations are likely to be located on or near these highways. Philadelphia is strategically located in close proximity to numerous major interstate highways that are heavily trafficked by HDVs including I-95, I-76, and I-676, making it a likely location for future LNG fueling infrastructure that PGW could supply and/or develop and own.

There is also a potential near-term opportunity for PGW to supply HDV fleets that may own and operate their own refueling stations before new liquefaction capacity targeting emerging markets is developed. Over the longer term, however, competition among

¹²⁴ Ibid.

¹²⁵ Zeus Intelligence website, <http://member.zeusintel.com/LNGFuel/Plant/Index.aspx>, accessed August 5, 2014.

¹²⁶ Ibid; Powered by LNG website, <http://poweredbylng.com/>, accessed on August 5, 2014.

¹²⁷ Ibid.

suppliers of LNG will intensify as liquefaction plants are built to serve transportation demand. Given the constraints of its existing LNG facilities, PGW will have to invest in additional liquefaction and possibly storage capacity to make significant inroads into this promising market.

b. Marine Vessels

Marine vessels typically run on liquid petroleum fuels - either residual fuel oil or low-sulfur diesel. This is an emerging market with the number of LNG-fueled vessels bunkering (i.e., refueling) in U.S. ports projected to increase modestly from zero today to approximately 30 vessels by 2018. There is optimism for this market due to both the fuel price differential and pending environmental regulations that would restrict the sulfur content of marine fuels.¹²⁸ Given the price advantage, LNG is an attractive alternative for ship owners who have already begun to consider converting to low sulfur fuels.

Residual fuel oil has significantly higher sulfur content than diesel. Only 30 percent of the domestic shipping market is fueled by residual fuel oil, but in international markets more than 90 percent of all shipping is fueled by residual fuel oil.¹²⁹ Pending updates to existing environmental regulations that will restrict the sulfur content of marine fuels provide further incentive for marine fleets to convert to LNG. Annex VI of the International Maritime Organization (“IMO”) International Convention for the Prevention of Pollution from Ships (“MARPOL”) establishes limits on the sulfur content in marine fuels.¹³⁰ Annex VI currently limits sulfur content to 4.5 percent on a global basis, and imposes an even stricter limit of 1.0 percent in designated Emission Control Areas (“ECA”), which include all U.S. territorial waters (and helps explain the low penetration of residual fuel oil in the domestic shipping market). In 2015, the limit on sulfur content in ECAs will be further reduced to 0.1 percent

¹²⁸ NGV Today, “Special Report: Vehicle grade LNG production capacity inventory growing”, April 15, 2014.

¹²⁹ IHS CERA, *Fueling the Future with Natural Gas: Bringing It Home*, January 2014.

¹³⁰ Annex VI currently limits sulfur content to 4.5 percent on a global basis, and imposes an even stricter limit of 1.0 percent in designated Emission Control Areas (“ECA”), which include all U.S. territorial waters. In 2015, the limit on sulfur content in ECAs will be further reduced to 0.1 percent and by 2020 the allowable sulfur content in marine fuels will be lowered to 0.5 percent on a global basis.

and by 2020 the allowable sulfur content in marine fuels will be lowered to 0.5 percent on a global basis. These future environmental requirements have ship owners looking for alternative low sulfur fuels and, with its price advantage and low sulfur content, LNG is an increasingly attractive alternative.

The potential market for LNG as a marine fuel within the U.S. is substantial. Total use of residual fuel oil and diesel for marine vessel bunkering in 2012 was 6.4 billion gallons nationwide, or the equivalent of 2.5 Bcf per day. Of this total, approximately 10 percent is consumed in the PADD 1B (Central Atlantic) District, which includes Philadelphia. PGW's LNG Facilities are located near some of the largest ports in the country, as the ports of Philadelphia, New York/New Jersey, Baltimore, and Pittsburgh are all among the 25 largest U.S. ports in terms of tonnage shipped.¹³¹ The types of vessels with the greatest conversion potential include towboats, ferries, and bulk carriers.¹³² Despite the size of this market, penetration levels in the U.S. are expected to develop slowly, with LNG usage in domestic shipping markets increasing from inconsequential levels in 2013 to two percent in 2040.¹³³

The two primary obstacles to development of this market are the cost to convert vessels to LNG and the lack of supporting LNG refueling infrastructure. Table B-2 provides the indicative cost and estimated payback period for the conversion of towboats, ferries, and bulk carriers.

¹³¹ Army Corps of Engineers, Waterborne Commerce Statistics Center, Tonnage by Port, 2012.

¹³² As of 2010, there were 590 tugboats, 181 pushboats, and 246 ferries operating on the U.S. east coast.

¹³³ U.S. Energy Information Administration, Annual Energy Outlook 2014, Transportation Sector Energy Use by Fuel Type within a Mode.

Table B-2: Marine LNG Economics¹³⁴

Vessel Class	Estimated Conversion Cost	Estimated Payback Period
Tugboat	\$7 million	10 years
Ferry Boat	\$11 million	10 years
Bulk Carrier	\$24 million	12 years

The infrastructure needed to support LNG use as a marine fuel includes construction of liquefaction plants to produce and store LNG, ideally located at ports. If the liquefaction infrastructure is located elsewhere, this results in an extra transportation step and requires additional facilities to handle delivery to ports by pipeline, ship or truck, with additional costs required to maintain the LNG at required temperatures. Likewise, port facilities would have to be outfitted with fueling berths in order to economically bunker vessels fueled by LNG. The majority of the fuel demand for marine vessels comes from international vessels bunkering in U.S. ports and the market potential in the U.S. will therefore also be dependent on whether ports around the globe take similar actions. In certain markets—Europe in particular—the development of LNG port refueling facilities has advanced further than in the U.S. Smaller-scale LNG bunkering facilities are already available in certain northern European countries, and additional facilities are expected to come on line in the next couple years. In early 2013, the European Union unveiled a clean fuels strategy that included a proposal that would mandate that LNG refueling infrastructure be installed in 139 major ports across Europe by 2020 (for maritime ports) or 2025 (for inland ports); however, this proposal is still under consideration.¹³⁵

The need to construct additional liquefaction, and possibly storage and/or dock facilities at either the Passyunk or Richmond facility diminishes any competitive advantage that PGW might have as a result of its waterway access and proximity to major Northeast ports. Furthermore, CH-IV was commissioned in 2013 to assess the feasibility of placing additional LNG production capacity at the Passyunk site and whether a transfer line could be installed

¹³⁴ American Clean Skies Foundation, *Natural Gas for Marine Vessels: U.S. Market Opportunities*, April 2012.

¹³⁵ EUROPA, Press Release, “EU Launches Clean Fuel Strategy”, January 24, 2013.

to allow for the loading of marine vessels. The CH-IV report, released in 2014, found that up to 60 MMcf per day of additional LNG production could be sited at Passyunk, but that marine fueling or loading from the Passyunk facility is not feasible due to regulatory restrictions on the size of the transfer line that could be installed from the LNG storage tank to a transfer station along the Schuylkill.¹³⁶ There are also a number of active refineries in the Philadelphia area, many of which have unused land and dock facilities and shipping experience that PGW lacks. PGW could also face viable competition in the marine fuel market if these refineries decided to offer ultra-low sulfur diesel as an alternative marine fuel.

c. Freight Rail

The displacement of diesel as the predominant fuel for freight rail locomotives offers another longer-term market opportunity for LNG. Fuel costs account for approximately 25 percent of all operating expenses for the dominant freight railroad companies. The expected savings from converting a diesel locomotive to run on LNG is currently \$1.48 per gallon and is expected to grow to \$1.77 per gallon by 2040.¹³⁷

In addition to the economic advantages of LNG as a rail fuel, pending regulations to restrict nitrogen oxide (NO_x) emissions from new locomotives will boost the conversion to LNG. There are currently no LNG locomotives commercially operating in the U.S., but major freight rail operators like BNSF Railway Company have recently initiated pilot programs to test LNG engines.

Diesel sales for railroad use in the PADD 1B (Central Atlantic) district in 2012 were approximately 187 million gallons (equivalent to 70 MMcf per day of LNG), of which

¹³⁶ CH-IV International, Interim Report for Passyunk LNG Facility, June 2014.

¹³⁷ U.S. Energy Information Administration, Annual Energy Outlook 2014, Potential of LNG as a Railroad Fuel.

approximately 70 percent occurred in Pennsylvania.¹³⁸ There are 32 freight rail yards and intermodal terminals located within the Delaware Valley.¹³⁹

As with all potential fuel conversion markets, there are substantial costs associated with converting from diesel locomotives to LNG; however, the fuel cost savings resulting from converting to LNG are sufficient to recover these upfront costs within 7 years, and within much shorter periods under certain circumstances. The cost of a new LNG engine is over \$3 million or at least 50% more than a new diesel engine. It is possible to retrofit a diesel engine to run on LNG for approximately \$600,000 to \$1 million. Freight locomotives are used heavily and over long periods of time, though, and on a net present value (“NPV”) basis the future fuel savings from converting to LNG outweigh the additional \$1 million in upfront costs.

As with the HDV and marine markets, new LNG infrastructure will be required to liquefy and transport LNG to rail fueling depots. LNG cargoes are not permitted without a waiver from the Federal Railroad Administration and there are no regulations yet for the use of LNG as a transportation fuel. The lower energy density of LNG relative to diesel also presents a design challenge because storage tanks must be larger. Models are being tested that would use a tender car to store LNG, akin to steam engines, but this would add an additional car and considerable weight to the train.

According to the U.S. EIA, the market penetration of LNG in the rail fuel market is projected to increase from virtually zero percent in 2013 to 35 percent of total freight rail fuel consumption by 2040. Little market penetration is expected in the next decade, however, with LNG accounting for five percent or less of fuel use until 2025. While a potentially promising market for LNG in the future, freight rail conversions are not likely to offer a viable market opportunity for PGW in the near-term.

¹³⁸ U.S. Energy Information Administration, Adjusted Sales of Distillate Fuel Oil by End Use.

¹³⁹ PhillyFreightFinder, <http://www.dvrpc.org/webmaps/phillyfreightfinder/#>.

d. Drilling/Fracking

There are also industrial activities that rely on diesel fuel to run high horsepower equipment, creating a potential new market for LNG. In the oil and gas industry, drilling and hydraulic fracturing (or “fracking”) are fuel-intensive processes and both drilling rigs and fracking pumps typically run on diesel. Most drilling rig motors and fracking pumps are capable of running on diesel, natural gas or a bi-fuel mix. The current gas-to-oil price differential, with LNG costing around \$2 per gallon while diesel costs \$4 per gallon, has made the economics of converting drilling and fracking equipment to LNG appealing to producers.¹⁴⁰

By comparison, field gas—the natural gas extracted by the drilling/fracking operations—costs approximately \$1 per gallon and is the most economic source of gas for drilling and fracking processes. But, infrastructure limitations make it difficult to move field gas from the source to the drilling rigs. This creates a near-term opportunity for both LNG and CNG. CNG may appeal to producers that can convert both their drilling rigs and vehicle fleets to CNG. However, CNG’s lower energy density makes it impractical as a fuel for hydraulic fracturing. Therefore, opportunities exist for LNG to replace diesel in both drilling and fracking operations.

The majority of the natural gas drilling in the Marcellus basin occurs in Pennsylvania, within 300 miles of the City of Philadelphia. In May 2014, there were an average of 59 drilling rigs active in Pennsylvania, most if not all of which are used to drill for natural gas.¹⁴¹ A drilling rig configured to operate on 70 percent LNG and 30 percent diesel, consumes approximately 85 Mcf per day of LNG.¹⁴² Assuming a drilling rig operates 12 hours a day, 365 days a year, this equates to approximately 31 MMcf per year. Assuming a rig count of 59, and that all drilling rigs are converted to operate using the 70/30 fuel mix of LNG and diesel, this results in a total LNG demand for this sector of approximately 1.8 Bcf per year in

¹⁴⁰ SNL Financial, “Marcellus producers eye ‘next phase’ of drilling economics: Field-gas-powered operations”, May 23, 2014.

¹⁴¹ Baker Hughes, North American Rig Count, Rigs by State – Current and Historical.

¹⁴² Global Hunter Securities, LLC, Thought of the Day: Converting diesel powered drilling rigs to natural gas, April 23, 2012.

Pennsylvania. According to one industry executive, natural gas (including LNG) is currently fueling approximately 7 percent of horizontal drill rig fleets in the U.S., but could rise to 50 percent within two years.¹⁴³

There are incremental capital costs associated with the conversion of drilling rigs to run on LNG or on a dual-fuel basis, but the payback periods are reasonable. Dual-fuel rig conversions can cost up to \$300,000, or \$1 million for a dedicated natural gas rig. An additional \$500,000 to \$1 million is required for on-site storage and vaporization, bringing the total conversion cost to between \$800,000 and \$2 million. Estimated fuel savings from converting to a dual-fuel rig are approximately \$475,000 per year, resulting in an estimated simple payback period of 2 to 4.5 years.¹⁴⁴

As with the other fuel conversion opportunities, the greatest obstacle to the use of LNG as a fuel source for drilling and fracturing is the lack of available LNG. Currently, there are no liquefaction plants located within the Marcellus production basin, providing a potential near-term opportunity for PGW to serve this market.

¹⁴³ Journal of Petroleum Technology, “Displacing Diesel: The Rising Use of Natural Gas by Onshore Operators”, December 2013.

¹⁴⁴ Ibid.