

**BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION**

Petition of Philadelphia Gas Works for :
Approval of Demand-Side Management : Docket No. P-2014-2459362
Plan for FY 2016-2020; and, Philadelphia :
Gas Works Universal Service and Energy :
Conservation Plan for 2014-2016 52 Pa :
Code § 62.4 – Request for Waivers :

DIRECT TESTIMONY

OF

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RESOURCE INSIGHT, INC.

On Behalf of

Philadelphia Gas Works

Topics Addressed:

Development of Avoided Costs
Conservation Adjustment Mechanism

May 4, 2015

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1 **I. INTRODUCTION AND BACKGROUND**

2 **Q. PLEASE STATE YOUR NAME, OCCUPATION, AND BUSINESS ADDRESS.**

3 A. I am Paul L. Chernick. I am the president of Resource Insight, Inc., 5 Water St.,
4 Arlington, Massachusetts.

5 **Q. PLEASE SUMMARIZE YOUR PROFESSIONAL EDUCATION AND**
6 **EXPERIENCE.**

7 A. I received an SB degree from the Massachusetts Institute of Technology in June 1974
8 from the Civil Engineering Department, and an SM degree from the Massachusetts
9 Institute of Technology in February 1978 in technology and policy. I have been elected to
10 membership in the civil engineering honorary society Chi Epsilon, and the engineering
11 honor society Tau Beta Pi, and to associate membership in the research honorary society
12 Sigma Xi.

13 I was a utility analyst for the Massachusetts Attorney General for more than three
14 years, and was involved in numerous aspects of utility rate design, costing, load
15 forecasting, and the evaluation of power supply options. Since 1981, I have been a
16 consultant in utility regulation and planning, first as a research associate at Analysis and
17 Inference, after 1986 as president of PLC, Inc., and in my current position at Resource
18 Insight. In these capacities, I have advised a variety of clients on utility matters.

19 My work has considered, among other things, conservation program design, cost
20 recovery for utility efficiency programs, the valuation of environmental externalities from
21 energy production and use, design of retail and wholesale rates, and performance-based
22 ratemaking and cost recovery in restructured gas and electric industries. My professional
23 qualifications are further summarized in Exhibit PLC-1.

1 **Q. HAVE YOU TESTIFIED PREVIOUSLY IN UTILITY PROCEEDINGS?**

2 A. Yes. I have testified approximately two hundred times on utility issues before various
3 regulatory, legislative, and judicial bodies, including utility regulators in 24 states and
4 three Canadian provinces, and two Federal agencies.

5 **Q. HAVE YOU TESTIFIED PREVIOUSLY BEFORE THIS COMMISSION?**

6 A. Yes. I testified in the following dockets:

- 7 • Docket R-842651, a Pennsylvania Power and Light rate case, on the need for,
8 and operating costs and rate effects of, the Susquehanna-2 nuclear plant, on
9 behalf of the Pennsylvania Consumer Advocate.
- 10 • Docket R-850152, a Philadelphia Electric Rate Case, on rate effects of Limerick
11 1, on behalf of the Utility Users Committee and University of Pennsylvania.
- 12 • Docket R-850290, on auxiliary rates for Philadelphia Electric, on behalf of the
13 University of Pennsylvania and Amtrak.
- 14 • Docket I-900005, R-901880, on electric-utility DSM and DSM-cost recovery,
15 for the Pennsylvania Energy Office.
- 16 • Docket No. 00061346, on real-time pricing for Duquesne Lighting, on behalf of
17 PennFuture.
- 18 • Docket No. R-00061366, et al., rate-transition-plan proceedings of Metropolitan
19 Edison and Pennsylvania Electric, on real-time and time-dependent pricing, on
20 behalf of PennFuture.
- 21 • Docket No. R-2009-2139884, on the first five-year DSM plan of Philadelphia
22 Gas Works.

1 **Q. ON WHOSE BEHALF ARE YOU TESTIFYING?**

2 A. My testimony is submitted on behalf of Philadelphia Gas Works (“PGW”).

3 **Q. PLEASE SUMMARIZE YOUR EXPERIENCE IN THE DEVELOPMENT OF**
4 **AVOIDED COSTS.**

5 A. I have developed or modified estimates of electric avoided costs for numerous electric
6 utilities; many of these estimates are listed in my resume. I estimated statewide avoided
7 costs for Vermont in 1997, and portions of the regional avoided generation costs for all of
8 New England for a consortium of utilities in 1999, 2001, 2007, 2009, 2011, and 2013.¹ I
9 also described the process of deriving avoided costs in a report to the Pennsylvania
10 Energy Office in 1993.² I have developed gas avoided costs for the following utilities:

- 11 • Boston Gas (now part of National Grid) in the late 1980s and early 1990s,
- 12 • Washington Gas Light in the 1990s,
- 13 • New England consortium reports (above) in 1999 and 2001 (plus some aspects
14 of more recent reports, including 2013),
- 15 • two reports for NYSERDA (“Natural Gas Energy Efficiency Resource
16 Development Potential in Con Edison Service Area” and “Natural Gas Energy
17 Efficiency Resource Development Potential in New York”) in 2006,
- 18 • New York’s energy-efficiency rulemaking in 2009,

¹ These are, respectively, “Avoided Energy Supply Costs for Demand-Side Management in Massachusetts” (1999), “Updated Avoided Energy Supply Costs for Demand-Side Screening in New England” (2001), “Avoided Energy Supply Costs in New England: 2007 Final Report” (2007), and “Avoided Energy Supply Costs in New England: 2009 Final Report” (2009), “Avoided Energy Supply Costs in New England: 2011 Report” (2011), and “Avoided Energy Supply Costs in New England: 2013 Report” (2013), all for the Avoided-Energy-Supply-Component Study Group, c/o National Grid Company (Northborough, Massachusetts).

² That work was in “Qualifying the Benefits of Demand Management,” the fifth volume of the five-volume *From Here to Efficiency: Securing Demand-Management Resources* published in 1992 and 1993 by the Pennsylvania Energy Office.

- 1 • Peoples Gas Company (Illinois) in 2009,
- 2 • PGW annually since 2009,
- 3 • Enbridge Gas in 2013,
- 4 • FortisBC in 2013.

5 **Q. PLEASE SUMMARIZE YOUR EXPERIENCE IN THE PLANNING AND**
6 **PROMOTION OF ENERGY-EFFICIENCY PROGRAMS.**

7 A. I have testified on demand-side-management potential, economics, and program design in
8 approximately 65 proceedings since 1980. In the 1990s I participated in several
9 collaborative efforts among utilities, consumer advocates, and other parties, including
10 those for PEPCo, BG&E, Delmarva Power, Potomac Edison, Washington Gas Light,
11 Central Vermont Public Service, Vermont Gas, and NYSEG. More recently, I have
12 participated in collaboratives related to Con Edison's gas- and electricity-efficiency
13 programs, New York statewide program rules and objectives, and energy-efficiency
14 collaboratives in Maryland and Illinois.

15 **Q. PLEASE SUMMARIZE YOUR EXPERIENCE REGARDING RECOVERY OF**
16 **UTILITY ENERGY-EFFICIENCY PROGRAM COSTS, ASSOCIATED**
17 **REVENUE LOSSES, AND PERFORMANCE INCENTIVES.**

18 A. I first proposed a combined revenue-stabilization and conservation-funding mechanism in
19 testimony on alternatives to the Seabrook nuclear power plant before the New Hampshire
20 Public Utilities Commission in Docket No. DE1-312 in October 1982. My qualifications
21 list a number of subsequent engagements related to ratemaking for energy efficiency,
22 including recovery of direct costs, lost revenue and performance incentives.

23 I have supported broader revenue stabilization than proposed by the utilities in
24 some cases (e.g., in Ontario), and proposed modifications to utility decoupling proposals
25 in other situations (e.g., for Con Edison's electric sales, Vectren's Indiana gas territories).

1 I have also worked on issues of cost recovery in collaborative efforts among utilities,
2 consumer advocates, and other parties, including Con Edison's gas revenue-per-customer
3 decoupling collaborative.

4 I have developed lost-revenue and performance-incentive mechanisms for
5 consumer advocates (including the Maryland Office of People's Counsel, the Ohio Office
6 of Consumer Counsel, and the City of New York) and other parties since the early 1990s.

7 **Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?**

8 A. The purpose of my testimony is to describe the derivation of PGW's avoided gas costs
9 and support PGW's proposal for the recovery of lost distribution margin through the
10 Conservation Adjustment Mechanism ("CAM") resulting from the proposed DSM II plan
11 described in the testimony of PGW witness Theodore Love. Throughout the process of
12 preparing PGW's filing in this proceeding, and in developing this testimony, I have
13 worked closely with Mr. Love.

14 **Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS.**

15 A. I recommend that the Commission approve the use of the avoided costs developed in my
16 testimony for screening PGW's energy-efficiency plan, the inclusion of lost margin in the
17 CAM and incentives for superior performance in delivering energy-efficiency services, as
18 proposed by Mr. Love.

19 **II. DEVELOPMENT OF AVOIDED COSTS**

20 *(A) Avoided Gas Costs*

21 **Q. DID YOU DEVELOP THE AVOIDED GAS COSTS USED IN THE ECONOMIC**
22 **SCREENING OF PGW'S PROPOSED DSM II PLAN?**

23 A. Yes.

1 **Q. PLEASE DESCRIBE YOUR APPROACH.**

2 A. The purpose of avoided costs is to estimate the benefit to consumers of reduced energy
3 usage. The major benefit is the reduction of the quantity of gas required to serve customer
4 loads and of the associated pipeline and storage capacity required to deliver the gas to the
5 PGW citygate at the times customers require it. This benefit does not necessarily equal
6 the rate paid by the customer to the utility or a natural-gas supplier in a particular month.
7 The market price of gas varies daily, while the utility (or supplier) may pay all year round
8 for capacity resources that serve customer loads only a few days in a typical year. The
9 costs resulting from customer gas consumption thus vary with load shape. For customers
10 using gas supplied by PGW, all the costs of gas used by customers will flow through to
11 customers and all the costs saved from energy efficiency will similarly flow through to
12 customers. Customers served by natural-gas suppliers may pay a contract rate in the short
13 term, but those rates are likely to be adjusted over time to reflect the costs of serving the
14 customer's actual load.

15 I outline my approach in this testimony. Exhibit PLC-2 presents the derivation of
16 avoided gas costs in greater detail.

17 **Q. HOW DID YOU PROJECT THE COST OF GAS OR THE BENEFIT OF**
18 **REDUCED GAS CONSUMPTION?**

19 A. A detailed explanation can be found in Exhibit PLC-2, but I'll outline the projection here.
20 My estimate of the avoided cost of natural gas for PGW's customers comprises the
21 following components:

- 22 • *Supply-area commodity costs:* The price of gas delivered at Henry Hub, for
23 normal-year weather.

- 1 • *Commodity delivery costs:* marginal pipeline and storage charges for gas
2 delivered from Henry Hub to PGW's citygate in a normal year.
- 3 • *Peaking capacity:* The costs of storage capacity to cover the difference between
4 normal and design-peak conditions.
- 5 • *Avoided costs of environmental compliance.*
- 6 • *The effect of load reductions* on the price of gas paid by Pennsylvania gas and
7 electric customers.

8 **Q. HOW DID YOU PROJECT THE SUPPLY-AREA COMMODITY COSTS?**

9 A. I began with the monthly forward prices for gas at Henry Hub as posted on April 20 2014
10 for the period September 2015 through August 2027.³ That period includes PGW's
11 September–August fiscal years from 2015/16 (FY2016) through 2025/26 (FY2026). In
12 the longer term, no forward market prices are available, so I relied on the Energy
13 Information Administration's 2014 Annual Energy Outlook (AEO), released May 7
14 2014.⁴ Since the 2026 AEO price differed from the 2026 forward price, I blended the two
15 projections together for 2019–2026. Beyond FY2026, I escalated the Henry Hub gas
16 price at the real 2027-2014 average escalation rate forecast by AEO, plus the 2% inflation
17 rate used across PGW's analysis.

18 For baseload efficiency measures, which save the same amount of energy every
19 day, the avoided supply-area commodity cost is simply the average of the gas prices
20 across months, weighted by the number of days in the month. For heating measures, I

³ Prices were posted only through December 2027.

⁴ The 2015 AEO report was released on April 14 2015, too late to be used in preparation of the filing. The changes in natural gas prices from AEO 2014 to AEO 2015 for 15–20 year lives in the period of the second five-year plan do not appear to be substantial.

1 assumed that the savings would be distributed across months in proportion to normal
2 monthly heating degree days. Within each month with significant heating load, I
3 estimated the historical ratio of prices weighted by normal heating degree days to the
4 simple average of the prices.

5 **Q. HOW DID YOU PROJECT THE DELIVERY PRICES?**

6 A. The delivery price has several components. First, I reduced the Henry Hub price by
7 10¢/Dth to reflect the lower cost at South Texas, the starting point for much of PGW's
8 gas contracts.

9 Second, I added in the costs of delivering gas in the off-peak months of April
10 through October from South Texas to PGW's citygate in the M-3 zone of the Texas
11 Eastern (TETCo) pipeline. I assume that contract capacity is not a binding constraint in
12 those months and set the delivery charge at Texas Eastern's variable commodity rate
13 (\$0.1105/Dth). In addition, the delivery costs include Texas Eastern's 5.8% tariff
14 transport fuel charge.

15 Third, for December through February, I assumed that the marginal source of
16 supply is the Texas Eastern CDS rate, which includes the following costs:

- 17 • the demand charges (from South Texas, into storage, and back out of storage to
18 Zone M-3) of \$21.88/Dth-month for 12 months, spread over 115 days of
19 storage, or an average of \$2.28/Dth;⁵
- 20 • about \$0.51/Dth for volumetric charges (the South Texas–M-3 charges, plus
21 space, injection, and withdrawal charges in seasonal storage);

⁵ I distributed the costs of the CDS capacity in proportion to the average heating degrees per day for each month, to recognize the higher value of the capacity at high-load periods. The resulting allocations ranged from \$3.25/Dth in January to \$2.35 in March and November.

- fuel use of about 11.7%.

Fourth, I recognized that November and March contain a mix of cold and milder days. While all the days in December through February fall in the coldest 115 days on the PGW system in a normal winter, only six days in November and nineteen days in March do so. Accordingly, I attributed the CDS cost to those days and the lower cost of the TETCo transportation rate (\$17.06/Dth-month) to the other days in each month, with the capacity costs allocated evenly over the heating months. The transportation capacity is equivalent to \$1.35/Dth, plus the commodity costs, and fuel use reflecting the mix of transport and storage in each month.

The annual delivery charge for baseload measures are the average of the delivered gas prices across months, weighted by the number of days in the month, while the annual delivery charge for heating measures is the average of the month prices, weighted by heating degree days.

Q. OTHER THAN COMMODITY DELIVERED TO THE CITYGATE IN A NORMAL-WEATHER YEAR, DOES ENERGY EFFICIENCY ALLOW PGW TO AVOID ANY OTHER COSTS?

A. Yes. In addition to providing gas to meet normal weather, PGW must provide enough reserve capacity to meet loads under design conditions, including both a design day with 65 heating degree days and a design winter with heating loads approximately 19.4% greater than normal. I estimated the cost of that reserve as the price of PGW's contracts supporting its most expensive storage supply (the SS-1B contract) times the percentage increase in heating load between normal and design winters. I took the fixed cost of the peaking supply as \$80.37/Dth-year. The reserve capacity needed to serve heating load on a design day is about 0.75% of the heating usage (about 34°F reserve spread over 4,613

1 HDD), so maintaining the reserve costs about \$0.62/Dth in FY2016. Baseload does not
2 increase under design conditions, and thus has no peaking-reserve cost.

3 **Q. DO ENERGY EFFICIENCY AND CONSERVATION INVESTMENT HAVE**
4 **OTHER BENEFITS, BEYOND THOSE YOU HAVE QUANTIFIED?**

5 A. Yes. PGW's energy-efficiency programs and resulting reductions in gas load would have
6 several positive effects including the following beneficial functions:

- 7 • Create local jobs for local businesses in implementing the programs, from
8 distributing equipment and materials to installation and inspections.
- 9 • Reduce wholesale-market gas prices, particularly in the Northeast. While this is
10 a small price effect per ccf, it has that effect over large amounts of retail sales
11 and the large amounts of electric energy that is priced at the marginal costs of
12 gas-fired generators.
- 13 • Improve customer comfort.
- 14 • Potentially improve PGW cash flow.
- 15 • Improve customer ability to pay.
- 16 • Leave customers with additional cash to be spent in Philadelphia, stimulating
17 the local economy.
- 18 • Provide a model for energy-efficiency programs for other Pennsylvania gas
19 utilities, which would directly benefit the customers of those utilities and
20 multiply the market-price benefits to consumers.
- 21 • Reduce carbon emissions, the social cost of those emissions, and the cost to
22 consumers of compliance with likely future carbon limits.

23 The benefits of reducing market prices and carbon emissions, addressed in
24 Sections II(B) and II(C) below, have been quantified as additional avoided costs and

1 provided within alternative TRC figures for consideration in DSM Phase I. In Phase II,
2 PGW proposes to include these components within the primary avoided costs and TRC
3 calculations. Philadelphia Gas Works has not quantified the other effects listed above, but
4 they are all properly included in the benefits of an energy-efficiency and conservation
5 program.

6 Where loads are growing, energy efficiency also frees up distribution capacity
7 that allows the utility to avoid some system upgrades. Most of PGW's system has
8 experienced declining loads and hence needs no capacity-related upgrades. Indeed,
9 PGW's miles of distribution mains have declined slightly but consistently since 2009.
10 Nonetheless, there may be areas in which PGW will eventually require increased delivery
11 capacity due to local growth. In those situations, PGW may be able to defer or avoid
12 distribution upgrades.

13 ***(B) Wholesale Price Suppression***

14 **Q. HOW DOES GAS CONSERVATION AFFECT THE PRICE OF GAS**
15 **PURCHASED FOR THE LOAD THAT REMAINS AFTER THE ENERGY-**
16 **EFFICIENCY INVESTMENTS?**

17 A. Reduced gas consumption reduces both the market price of natural gas in North America
18 and the market price of transportation to deliver gas to the citygate. The following
19 sections summarize my analyses of these effects; details are provided in Appendix 6.1 of
20 Exhibit TML-4.

21 **1) Supply Market Effects on PGW Gas Bills**

22 **Q. HOW MUCH DOES THE PRICE OF GAS SUPPLY RESPOND TO THE**
23 **CHANGES IN GAS CONSUMPTION?**

24 A. To examine this question, I reviewed the literature and found that a number of analyses
25 estimated that a 1% reduction in US gas consumption would reduce gas prices by about

1 1%–3%. I updated these analyses by using the results of the sensitivity analyses that the
 2 EIA ran for the 2012 and 2014 AEOs.

3 As shown in Appendix 6.1 of Exhibit TML-4, plots of the changes in price against
 4 demand in the EIA sensitivity results are remarkably linear, with the small changes in the
 5 early years clustered near the origin and the large changes in later years closer to the ends
 6 of the trend line. The 2012 AEO results imply that every quad (billion Dth) decrease in
 7 annual gas consumption results in a \$0.632/Dth decrease in Henry Hub gas price (in
 8 2010\$).⁶

9 **Q. HOW DOES THAT COEFFICIENT OF PRICE CHANGE PER CONSERVED**
 10 **DTH TRANSLATE TO A SAVINGS TO PENNSYLVANIA CONSUMERS AS A**
 11 **RESULT OF CONSERVED GAS?**

12 A. The effect of this change in price on consumer bills is the product of the \$0.632/Dth per
 13 quad times the annual gas use by the relevant consumers. Since PGW's end-use gas
 14 sendout for FY2014 was about 78 million Dth, the potential effect on PGW gas end
 15 users' gas supply bill of one Dth reduction in gas consumption is

$$16 \quad (\$0.632 \times 10^{-9}/\text{MMBtu}) \times (0.078 \times 10^9 \text{ MMBtu}) = \$0.05/\text{Dth saved}.$$

17 Similarly, PECO has gas deliveries of about 90 million Dth, so every Dth
 18 reduction in usage would save PECO gas customers another \$0.036/Dth. The statewide
 19 gas deliveries to customers are about 582 million Dth, producing statewide benefits of
 20 \$0.233/Dth.

⁶ The AEO data do not appear to show any significant decay in the price-reduction values over time.

1 **2) Gas-Supply Market Effects on Electric Bills**

2 **Q. DO THESE REDUCTIONS IN SUPPLY-AREA GAS PRICES REDUCE**
3 **ELECTRIC PRICES?**

4 A. Yes. Natural gas set the market price in PJM about 33% of the time in calendar 2013; that
5 value appears to be rising as coal plants are retired. Unfortunately, PJM does not report
6 the marginal supply for various parts of the power pool, so we cannot tell how much of
7 the marginal energy serving the area around Philadelphia is from gas. However, the value
8 is almost certainly higher than the system-wide average.⁷

9 When gas sets the market electric price, reductions in gas prices reduce market
10 prices for electric energy. Assuming an average heat rate of 9.5 Dth/MWh, the savings to
11 PECO customers (many of which are also PGW customers) from a Dth reduction in gas
12 use would be

13
$$(\$0.632 \times 10^{-9} / \text{MMBtu}) \times (9.5 \text{ MMBtu/MWh}) \times 39.7 \times 10^6 \text{ MWh} \times 33\% = \$0.08 / \text{MMBtu}$$

14 For all of Pennsylvania, with deliveries of about 146.3 million MWh, lower gas supply
15 prices would save customers statewide about \$0.29 for every MMBtu saved.

16 **3) Transportation Market Effects on Electric and Gas-Transport Bills**

17 **Q. HOW DO LOAD REDUCTIONS AFFECT THE COSTS OF GAS**
18 **TRANSPORTATION?**

19 A. Reductions in gas loads reduce the market-price difference (or basis) from supply areas to
20 consumption areas. Most gas distribution companies, including PGW, purchase almost all
21 their gas transportation services under fixed-price regulated contracts (such as those
22 described in Section II(A)) and are thus not affected by market basis. But most electric

⁷ Compared to Pennsylvania, areas to the west have more coal, which makes up about half the marginal supply overall, and wind, which makes up 5% of the margin.

1 generators in PJM (and other restructured regions) purchase all their gas transportation at
2 market prices. Reducing gas transportation costs will tend to reduce electric market
3 prices, in the periods for which gas sets the market price. Most interruptible gas
4 transportation customers also probably purchase their gas on the spot markets.

5 **Q. HOW DID YOU ESTIMATE THE MAGNITUDE OF THE EFFECT OF**
6 **REDUCED GAS USAGE ON MARKET TRANSPORTATION PRICES?**

7 A. I examined the historical relationship between monthly consumption in the Northeast and
8 basis from Henry Hub to the TETCo M-3 zone, which is a major pricing point for
9 generation in eastern Pennsylvania, New Jersey, and surrounding regions. I defined the
10 Northeast as including the states served by the M-3 zone and those downstream:
11 Pennsylvania, New Jersey, New York, Massachusetts, Rhode Island, Connecticut and
12 New Hampshire.⁸ As shown in Appendix 6.1 of Exhibit TML-4, I found that the reducing
13 winter gas consumption by one quad reduces basis by \$0.021/MMBtu.

14 **Q. HOW DOES THIS REDUCTION IN TRANSPORTATION PRICE AFFECT**
15 **ELECTRIC PRICES?**

16 A. As shown in Appendix 6.1 of Exhibit TML-4, the benefit for PECO customers would be
17 about \$0.20/MMBtu of saved space-heating gas and \$0.09/MMBtu for baseload savings.
18 The Pennsylvania utilities in the MAAC region (PECO, PPL, Penelec, MetEd and UGI),
19 collectively use about three times as much energy in the four winter months (December
20 to March) as does PECO, so the statewide savings would be about three times the PECO
21 savings. Since most electric customers are supplied through fixed-price contracts that last
22 several months or a few years, the price reduction will flow through to customers with a
23 delay averaging about a year.

⁸ Only eastern Pennsylvania should be included in this area, since western Pennsylvania is upstream of Zone M-3, but I do not have monthly data on gas consumption for areas smaller than states.

1 For PGW's interruptible transport customers, each saved Dth saves about
 2 \$0.042/MMBtu of saved space-heating gas and \$0.019/MMBtu of saved baseload gas, at
 3 the end of a three-year phase-in period (assuming that customers have fixed-price
 4 transportation contracts averaging three years in duration).⁹

5 Since less congestion on the pipelines may slow expansion of lines, it is
 6 reasonable to phase out the basis price effect over a few years, starting in 2020.

7 ***(C) Avoided Environmental Costs***

8 **Q. WHAT ENVIRONMENTAL COSTS DID YOU ESTIMATE FOR INCLUSION IN**
 9 **PGW'S ECONOMIC EVALUATION OF ITS ENERGY-EFFICIENCY**
 10 **PROGRAMS?**

11 A. A: I compiled information on the following costs:

- 12 • Likely future carbon prices that may be applied economy-wide, including on
 13 gas burned by PGW's customers.
- 14 • The social cost of carbon emissions.
- 15 • The health costs of NOx and SO2 emissions from power plants.

16 These costs, per unit of pollution emitted, and the value of avoiding the emissions
 17 per Dth or MWh conserved, are described in detail in Appendix 6.1 of Exhibit TML-4.

18 **Q. HOW DID YOU ESTIMATE THE INTERNALIZED COSTS OF CARBON**
 19 **CHARGES?**

20 A. I relied on the 2013 summary of carbon-pricing forecasts from Synapse Energy
 21 Economics, as described in Appendix 6.1 of Exhibit TML-4. I used Synapse's mid-case
 22 projection of carbon allowance prices, which assumes that carbon caps take effect in
 23 2020, starting at \$15/ton in 2012 dollars, rising linearly to \$37.5 in 2030 and \$60 in 2040.

⁹ If the customers pay market prices on a daily, weekly, or monthly basis, or if fixed-price contract durations are shorter than three years, the phase-in period would be shorter or non-existent.

1 I multiplied that price by emissions of 118 pounds of CO₂ per Dth, to get
2 internalized carbon prices of \$0.92/Dth in 2020; \$2.30/Dth in 2030 and \$3.68/Dth in
3 2040.

4 **Q. HOW DID YOU ESTIMATE THE SOCIAL COSTS OF CARBON EMISSIONS?**

5 A. I relied on the Federal Interagency Working Group mid-range results, using a 3% real
6 discount rate, as shown in Appendix 6.1 of Exhibit TML-4. Those costs (in 2007 dollars)
7 start at about \$38/ton in 2015, rising to \$43 in 2020, \$52 in 2030, and \$62/ton in 2040.

8 Converting to a cost per Dth of gas burned, the costs are \$2.42/Dth in 2015, \$2.53
9 in 2020, \$3.07 in 2030, and \$3.66/Dth in 2040.

10 **Q. HOW DID YOU ESTIMATE THE HEALTH COSTS OF NOX AND SO₂**
11 **EMISSIONS FROM POWER PLANTS?**

12 A. As described in Appendix 6.1 of Exhibit TML-4, I used the EPA's estimates of the
13 health-related damages of particulate matter resulting from releases of SO₂ and NO_x by
14 electric generators in a wide area encompassing the Philadelphia and New York City,
15 which would be broadly typical of the area in which most of the electricity generated for
16 PECO customers would be generated. Depending on the year, these estimates are around
17 \$100,000/ton for SO₂ and \$1,500–\$2,500/ton for NO_x.

18 Appendix 6.1 of Exhibit TML-4 explains in some detail the manner in which I
19 estimated the marginal emissions rates for PJM over time and converted the cost per ton
20 to cost per MWh.

21 ***(D) Avoided Electric Costs***

22 **Q. WHY ARE AVOIDED ELECTRIC COSTS RELEVANT TO THE EVALUATION**
23 **OF PGW'S ENERGY-EFFICIENCY PROGRAMS?**

24 A. Gas energy-efficiency measures can increase or decrease electricity use. For example,
25 tradeoffs between gas and electric savings arise in choosing between window designs that

1 admit solar energy in the winter and those that keep out sunshine in the summer. On the
2 other hand, building-shell measures (wall and roof insulation, tighter windows), setback
3 thermostats, and duct sealing in gas-heated buildings are likely to decrease electric use
4 both for circulating heat (with pumps and/or fans) and for summer cooling. Accurately
5 evaluating the cost-effectiveness of the gas energy-efficiency and conservation programs
6 requires valuation of the changes in electricity use, along with all other costs and benefits.

7 **Q. HOW DID YOU ESTIMATE ELECTRIC AVOIDED COSTS?**

8 A. My computation of avoided energy costs started with April 17 2014 NYMEX monthly
9 forward on- and off-peak energy prices for PECO for 2015, escalated through 2018 at the
10 growth rates for PJM energy.¹⁰ After 2018, I interpolated the energy prices so that the
11 growth rates matched the 2014 AEO's projection of nominal Henry Hub gas prices by
12 2026, and used AEO's escalation projections thereafter.¹¹ I then weighted the market
13 energy costs across months, to derive an average annual avoided energy cost for each gas
14 year.

15 I did not explicitly recognize any effects of intra-month load shape, line losses,
16 carbon caps or changing fuel mix in the future.

17 To the energy costs, I added capacity costs at the market-clearing price applicable
18 to electric service. Since PJM obtains capacity on a locational basis, the capacity price
19 may be essentially uniform across the entire PJM RTO, or may vary between regions.
20 The capacity price applicable to the Philadelphia region for 2014/15 through 2016/17 was
21 the MAAC zone, plus losses and required reserves. I assumed that the capacity price after

¹⁰ The forwards ran only to 2015 for PECO and 2018 for PJM

¹¹ This approach is very similar to that described by the PAPUC in Docket No. M 2009-2108601.

1 2016/17 would be constant in real terms, at the average of those three previous auction
2 prices, which was about \$73/kW-year including losses and reserves.

3 I also included the avoided T&D costs estimated by PECO in its Revised Phase II
4 Energy Efficiency and Conservation Plan for Program Years 2013-2015 under Act 129.
5 While these are avoided capacity costs, PECO reported them in dollars per kWh, and I
6 included them as energy benefits.

7 The results of my computations are described in Exhibit PLC-3.

8 **III. CONSERVATION ADJUSTMENT MECHANISM**

9 **Q. WHAT ISSUES WILL YOU ADDRESS REGARDING THE CONSERVATION** 10 **ADJUSTMENT MECHANISM?**

11 A. I will address the equity and efficiency benefits of inclusion of PGW's lost revenues in
12 the Conservation Adjustment Mechanism (CAM).

13 **Q. ARE LOST REVENUES A COST OF THE DSM PROGRAM TO PGW?**

14 A. Yes. The principal purpose of energy-efficiency programs is to reduce customer costs by
15 reducing the usage of commodity. The Total Resource Cost test (TRC), the primary test
16 of efficiency-program effectiveness utilized by Act 129 programs in Pennsylvania and
17 PGW's DSM, is based on the value to customers of the reductions in energy and capacity
18 costs resulting from commodity savings. The benefits of efficiency programs exclude any
19 additional short-term reductions in customer bills resulting from decreased contributions
20 to paying for fixed utility costs. The short-term reduction in distribution charges is thus
21 an unintended side-effect of the efficiency programming and is not counted as
22 contributing towards PGW's stated goals or estimated benefits. Lost margins represent
23 important additional costs imposed upon the utility and must be mitigated to facilitate full
24 development of the efficiency resource. Since PGW flows through the costs of