

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Petition of PPL Electric Utilities :
Corporation for Approval of an : Docket No. M-2012-2334388
Energy Efficiency and Conservation Plan :

DIRECT TESTIMONY

OF

GEOFFREY C. CRANDALL

ON BEHALF OF

THE OFFICE OF CONSUMER ADVOCATE

December 28, 2012

1 **Q. What is your name and business address?**

2 A. My name is Geoffrey C. Crandall. My business address is MSB Energy Associates, Inc.,
3 1800 Parmenter Street Suite 204, Middleton, Wisconsin 53562.

4 **Q. On whose behalf are you testifying today?**

5 A. I am testifying on behalf of the Office of Consumer Advocate (OCA).

6 **Q. Please describe your background and experience in the field of gas and electric**
7 **utility regulation.**

8 A. I am a principal and the Vice President of MSB Energy Associates, Inc. I have over 35
9 years of experience in utility regulatory issues, including energy efficiency, conservation
10 and load management resources program design and implementation, resource planning,
11 restructuring, mergers, fuel, purchase power, gas cost recovery, planning analysis, and
12 related issues. I have provided expert testimony before more than a dozen public utility
13 regulatory bodies throughout the United States. I have provided expert testimony before
14 the United States Congress on several occasions.

15 My experience includes over 15 years of service on the Staff of the Michigan Public
16 Service Commission (Commission). In my tenure at the Commission, I served as an
17 analyst in the Electric Division (Rates and Tariff section) involving rate as well as fuel
18 and purchase power cases. I also served as the Technical Assistant to the Chief of Staff,
19 Supervisor of the Energy Conservation Section (involving residential and commercial
20 energy efficiency programs). I also served as the Division Director of the Industrial,
21 Commercial and Institutional Division. In that capacity, I was Director of the Division
22 that had responsibility for the energy efficiency and conservation program design,
23 funding, and implementation of Michigan utility and DOE-funded programs and

1 initiatives involving Industrial, Commercial and Institutional gas and electric customers
2 throughout Michigan.

3 In 1990, I became employed by MSB Energy Associates, Inc. and have served clients
4 throughout the United States on numerous projects related to energy efficiency and load
5 management program development, system planning, fuel, purchase power and gas cost
6 recovery assessments, electric restructuring, customer impact analyses, and other issues.

7 My vita is attached as Exhibit GCC-1.

8 **Q. What is the purpose of your testimony?**

9 A. The purpose of my testimony is to respond and suggest improvements to the Energy
10 Efficiency and Conservation (EE&C) Plan proposed by PPL Electric Utilities
11 Corporation (PPL).

12
13 **OVERALL REACTION**

14 **Q. What overall reaction do you have to PPL's proposed Energy Efficiency and**
15 **Conservation Plan regarding Act 129 Phase II?**

16 A. I believe that PPL has made a good effort in deriving and assembling its proposed
17 portfolio. However, I believe there is room for improvement. I have several comments
18 and concerns regarding specific aspects of the proposed PPL plan. My concerns include:

- 19 1. The need for continuation of a robust collaborative process.
- 20 2. Amending the EE&C Plan to specifically include data centers.
- 21 3. Improving the Energy Efficiency Behavior and Education Program.

- 1 4. Increasing participation in PPL's Low Income Programs.
- 2 5. Improving PPL's Master Metered Low Income Multi-Family Housing Program.
- 3 6. Providing appropriate incentives for efficient lighting, i.e., not incenting standard
- 4 efficiency bulbs.
- 5 7. Improving the installation rates of energy efficiency kits.
- 6 8. Limiting availability of heat pump water heaters to low income customers not served
- 7 by natural gas.
- 8 9. Correcting inequitable allocation of program costs among the customer classes.
- 9 10. Calculating the Act 129 Cost Recovery (ACR) rates.

10

11 **ROBUST COLLABORATIVE PROCESS**

12 **Q. Do you believe that an active PPL stakeholder input/collaborative process would**

13 **continue to be useful in developing, implementing, and improving the energy**

14 **efficiency and demand response programs for the June 1, 2013 – May 31, 2016**

15 **period?**

16 **A.** Yes. It is my understanding that PPL has conducted an active and robust stakeholder

17 process during Phase I. An active and robust PPL collaborative working group process

18 should be a high priority activity for Phase II, as well with regularly scheduled meetings

19 and full participation by interested parties. A systematic process for sharing ideas will

1 continue to assist PPL program managers and implementers to develop, modify, and
2 continuously improve programs.

3 **Q. What are some of the hallmarks of a sound stakeholder process?**

4 A. I believe that a sound stakeholder process should meet at least quarterly. At least one
5 week in advance, PPL should provide the collaborative group with meeting agendas, pre-
6 meeting documents and materials that will be covered during the meetings. Having those
7 materials in advance will afford the participants the opportunity to review the pre-
8 meeting materials and be prepared to participate and contribute during the meetings. This
9 group's objective would be to improve program delivery, offer ideas to enhance customer
10 acceptance and marketing strategies, and to provide feedback and advice to help sort out
11 evolving implementation and coordination strategies. The collaborative group could add
12 value by informing PPL implementers of current market conditions, new developments
13 e.g. new federal, state or local laws, product delivery and manufacturing problems,
14 reacting to program oversubscription problems, becoming aware of backlog problems
15 with related programs, etc. The collaborative group should be kept informed of
16 implementation, budget, cost recovery, and other activities to assess whether any mid-
17 course corrections are needed. Recommendations resulting from the collaborative group
18 would be advisory in nature and non-binding on PPL. However, an active collaborative
19 provides considerable assistance to PPL program managers and implementers.

20 **Q. What is your recommendation for the PPL collaborative for this Plan period?**

1 A. I recommend that the Commission direct PPL to continue a robust collaborative
2 following the guidelines I described in this testimony.

3

4 **DATA CENTER ENERGY EFFICIENCY PROGRAM**

5 **Q. During the course of your review of PPL's proposed plans do you believe any**
6 **important programs or technologies were omitted?**

7 A. Yes. The Company did not propose a comprehensive data center energy efficiency
8 program.

9 **Q. What is the basis for your concern about not having a data center energy efficiency**
10 **program in the proposed plan?**

11 A. As a result of significant societal changes in how information is transferred and
12 exchanged in this country, (less reliance on paper-based information), energy usage by
13 data centers has increased dramatically. In response to this increase, the 109th Congress
14 passed Public Law 109-431, attached as Exhibit GCC-2. Congress required that the
15 Environmental Protection Agency conduct a study of energy consumption of computer
16 data centers owned by both the government and private enterprise. In addition to
17 assessing cost savings and growth trends associated with data centers, the study reviewed
18 the existing incentives offered for data center energy efficiency services and products.
19 Congress also required that specific recommendations be formulated regarding potential
20 incentives and voluntary programs to encourage adoption of energy efficient data centers
21 and computing.

1 **Q. How does this relate to PPL?**

2 A. With the proliferation of and access to cell phones, personal computers, tablets, etc.,
3 many customers in Pennsylvania are becoming less dependent on paper-based
4 information and more dependent on digital information. As a result, the Company's
5 customers in Pennsylvania are relying more and more on digital information management
6 and data centers. Data centers have become essential to the basic operation of businesses
7 and many organizations. Data centers are relied on heavily in nearly every sector of the
8 economy including universities, businesses, government operations, media, financial
9 services, security, etc.

10 In a report to Congress,¹ the U.S. Department of Energy (DOE) stated that the energy
11 used by the nation's servers and data centers is significant and that the energy use of the
12 nation's servers more than doubled between 2000 and 2006. U.S. DOE indicated that
13 energy use for servers was forecasted to double again between 2006 and 2011. The U.S.
14 DOE expected consumption of more than 100 billion kWh/year in 2011 costing
15 approximately \$7.4 billion annually in electricity costs. The U.S. DOE indicated that
16 data center space can consume up to 100 to 200 times as much electricity per square foot
17 as standard office spaces. With such large power consumption, these customers are
18 prime targets for energy efficiency design measures that could reduce electricity use and
19 save money. This is a high-growth sector driven by increased reliance on cell phones,
20 digital data, and enhanced communications systems. Data center growth in the
21 government sector results from:

22 1. Publishing government information by use of the internet,

¹ "Report to Congress on Server and Data Center Energy Efficiency Public law 109-431, August 2, 2007"

- 1 2. Government regulations requiring digital records retention,
- 2 3. Enhanced disaster recovery requirements,
- 3 4. Emergency, health and safety services,
- 4 5. Information security and national security,
- 5 6. E-filing of taxes and USPS on-line tracking, and
- 6 7. High- performance scientific computing.

7 PPL has not proposed in their 2013-2016 programs a high priority, dedicated data center
8 program. These energy intensive data centers and server operations are prime
9 opportunities for energy efficiency.

10 **Q. Did the Pennsylvania State Wide Evaluator (SWE) market potential study include**
11 **an assessment of end use consumption by customers who operate data centers?**

12 A. The SWE market potential study assessed end use consumption for the non-residential
13 sector, which would include customers who operate data centers, but did not specifically
14 assess data centers. Table 7-3 of the Electric Energy Efficiency Potential For
15 Pennsylvania Final Report (May 10, 2013, page 73), includes a chart that indicates
16 economic potential by non-residential end use. End use economic potential breakouts are
17 shown as 11.7% HVAC, and 40.7 % for lighting. The SWE market potential study did
18 not specifically disaggregate the existing or projected energy use or savings potential for
19 data centers in Pennsylvania. Data centers use electricity directly for the operation of
20 servers, lighting, ventilation and cooling to operate sensitive electronic equipment within
21 a specific temperature range and humidity level which is required for reliable operation.
22 Given this analysis of energy efficiency potential by the SWE and the U.S. DOE
23 analyses, it appears highly likely that significant potential exists to enhance the energy

1 efficiency for the energy intensive data centers operating in PPL's service territory.

2 **Q. What are you suggesting PPL do regarding data center energy efficiency**
3 **opportunities?**

4 **A.** I realize that developing a comprehensive data center energy efficiency plan will take
5 time and effort. However, I believe since these programs will cover the 2013-2016
6 period, such a program should be developed and offered by PPL during this program
7 cycle. Given the high-growth nature of this customer segment I believe a comprehensive
8 data center program should be developed and offered to customers in the near future.
9 Exhibit GCC-3 is an example of a comprehensive data energy center program that is
10 being operated by an investor-owned utility in Colorado and Minnesota.

11 **Q. What is your recommendation regarding the data center program for this Plan**
12 **period?**

13 **A.** I recommend that the Commission direct PPL to work with the stakeholder group to
14 develop a data center program with a target date of starting a program by September
15 2013.

16

17 **ENERGY EFFICIENCY BEHAVIOR AND EDUCATION PROGRAM**

18 **Q. Please describe the Energy Efficiency and Education Programs for the Residential**
19 **and Low Income sectors.**

20 **A.** The Residential Energy Efficiency Behavior & Education program and the Low Income
21 Energy Efficiency Behavior & Education program both rely on report cards to customers

1 comparing their usage to other similar customers. The intent of these programs is to
2 motivate the recipients to compete with others in their cohort to reduce energy use.

3 These programs were developed by a contractor having a proprietary method and brand
4 which is also in use by a number of utilities throughout the U.S.

5 **Q. Are the behavior modification programs effective in reducing energy consumption?**

6 A. The results vary with jurisdiction and utility, but based on the reported savings estimates,
7 energy reductions in the range of 1% to 3% are being realized while the messaging is
8 taking place, i.e., during the time the customer is receiving the report card. One of the
9 concerns with these behavior programs has been the persistence of savings after the
10 messaging stops, i.e., beyond the report card period.

11 To increase persistence of savings, the energy saving behavior must be ingrained. The
12 longer that the customer receives report cards, the higher probability that the energy
13 saving behavior will be ingrained. According to its response to interrogatory OCA-17
14 (attached as Exhibit GCC-4), PPL assigns behavior programs a one-year life because the
15 program provider "has not presented any evidence that savings for this type of behavior
16 program persist for more than 1 year after the messaging stops."

17 PPL proposes to spend 5.1% of the residential budget and 7.8% of the low income
18 budget, a total of \$3.623 million, on the behavior programs (Table 5a). Even though PPL
19 estimates a B/C of 1.69 for residential and 0.92 for Low Income, PPL has not addressed
20 the persistence of savings issue.

21 **Q. How can the persistence of savings from behavior modification energy efficiency**
22 **programs be improved?**

1 A. Persistence can be improved by using the report cards to motivate customers and then
2 provide customers with tips on saving energy based on hardware improvements and links
3 to other of PPL's energy efficiency programs. If customers can be moved by the report
4 cards to install energy efficient hardware, the savings associated with that hardware
5 would be expected to persist beyond the one-year life that PPL currently projects.
6 According to the response to OCA-18 (attached as Exhibit GCC-4), the Company's
7 behavior programs encourage customers to participate in the Company's other energy
8 efficiency programs, some of which install efficient hardware.
9 I believe that persistence of savings is likely to improve if the messaging is continued
10 consistently over a long enough time for the behavior to become ingrained. This would
11 be especially true of behaviors involving lifestyle changes, such as taking shorter
12 showers, adjusting thermostats, turning out excess lights, etc. Lifestyle changes can be
13 easily undone if the customer loses interest, whereas energy efficient equipment and
14 hardware changes would be expected to persist.

15 **Q. What are your recommendations?**

16 A. The report cards build energy awareness in the recipients and comparisons of the
17 recipient's energy use to that of other customers is likely to provide motivation,
18 especially for the high energy users, to reduce their energy consumption. I recommend
19 that the Commission require that PPL's behavior modification programs provide easy and
20 straightforward links to PPL's other programs to install energy efficient hardware.
21 I also recommend that PPL operate the behavior modification program without
22 interruption between Phase I and Phase II and continuously over a long enough period to
23 allow the messaging to become ingrained.

1 **LOW INCOME PROGRAMS**

2 **Q. What is the TRC benefit/cost ratio for PPL's Low Income Programs?**

3 A. The overall TRC benefit/cost ratio is 0.71, according to PPL's calculations reported on
4 Table 7 (Plan, page 186).

5 **Q. In light of the benefit/cost ratio being less than 1.0, are you in favor of continuing
6 the Low Income Programs?**

7 A. Yes. Low income customers do not have the disposable income of other residential
8 customers. Thus, low income customers, even if they are aware of energy saving
9 opportunities, and even if they are aware that implementing those opportunities in the
10 long run would save them money, do not have the resources to pay the first costs needed
11 to purchase and install energy efficient equipment.

12 PPL recognizes this problem by ensuring that all customers participating in the Low
13 Income programs have no participant cost (Response to Interrogatory OCA-26, attached
14 as Exhibit GCC-5). This affords low income customers the opportunity to implement
15 cost saving energy efficiency measures.

16 In addition, because of differences in the way that costs are determined, the cost
17 effectiveness of the measures being installed for Low Income customers under the Low
18 Income WRAP program will be worse than the cost effectiveness of the same measure
19 installed under a general residential program. The reason is that PPL generally considers
20 measures such as heat pumps, heat pump water heaters and appliances to be replacement
21 at burnout, which for the general residential programs, means the TRC cost is the
22 incremental cost of the energy efficient device above the cost of the standard efficiency
23 device. In contrast, PPL bases the TRC calculation for all measures offered under the

1 Low Income WRAP program on the full measure cost (Response to Interrogatory OCA-
2 21, attached as Exhibit GCC-6). For the same device and the same savings, the TRC for
3 the Low Income program will be lower than the TRC for the general Residential
4 Program.

5 **Q. PPL projects that it will surpass the Commission's target that low income customers**
6 **achieve an energy reduction of 36,948 MWh/year² by May 31, 2016 (4.5% of PPL's**
7 **total energy savings target). Have you any concerns about the manner in which**
8 **PPL achieves its low income energy target?**

9 A. Yes. PPL's Low Income programs are projected to achieve only 22,091 MWh/year by
10 May 31, 2016, or 60% of the low income savings target. In addition, PPL is projecting
11 achieving 49,192 MWh/year by May 31, 2016 as a result of low income customers
12 participating in general residential programs. PPL estimates that the general residential
13 programs include low income participation that results in savings of 2,500 MWh/year
14 from the Appliance Recycling Program, 4,000 MWh/year from the Residential Home
15 Comfort Program, and 43,000 MWh/year from the Residential Retail Program. (See
16 interrogatory OCA-23, attached as Exhibit GCC-7)

17 **Q. Why are you concerned that the contribution from low income participation in**
18 **general residential programs plays such a dominant role in achieving the low**
19 **income target?**

² PPL reports its energy reduction targets and projected energy targets as "MWh/year." It has come to my attention that other Pennsylvania utilities are reporting their targets and projected reductions as "MWh." Although labeled differently, PPL seems to be reporting the same information as the other utilities in compliance with the Implementation Order. The Implementation Order requires PPL to achieve a 2.1% reduction from the 12-month baseline forecast period June 1, 2009 through May 31, 2010 (page 23). The Implementation Order requires the cumulative effect of the Phase II programs to achieve an 821,072 MWh reduction to the 12 month forecast by the end of the Phase II period (page 24). Thus, PPL is reporting the projected energy reductions for the last year in the Phase II Plan period resulting from all of the energy efficiency measures installed and actions taken during the three-year Phase II period, consistent with the Implementation Order and the other utilities.

1 A. I believe that the Low Income Programs were carved out in recognition of the difficult
2 problems facing low income customers. It would follow that the targets were intended to
3 get more low income customers in low income programs – otherwise you would have
4 neither the targets, nor the low income programs. My concern is that PPL projects that it
5 is able to meet the low income targets without any reliance on the low income programs.
6 If it is that easy for PPL to meet the low income target, it could and should be doing more
7 to address low income customer needs.
8 In addition, participating in the general residential programs when Low Income Programs
9 offer the same energy efficiency measures is not likely to be in the best interests of the
10 low income customers.

11 **Q. Why would it not be in the best interests of low income customers to reduce their**
12 **energy consumption through general residential energy efficiency programs?**

13 A. By participating in the general residential programs, low income customers will pay more
14 than if they reduced consumption through the Low Income Programs. They will pay
15 more because PPL's income-qualified programs have no participant cost, while the
16 standard residential programs provide incentives covering part of the cost. The question
17 is why low income customers would choose to participate in a standard residential
18 program in which they paid part of the energy efficiency measure cost as opposed to a
19 Low Income Program at no measure cost.

20 Some qualified low income customers choose not to participate. PPL suggested that
21 some of these customers do not consider themselves to be low income even though they
22 met the requirements (interrogatory OCA-26, attached as GCC-5). It is also possible that
23 they do not participate because they don't know the Low Income Program exists or

1 because they perceive a stigma associated with the phrase “low income.” Removal of
2 those barriers (by more marketing and by informing all participants in the general
3 residential programs that the low income programs exist, as well as calling them
4 “income-qualified” or something other than “low income”) may improve the participation
5 levels in the Low Income Programs.

6 **Q. What are your recommendations?**

7 A. First, the Company should recognize that it is better for the low income customers to
8 participate in Low Income Programs rather than general residential programs.

9 Second, PPL should increase the participation of low income customers in its Low
10 Income Programs. PPL’s EE&C Plan currently projects that only 31% of the energy
11 reductions by low income customers result from their participation in PPL’s Low Income
12 Programs (PPL’s Low Income Programs contribute 22,091 MWh/year out of 71,283
13 MWh/year counted toward PPL’s low income target).

14
15 **LOW INCOME MASTER METERED MULTI-FAMILY HOUSING**

16 **Q. Did PPL credit the energy reductions from master metered low income multi-family**
17 **housing under the government/non-profit (GNI) sector programs?**

18 A. Yes. In response to interrogatory OCA-23 (Exhibit GCC-7), PPL stated the savings from
19 the low-income multi-family master metered program offered as one of the GNI
20 programs were counted as part of the GNI sector savings, rather than being counted in the
21 low income savings to meet the Low Income target. I find this an appropriate treatment
22 of these savings.

1 The GNI sector is composed of government/education/nonprofit customers served under
2 Small C&I or Large C&I rates. The owner of the master metered low income multi-
3 family housing is the account holder, pays the rates, including the cost of energy
4 efficiency programs and the EE&C Plan applicable to the C&I rates. The low income
5 customer in a master metered housing unit is not individually responsible for the utility
6 bill. It is appropriate that the C&I sector and the GNI sector target get credited with the
7 energy savings, since the costs of the master metered low income multi-family program
8 are paid by that sector.

9 **Q. What is your opinion of PPL's proposed master metered low income multi-family**
10 **program?**

11 A. The proposed master metered Low-Income Multifamily Housing Program appears to be
12 well-designed. It would use a turnkey CSP that has the experience and background to
13 implement, track and suggest adjustments to the program depending on how these new
14 services are received by PPL's customers. It is designed to rely heavily on walk-through
15 audits coupled with recommending and persuading customers (of account) to install and
16 employ a comprehensive set of highly energy efficient measures. Recycling and
17 replacement of inefficient refrigerators is a major program element that is expected to
18 produce savings, according to PPL. Table S3 on page 141 of the plan, lists a multitude of
19 program measures that are eligible for qualifying customers.

20 **Q. Do you have any concerns about PPL's proposed master metered low income multi-**
21 **family program?**

22 A. Yes. PPL should include additional LED lighting in this measure list. Other than the
23 LED exit sign, LED lighting does not appear to be an eligible measure in this program.

1 New, highly efficient LED lighting technology (interior and exterior) should be included
2 as eligible measures in this program.

3 PPL should also further define its implementation strategy for its master metered Low-
4 Income Multifamily Housing Program. On page 138 of its Plan, PPL indicates that it
5 intends to educate building owners as well as tenants regarding energy efficiency. The
6 problem of split incentives between property owners/managers and tenants is an age-old
7 problem. Much, if not all of the description of this program states how PPL will be
8 working with property owners to provide the audit, encouraging them to acquire energy
9 efficient hardware, cross promoting these efforts with other PPL programs and services,
10 etc. What is lacking is an explanation and description of how PPL and its CSP intend to
11 “educate building owners and tenants on energy efficiency.” PPL has failed to
12 demonstrate what information and educational techniques, approaches and strategies it
13 will employ to educate building owners and tenants. This is particularly complex,
14 difficult and important with respect to how PPL intends to educate, encourage and
15 motivate tenants who reside in master metered premises. The Commission should ensure
16 that PPL provides a sufficient explanation of this important issue.

17 **Q. What are your recommendations regarding PPL’s proposed master metered low**
18 **income multi-family program?**

19 **A.** I recommend that the Commission direct PPL to include LED lighting among the
20 measures covered by this program.

21 I also recommend that the Commission require PPL to provide an explanation of the
22 information and educational techniques, approaches and strategies it will employ to
23 educate building owners and tenants.

1 **INCENTIVES FOR EFFICIENT LIGHTING**

2 **Q. Do you have any specific suggestions for improvement regarding the proposed**
3 **measures or other aspects of the proposed programs?**

4 **A.** I am concerned about the proposed inclusion of several measures in PPL's plan. PPL is
5 proposing to offer rebates on standard T-8 lamps and fixtures. Since standard T-8
6 technology is expected to replace the outdated T-12 lamps and fixtures, a rebate should
7 not be available for the standard efficiency T-8 technology, but instead should be applied
8 to the high performance T-8 and T-5 technologies. In my experience working in the
9 Illinois Collaborative for the past several years, I am aware that the Commonwealth
10 Edison lighting program promotes energy efficiency improvement typically by requiring
11 T-8 lamps to be either high performance or reduced wattage in order to qualify for their
12 incentives. In terms of providing rebates on bulbs, PPL should encourage customers to
13 purchase the most efficient bulbs available.

14 It is not clear to me if PPL will provide an incentive for Energy Independence and
15 Security Act (EISA) compliant incandescent lighting (e.g., the 72 Watt halogena bulbs to
16 replace standard 100 Watt incandescent bulbs) in conjunction with its prescriptive or
17 custom rebate programs. While EISA compliant incandescent bulbs are expected to be
18 readily available during the 2013-2016 plan period these bulbs are far less efficient than
19 the CFL and LED bulbs that are readily available on the market. While customers may
20 choose those bulbs, providing rebates would encourage them to make the less efficient
21 choice. PPL should not provide an incentive for these minimally EISA compliant
22 incandescent bulbs as part of this Plan.

1 **Q. What is your recommendation?**

2 **A.** I recommend that the Commission should allow PPL to provide incentives on lighting
3 technologies as identified in the EE&C Plan, with the caveat that no incentives should be
4 provided for standard T-8 systems or EISA compliant incandescent bulbs.

5

6 **ENERGY EFFICIENCY KITS**

7 **Q. Do you have an opinion regarding the energy efficiency kits that have been**
8 **proposed by PPL in the plan?**

9 **A.** Yes. The problem of installation rates for the measures included in the kits that the SWE
10 pointed out for Phase I activities has not been addressed in this filing. If the kits are
11 authorized and provided to customers without heightened efforts to improve the
12 realization rates, and the installation rates were low, this program element would be a
13 questionable use of ratepayer funds.

14 **Q. What is your recommendation regarding the energy kits for this Plan period?**

15 **A.** I recommend that the Commission direct PPL to work with the stakeholder group to
16 improve the realization rate of the energy efficiency kits. The kits are appropriate, but
17 are of no value if they are not installed.

18

19

20

1 **HEAT PUMP WATER HEATERS**

2 **Q. Does PPL's proposed EE&C Plan include heat pump water heaters for its**
3 **residential customers?**

4 A. Yes. The proposed plan includes the heat pump water heater measure in its Residential
5 Retail Program (Plan, page 45, Table E3A) and Low-Income WRAP Program (Plan, page
6 72). For the Residential Retail Program the proposed incentive is approximately \$200-
7 \$300 per energy star rated unit. In the WRAP program, PPL proposes that the program
8 cover the full cost of the measure. According to information PPL provided in response to
9 interrogatory OCA-4 (see Exhibit GCC-8), the full cost of the heat pump water heater is
10 \$1,570 per unit. (See OCA-4, part a, Exhibit 2 "LI WRAP TRC by Appliance.xls")

11 **Q. Does the cost of the heat pump water heater concern you?**

12 A. Yes. Including such a capital-intensive measure drives up the first year cost of saved
13 energy per kWh very considerably. On page 27 of the plan Table 5a, the cost of saved
14 energy per kWh is generally in the range of \$.04 to \$.52 per first year saved kWh. The
15 exception to this is the Low-Income WRAP program, which has a cost per first year
16 saved kWh of \$1.39. The high first cost of the heat pump water heater contributes to this
17 huge discrepancy. This raises a serious question as to whether heat pump water heaters
18 should be offered in all circumstances. In particular, where natural gas is available and
19 the customer has other natural gas appliances in the home, I would question the use of
20 heat pump water heaters.

1 **Q. Does PPL propose to encourage customers to switch to natural gas if doing so would**
2 **be less expensive for the customer and/or PPL?**

3 A. No. PPL responded in OCA-4 (d) that “PPL Electric believes it is more appropriate for a
4 customer, not PPL Electric, to decide whether to heat their home, heat their water, cook,
5 or dry their clothes with gas, electric, oil, propane or other energy sources.” While this
6 statement may be reasonable for non low-income customers, low income customers do
7 not have the discretionary income to spend \$1,575 on a heat pump water heater or \$500
8 on a gas unit. An offer by PPL to pay the entire cost of the heat pump water heater for
9 low income customers will be most favorably viewed by the participating customer,
10 virtually ensuring that the heat pump water heater will be installed even if the lifetime
11 operating costs (which would be paid by the low income customer) of the heat pump
12 water heater were higher.

13 In the instance of housing that currently has natural gas service in the residence, the
14 bigger policy question is “What is in the best long term interest of the customer?” In
15 cases where low-income customers do not have reasonable access to natural gas or other
16 fuels, including a heat pump water heater will clearly save energy compared to the typical
17 electric resistance water heater. To include this measure as a no-cost option for qualified
18 low-income customers (who have gas service) would allow PPL, for all intents and
19 purposes, to decide for the customer how the water would be heated in their home, due to
20 high first cost hurdle and a low-income customer’s lack of access to capital. This would
21 allow PPL to retain water heating load at the low-income customer’s home, even if it
22 results in higher operating costs compared to natural gas to the customer who is already

1 strapped for lack of income. While a heat pump water heater saves low income
2 customers money for operating the water heater relative to a standard electric resistance
3 water heater, it would be expected to cost them more than it would to operate an efficient
4 natural gas water heater. PPL indicated that it did not consider fuel switching and did not
5 perform an analysis of the cost effectiveness of high efficiency natural gas water heaters
6 instead of heat pump water heaters (see Exhibit GCC-8).

7 **Q. What is your recommendation regarding heat pump water heaters?**

8 A. I recommend that the Commission modify PPL's proposed EE&C Plan to remove electric
9 heat pump water heaters from the eligible measures available in the Low Income WRAP
10 program for qualified customers residing in housing that already has natural gas service.

11
12 **INEQUITABLE ALLOCATION OF PROGRAM COSTS**

13 **Q. As described in PPL's EE&C Plan, does PPL's proposed allocation of energy**
14 **efficiency program costs result in cross subsidies between the major customer**
15 **classes?**

16 A. Yes. The costs of the Residential Retail and Residential Appliance Recycling programs
17 are directly allocated to and will be recovered from the residential sector, but these
18 programs are open to all customer sectors. Thus customers in other sectors will benefit
19 from these Phase II programs, but will initially bear none of the program costs recovered
20 during Phase II.

21 Table 5a on page 27 of PPL's EE&C Plan shows the entire \$5,763,000 cost of the
22 Appliance Recycling Program is allocated to the residential sector. Table D1 on page 35

1 of PPL's EE&C Plan shows that the Appliance Recycling Program is available to all
2 customer sectors.

3 Table 5a also shows the entire \$25,755,000 cost of the Residential Retail Program is
4 allocated to the residential sector. Table E1 on page 41 of PPL's EE&C Plan shows that
5 the Residential Retail Program is available to all customer sectors.

6 **Q. Are there any other programs as described in PPL's EE&C Plan which are**
7 **available to residential and non-residential sectors?**

8 A. Yes. Table C on page 31 of the EE&C Plan indicates a Prescriptive Equipment –
9 Residential program that is also available to the Small C&I sector and a Prescriptive
10 Equipment – Small C&I program that is also available to the Residential sector. In fact,
11 these are the same Prescriptive Equipment program. As described on page 67 of the
12 EE&C Plan, there are measures in the Small C&I program that are available to farms
13 served on the C&I rates. Some farms in PPL's service territory are served under the
14 residential rate class, and PPL has offered the same measures to farms under residential
15 rates as they have to farms under C&I rates. The Plan's description of the Prescriptive
16 Equipment – Residential program in fact directs the reader to the Prescriptive Equipment
17 - Small C&I program.

18 According to Table 5a on page 27 of PPL's EE&C Plan, the cost of the Prescriptive
19 Equipment Incentive Program allocates \$208,000 to the residential sector and
20 \$43,820,500 to the Small C&I sector (\$34,418,000 plus one half of the \$18,805,000
21 Government/Non-Profit cost for the Prescriptive Equipment Program).

22 **Q. As proposed, does the Prescriptive Equipment Program result in unreasonable cross**
23 **subsidies to the Residential Sector?**

1 A. No. To the extent that residential customers are expected to participate in the Small C&I
2 Prescriptive Equipment Program, the costs of serving residential customers in the Small
3 C&I Prescriptive Equipment Program are allocated to and will be recovered from the
4 Residential sector.

5 **Q. As described in PPL's EE&C Plan, is the cost allocation of Residential programs**
6 **available to other customer sectors treated the same way as the cost allocation of**
7 **Small C&I programs available to the Residential sector?**

8 A. No. Under PPL's Phase II cost recovery as proposed in the EE&C Plan, the costs of
9 Residential programs available to the Small C&I and other sectors are recovered solely
10 from the Residential sector during the Phase II period while the cost of the Phase II Small
11 C&I Prescriptive Equipment Program, which is available to a small segment of the
12 Residential sector (farms), is allocated between the Residential and Small C&I sectors.

13 **Q. Did you attempt to clarify the cross subsidy in the proposed cost allocations with**
14 **PPL?**

15 A. Yes. I submitted interrogatories OCA-6 through OCA-9 to PPL requesting information
16 regarding the allocation of costs of programs available to multiple customer sectors.
17 Copies of PPL's responses to these interrogatories are contained in Exhibit GCC-9.
18 PPL stated that the "participation [in the Residential Programs] by non-residential
19 customers is expected to be very small so the EE&C Plan estimates that all costs will be
20 associated with the residential class." PPL goes on to say that the actual costs in Phase I
21 of non-residential customers participating in Residential Retail and Appliance Recycling
22 programs were less than 1% of the programs' costs.

1 **Q. Does the assumption that the participation by non-residential customers will be very**
2 **small, less than 1% of the costs, justify not allocating those costs to the non-**
3 **residential sectors responsible for those costs as proposed by PPL?**

4 A. No. Actual experience in Phase I indicates the participation of non-residential customers
5 in the residential programs is less than 1% of the residential program cost. PPL chose to
6 allocate all of these costs to the residential sector in the EE&C Plan due to the low
7 participation levels. Yet PPL chose to allocate costs to the residential sector for
8 residential customers (farm) choosing to participate in the Small C&I Prescriptive
9 Equipment Program, although the cost allocation to residential customers was less than
10 0.5%.

11 **Q. In Exhibit GCC-9, PPL states that the actual costs and savings will be assigned to**
12 **the non-residential rate class that actually participates in the Appliance Recycling**
13 **and Residential Retail programs, and that any difference between the actual and**
14 **planned costs will be reconciled at the conclusion of Phase II. Does that resolve your**
15 **concerns about the residential customers subsidizing non-residential customers who**
16 **participate in residential energy efficiency programs?**

17 A. No. First, I could find no reference in PPL's EE&C Plan or testimony that commits them
18 to reconciling and reversing the cross subsidies. PPL indicates (Plan, page 179) that at
19 the end of the three-year plan it "will reconcile total revenue collected to its total budget
20 for the three-year Plan," but this does not address reconciling and reversing cross
21 subsidies. The Commission's approval of the EE&C Plan would approve the proposed
22 cost allocation, including the residential sector subsidies of the other customer sectors
23 that are eligible to participate in the residential programs.

1 Second, even if the reconciliation approach PPL described in its response in Exhibit
2 GCC-9 was implemented, it would not be performed until the conclusion of Phase II.
3 Residential ratepayers would be subsidizing non-residential customers for more than
4 three years before the actual costs were determined and the rates were adjusted.

5 **Q. What are your recommendations?**

6 A. I recommend that PPL allocate 1% of the cost of the Appliance Recycling and
7 Residential Retail Programs to the Small C&I sector, or \$57,600 and \$257,600,
8 respectively. This allocates planned costs consistently with the expectations for
9 participation of non-residential customers in residential programs. It also brings it into
10 alignment with PPL's treatment of residential customers participating in the Small C&I
11 Prescriptive Equipment Program in that both Residential and Small C&I customers
12 would be allocated costs in proportion to their expected participation.

13 I also recommend that the Commission incorporate PPL's reconciliation process as
14 described in Exhibit GCC-9 into the formal approval of PPL's EE&C Plan. The
15 reconciliation process is important to removing residual subsidies, but is currently not
16 included in PPL's EE&C Plan.

17
18
19 **CALCULATION OF ACR RATES**

20 **Q. Has PPL provided the ACR rates it proposes to charge to recover costs of**
21 **implementing the energy efficiency programs in the EE&C Plan?**

22 A. No. PPL provided its proposed Act 129 Compliance Rider in Appendix G to the EE&C
23 Plan. However, Appendix G presented only the formula for computing the ACR, and not

1 the ACR rates for the Residential, Small C&I and Large C&I sectors. PPL should
2 present for Commission consideration the ACR rates that it proposes to charge.

3 **Q. Did PPL's EE&C Plan contain its expected costs for implementing the EE&C Plan**
4 **allocated by customer sector?**

5 A. Yes. The total of all estimated EDC portfolio costs are summarized by customer sector in
6 Table 6C (Plan, page 176). The customer sectors are Residential (including Low
7 Income), Small C&I, Large C&I, and Governmental/Educational/Non-profit. Since there
8 is no Governmental/Educational/Non-profit rate class, PPL estimates that the
9 Governmental/Educational/Non-profit costs are split equally between the Small C&I and
10 Large C&I rate classes (interrogatory OCA-12 attached as Exhibit GCC-10). With the
11 adjustment to split the Governmental/Educational/Non-profit costs, Table 6C indicates
12 the following allocations:

	Residential (Inc. Low Income)	Small C&I	Large C&I	Total
PPL Proposed	76,541,597	57,646,764	52,539,296	186,727,658
OCA Adjusted	76,226,397	57,961,964	52,539,296	186,727,658

13
14 **Q. How would these costs be used in the determining the ACR rates?**

15 A. The costs in Table 6C are three-year Phase II costs. I would first move \$315,200 from
16 the Residential to the Small C&I classes to adjust for the cross subsidies involving the
17 Residential Retail and Appliance Recycling programs that I addressed earlier in my
18 testimony. The adjusted costs would be divided by three to yield the annual cost. The
19 Residential and Small C&I annual costs would be divided by the projected class annual

1 retail energy sales to determine the ACR rates. The Large C&I costs would be divided
2 by the projected annual total monthly billing demands projected for the Large C&I class.
3 PPL did not provide the projected retail energy sales for the Residential and Small C&I
4 classes or the projected annual total monthly billing demands for the Large C&I class.

5 **Q. What is included in the costs shown in Table 6 and above?**

6 A. The costs include all customer incentives, PPL labor, materials and supplies, CSP labor
7 materials and supplies, and all common costs. Common costs include EE&C Plan
8 development, program evaluation, measurement and verification, quality
9 assurance/quality control and technical support, advertising and marketing, tracking
10 system, general and Plan management, market research and major C&I accounts.

11 **Q. Are all of the costs subject to the EE&C budget cap?**

12 A. No. The budget cap set by the Commission is \$184.5 million for the three-year Phase II
13 period. The Table 6C costs include \$3 million for the Statewide Evaluation (SWE)
14 which is not subject to the cap. Excluding the SWE costs, PPL's proposed budget is
15 \$183.7 million, which approaches, but is less than PPL's budget cap.

16 **Q. Are PPL's projected costs reasonable?**

17 A. They appear to be, with the adjustment that I have recommended. It is appropriate to
18 utilize the full amount of revenue under the budget cap in order to maximize the amount
19 of cost-effective energy efficiency.

20 **Q. What are your recommendations?**

21 A. I recommend that the Commission direct PPL to provide the Commission with the
22 proposed ACR rates, as well as the projected kWh retail energy sales for the Residential

1 and Small C&I classes and the projected annual total monthly billing demands (kW) for
2 the Large C&I class.

3
4 **SUMMARY RECOMMENDATIONS**

5 **Q. Could you please summarize your recommendations?**

6 **A.** Yes. I recommend that:

- 7 1. The Commission direct PPL to continue a robust stakeholder collaborative following
8 the guidelines I described in this testimony.
- 9 2. The Commission direct PPL to work with the stakeholder group to develop a data
10 center program with a target date of starting a program by September 2013.
- 11 3. The Commission require that PPL's behavior modification programs provide easy
12 and straightforward links to PPL's other programs to install energy efficient
13 hardware.
- 14 4. PPL operate the behavior modification program without interruption between Phase I
15 and Phase II and continuously over a long enough period to allow the messaging to
16 become ingrained.
- 17 5. PPL increase the participation of low income customers in its Low Income Programs.
- 18 6. The Commission direct PPL to include LED lighting among the measures covered by
19 master metered low income multi-family program.
- 20 7. The Commission require PPL to provide an explanation of the information and
21 educational techniques, approaches and strategies it will employ to educate building
22 owners and tenants regarding the master metered low income multi-family program..

- 1 8. The Commission allow PPL to provide incentives on lighting technologies as
2 identified in the EE&C Plan, with the caveat that no incentives should be provided for
3 standard T-8 systems or EISA compliant incandescent bulbs.
- 4 9. The Commission direct PPL to work with the stakeholder group to improve the
5 realization rate of the energy efficiency kits.
- 6 10. The Commission modify PPL's proposed EE&C Plan to remove electric heat pump
7 water heaters from the eligible measures available in the Low Income WRAP
8 program for qualified customers residing in housing that already has natural gas
9 service.
- 10 11. PPL allocate 1% of the cost of the Appliance Recycling and Residential Retail
11 Programs to the Small C&I sector, or \$57,600 and \$257,600, respectively.
- 12 12. The Commission incorporate PPL's reconciliation process as described in Exhibit
13 GCC-9 into the formal approval of PPL's EE&C Plan.
- 14 13. The Commission direct PPL to provide the Commission with the proposed ACR
15 rates, as well as the projected kWh retail energy sales for the Residential and Small
16 C&I classes and the projected annual total monthly billing demands (kW) for the
17 Large C&I class.

18 **Q. Does this complete your testimony?**

19 **A. Yes.**

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BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Petition of PPL Electric Utilities :
Corporation for Approval of an Energy : Docket No. M-2012-2334388
Efficiency and Conservation Plan :

EXHIBITS

OF

GEOFFREY C CRANDALL

ON BEHALF OF

THE OFFICE OF CONSUMER ADVOCATE

December 28, 2012

Geoffrey C. Crandall

Vice President and Principal

EDUCATION

B.S. in Business and Pre-Law, Western Michigan University, 1974.

Mr. Crandall has also completed courses at Michigan State University Graduate School, the University of Wisconsin-Madison and Wayne State University, in areas of federal taxation, accounting, management and the economics of utility regulation. Mr. Crandall also completed the examination for the National Conference of States on Building Codes and Standards Energy Auditor.

EXPERIENCE

Mr. Crandall joined MSB in January 1990. He specializes in residential and low-income issues, the impact of energy efficiency and utility restructuring on customers. Mr. Crandall has addressed issues related to energy efficiency and residential customers and utility restructuring in California, New York, Colorado, Iowa, and Michigan. He has analyzed and/or designed energy efficiency programs for residential customers in Michigan, Georgia, Wisconsin, Arizona, and New Orleans, and has conducted workshops on low-income restructuring and energy efficiency issues in over 20 states, including Washington, Hawaii, Nevada, Kansas, Michigan, Rhode Island, California, Virginia, and New Orleans. In the energy efficiency area, Mr. Crandall has analyzed and proposed modifications to utility demand-side programs in the states of Arizona, Georgia, Hawaii, Illinois, Maine, Michigan, Minnesota, North Carolina, Ohio, Pennsylvania, Utah, Washington State, California, Iowa, Montana, Colorado, Missouri, Virginia, Wisconsin, and Washington D.C.

Prior to joining MSB, Mr. Crandall was employed by the Michigan Public Service Commission from 1974 through 1989, where he served as the Director of the Demand-Side Management Division. He was responsible for the development, implementation and monitoring of government- and utility-sponsored demand-side management, energy-efficiency and conservation policies and programs. These activities

involved customers in the residential, commercial, industrial and institutional sectors. He was responsible for both pilot and full-scale programs, and conducted demand-side program design and implementation. Mr. Crandall is familiar with marketing strategies, segmentation and market-penetration analyses, as well as the implementation of successful demand-side programs.

Mr. Crandall has dealt with a wide variety of regulatory issues beyond energy conservation, including utility diversification, non-traditional regulatory concepts, incentive regulation, utility billing practices, utility power plant maintenance and management of plant outages.

Mr. Crandall served as Chair of the NARUC Energy Conservation Staff Subcommittee from 1986-1989. He has lectured and made presentations to many groups on demand-side programs and least-cost planning, including two NARUC-sponsored least-cost planning conferences; the 1990 NARUC Regional Workshops on Least-Cost Utility Planning in Newport, Rhode Island and Little Rock, Arkansas; the Wisconsin Public Service Commission's Integrated Resource Planning Workshop; the 1988, 1989, and 1990 Michigan State University Graduate School of Public Utilities and the U.S. Department of Energy.

Mr. Crandall has testified before the: United States Congress, Michigan Legislature, Michigan Public Service Commission, North Carolina Utilities Commission, Public Service Commission of the District of Columbia, Illinois Commerce Commission, Maine Public Utilities Commission, Massachusetts Department of Public Utilities, Public Service Commission of Hawaii, Minnesota Public Service Commission, Iowa Public Service Commission, Georgia Public Service Commission, Public Utility Commission of Ohio, Virginia Public Service Commission, Wisconsin Public Service Commission, and the City Council of the City of New Orleans, Louisiana.

Mr. Crandall has written several articles published in the Public Utilities Fortnightly and Electricity Journal, Natural Gas Magazine, and a number of proceedings for the Biennial Regulatory Information Conference and the American Council for an Energy-Efficient Economy.

TESTIMONY

Case No. U-5531, (8/77), Consumers' Power Company electric rate increase application. Mr. Crandall served as the Staff Witness and recommended that the Applicant initiate the Residential Electric Customers' Information program.

Case No. U-6743, (3/81), Michigan Consolidated Gas Company. Mr. Crandall served as the Staff policy witness and recommended that the Commission approve a surcharge to cover all reasonable and prudent costs associated with Applicant's implementation of the Michigan Residential Conservation Services Program.

Case No. U-6819, (6/81), Michigan Power Company-Gas. Mr. Crandall served as the Staff policy witness and described the basis for the program and the expected level of activity, recommending that the Commission approve a surcharge to cover all reasonable and prudent costs associated with Applicant's implementation of the Michigan Residential Conservation Service Program.

Case No. U-6787, (6/81), Michigan Gas Utilities Company. Served as the Staff policy witness and described the basis for the program and the expected level of activity, recommending that the Commission approve a surcharge to cover all reasonable and prudent costs associated with the implementation of the Michigan Residential Conservation Service Program.

Case No. U-6820, (6/81), Michigan Power Company-Electric. Served as the Staff policy witness and reviewed the Applicant's request to operate the Michigan Residential Conservation Service Program. Although not mandated by federal law, Applicant chose to operate the program in conjunction with its other services offered to residential gas customers. Recommended the establishment of a surcharge to cover all reasonable and prudent costs associated with the operation of that program.

Case No. U-5451-R, (10/82), Michigan Consolidated Gas Company. Served as the Staff policy witness and described the Staff's position regarding Applicant's proposed adjustment of surcharge level. Recommended that the eligibility criteria for customers be adjusted to more accurately reflect proper fuel consumption and to include customers who would be likely to realize a seven-year return on their investment by installing flue-modification devices in conjunction with Applicant's financing program.

Case No. U-6743-R, (10/82), Michigan Consolidated Gas Company. Served as the Staff policy witness regarding the Applicant's proposed expenses and revenues, as well as the reasonableness of activity and expense levels in the company's projected period.

Case No. U-7341, (12/84), Detroit Edison Company, Request for Authority for Certain Non-Utility Business Activities. Represented the Staff's position during settlement discussions and sponsored the settlement agreement.

Case No. U-6787-R, (3/84), Michigan Gas Utilities Company. Served as the Staff witness regarding the Applicant's proposed expenses and revenues. This also included a review of the company's future expenses associated with the Energy Assurance Program, the Specialized Unemployed Energy Analyses, and the Michigan Business Energy Efficiency Program expenses.

Case No. U-8528, (3/87), Commission's Own Motion on the Costs, Benefits, Goals and Objectives of Michigan's Utility Conservation Programs. Represented the Staff on the costs and savings of conservation programs and the other benefits of existing programs, and described alternative actions available to the Commission relative to future energy-conservation programs and services and other conservation policy matters.

Case No. U-8871, et al., (4/88), Midland Cogeneration Venture Limited Partnership. For approval of capacity charges contained in a power-purchase agreement with Consumers' Power Company. Served as the Staff witness on Michigan conservation potential and reasonably achievable programs that could be operated by Consumers' Power Company, and testified to the potential impact of these conservation programs on the Company's request for use of its converted nuclear plant cogeneration project. Also recommended levels of demand-side management potential for the commercial, industrial and institutional sectors in Consumers' Power service territory.

Case No. U-9172, (1/89), Consumers' Power Company, Power-Supply Cost-Recovery Plan and Authorization of Monthly Power-Supply Cost-Recovery Factors for 1989. Served as Staff witness on the conservation potential and reasonably achievable programs that could be operated by Consumers' Power Company. Testified to the potential impact of these conservation programs on the Company's fuel and purchase practices, its five-year forecast and the fuel factor. Recommended levels of demand-side management potential for the commercial, industrial and institutional sectors in Consumers' Power service territory as an offset to its more-expensive outside and internally generated power. Suggested that CPCO vigorously pursue conservation, demand-side management research, and planning and program implementation.

Case No. U-9263, (4/89), Consumers' Power Company Request to Amend its Gas Rate Schedule to Modify its Rule on Central Metering. Served as a Staff witness on the conservation effect of converting from individual metered apartments to a master meter. Suggested that the Commission continue its moratorium on the master meters, due to the adverse energy-conservation and efficiency impact.

Case No. E-100, (1/90), North Carolina Public Service Commission proceeding on review of the Duke Power Company's least-cost utility plan. Testified on behalf of the North Carolina Consumers' Council regarding utility energy-efficiency and demand-side management programs and the concept of profitability and implementation of demand-side management programs.

Case No. 889, (1/90), Public Service Commission of the District of Columbia. Testified on behalf of the Government of the District of Columbia in the Potomac Electric Power Company's application for an increase in its retail rates (general rate case). Sponsored testimony regarding the design and implementation and overall appropriateness of PEPCO's existing and proposed energy-efficiency and conservation programs.

Case No. 889, (4/90), Public Service Commission of the District of Columbia. Provided supplemental direct testimony and testified on behalf of the Government of the District of Columbia in the Potomac Electric Power Company's application for an increase in its retail rates (general rate case). Offered supplemental testimony regarding a more detailed review of PEPCO's existing pilot and full-scale energy-efficiency and conservation programs. Offered suggestions and recommendations for a future direction for PEPCO to pursue in order to implement more cost-effective and higher-impact energy-efficiency and conservation programs.

Case No. ICC Docket 90-004 and 90-0041, (6/90), Illinois Commerce Commission proceeding to adopt an electric-energy plan for Central Illinois Light Company (CILCO). Testified on behalf of the State of Illinois, Office of Public Counsel and the Small-Business Utility Advocate. Reviewed the CILCO electric least-cost plan filing and the conservation and load-management programs proposed in its filing. Sponsored testimony regarding my analysis of the proposed programs, and offered alternative programs for the Company's and the Commission's consideration.

Case No. D.P.U. 90-55, (6/90), Commonwealth of Massachusetts Department of Public Utilities. Testified on behalf of the Commonwealth of Massachusetts, Division of Energy Resources. Reviewed and analyzed Boston Gas' proposed energy-conservation programs that were submitted for pre-approval in its main rate case. In addition, suggested that it might consider implementation of other natural-gas

energy- efficiency programs, and not award an economic incentive for energy-efficiency and conservation programs until minimum program-implementation standards are satisfied.

Case No. U-9346, (6/90), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency Association. Reviewed and analyzed the Consumers' Power Company rate-case filing related to energy-efficiency and demand-side management programs. Proposed alternative energy-efficiency programs and recommended program budgets and a cost-recovery mechanism.

Case No. 89-193; 89-194; 89-195; and 90-001, (6/90), Maine Public Utilities Commission. Testified on behalf of the Maine Public Advocate's Office. Reviewed the appropriateness of Bangor Hydro-Electric Company's existing energy-efficiency and demand-side management programs in the context of BHE's main rate case and request for approval to construct the Basin Mills Hydro-Electric dam. Reviewed the overall resource plan and suggested alternative programs to strengthen the energy-efficiency and demand-side management resource efforts.

Case No. 6617, (4/91), Hawaii Public Utility Commission. Testified on behalf of the Hawaii Division of Consumer Advocacy. Described what demand-side management resources are, why they should be included in the integrated resource planning process, and proposed the implementation of several pilot projects in Hawaii along with guidelines for the pilot programs.

Case No. E002/GR-91-001, (5/91), Minnesota Public Utilities Commission. Testified on behalf of Minnesotans for an Energy Efficient Economy. Assessed the DSM programs being operated or proposed by Northern States Power Company and made recommendations as to ways in which NSP could improve its DSM efforts.

Case No. 905, (6/91), Public Service Commission of the District of Columbia. Testified on behalf of the District of Columbia Energy Office. Responded to the energy-efficiency and load management aspects of Potomac Electric Company's filing and made several recommendations for DC-PSC action.

Case No. 6690-UR-106, (9/91), Public Service Commission of Wisconsin. Testified on behalf of The Citizens' Utility Board of Wisconsin. Assessed the DSM programs being operated or proposed by the Wisconsin Public Service Corporation, made recommendations as to the WPSCO energy efficiency programs, and suggested ways the company could improve its DSM efforts.

Case No. E002/CN-91-19, (12/91), Minnesota Public Utilities Commission. Testified on behalf of Minnesota Department of Public Service. Assessed the DSM potential and programs being operated or proposed by Northern States Power Company and made recommendations as to the potential for energy efficiency in the NSP service territory and ways in which NSP could improve its DSM efforts.

Case No. 912, (4/92), Public Service Commission of the District of Columbia. Testified on behalf of the Government of the District of Columbia in the Potomac Electric Power Company's application for an increase in its retail rates for the sale of electric energy. Testified regarding the reasonableness of DSM and EUM policy changes, the cost allocation of the DSM and EUM expenses, an examination of the prudence of management regarding the energy-efficiency programs, and an examination of the appropriateness of the costs associated with energy-efficiency programs.

Case No. PUE 910050, (5/92), Virginia State Corporation Commission. Testified on behalf of the Citizens for the Preservation of Craig County regarding the need for the Wyoming-Cloverdale 765 kV transmission line. Specifically, addressed the adequacy of the DSM planning of Appalachian Power Company and Virginia Power/North Carolina Power. Made recommendations as to APCO and VEPCO's energy efficiency programs, and suggested ways the company could improve its DSM efforts.

Case No. EEP-91-8, (5/92), Iowa Utilities Board. Testified on behalf of the Izaak Walton League concerning the adequacy of Iowa Public Service Company's Energy Efficiency Plan. Reviewed the plan and suggested modifications to it.

Case No. 4131-U and 4134-U, (5/92), Georgia Public Service Commission. Testified on behalf of the Georgia Public Service Commission staff regarding the demand-side management portions of Georgia Power Company's and Savannah Electric and Power Company's Integrated Resource Plans. Testimony demonstrated that it is reasonable for the Commission to expect that the utilities can successfully secure substantial amounts of demand-side management resources by working effectively with customers.

Case No. 917, (8/92), Public Service Commission of the District of Columbia. Testified on behalf of the District of Columbia Energy Office in hearings on Potomac Electric Power Company's Integrated Resource Planning process. Addressed a number of program-specific issues related to PEPCO's demand-side management efforts.

Case No. 4132-U, 4133-U, 4135-U, 4136-U, (10/92), Georgia Public Service Commission. Testified on behalf of the Staff Adversary IRP Team of the Georgia PSC. Provided a critique of Georgia Power Company's and Savannah Electric and Power Company's proposed residential and small commercial DSM programs.

Case No. 4135-U, (3/93), Georgia Public Service Commission. Testified on behalf of the Staff Adversary IRP Team of the Georgia PSC. Provided a critique of Savannah Electric and Power Company's proposed Commercial and Industrial DSM programs.

Case No. R-0000-93-052, (12/93), Arizona Corporation Commission. Testified on behalf of the Arizona Community Action Association. Critiqued and made recommendations regarding the integrated resource plans and demand-side management programs of Arizona Public Service Company and Tucson Electric Power Company.

Case No. 934, (4/94), Public Service Commission of the District of Columbia. Filed testimony on behalf of the District of Columbia Energy Office in hearings concerning the Washington Gas Light Company (WGL) general rate case application to increase existing rates and charges for gas service. Testimony involved critiquing and reviewing WGL's least cost planning efforts and integration of DSM, marketing and gas supply efforts.

Case No. U-10640, (10/94), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency Association concerning the need to integrate DSM and load promotion analysis into MichCon's GCR planning process.

Case No. 05-EP-7, (3/95), Wisconsin Public Service Commission. Testified on behalf of the Citizens' Utility Board on level of utility DSM and program designs and strategies.

Case No. 05-EP-7, (3/95), Wisconsin Public Service Commission. Testified on behalf of the Wisconsin Community Action Program Association on low-income customers and utility DSM programs.

Case No. TVA 2020-IRP, (9/95), Tennessee Valley Authority. Testified on behalf of the Tennessee Valley Energy Reform Coalition. Assessed, critiqued and made recommendations regarding the integrated resource plans and demand-side management programs proposed by the Tennessee Valley Authority.

Case No. R-96-1, (10/95), Alaska Public Utilities Commission. Testified on behalf of the Alaska Weatherization Directors Association regarding the proposed standards and guidelines for integrated resource planning and energy efficiency initiatives under consideration in Alaska.

Case No. D95.9.128, (2/96), Montana Public Service Commission. Testified on behalf of the District XI Human Resources Council concerning the low-income energy efficiency programs offered by the Montana Power Company.

Case No. DPSC Docket No. 95-172, (5/96), Delaware Public Service Commission. Prepared draft testimony on behalf of the Low-Income Energy Consumer Interest Group regarding Delmarva Power & Light Company's application to revise its demand-side programs. The case was settled, with LIECIG obtaining funding for low-income energy efficiency programs, prior to testimony.

Case No. U-11076, (8/96), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency regarding the Michigan Jobs Commission's recommendations regarding electric and gas reform. Discussed the implications of utility restructuring and the needs of residential and low-income households, and proposed regulatory and industry solutions.

Case No. 96-E-0897, (3/97), New York Public Service Commission. Prepared draft testimony for New York's Association for Energy Affordability regarding the impact of proposed utility restructuring plans on low-income customers. The case was settled in the spring of 1997.

Case No. R-00973954, (7/97), Pennsylvania Public Utilities Commission. Testified on behalf of the Commission on Economic Opportunity regarding the economics of demand-side measures and programs proposed for implementation by Pennsylvania Power & Light Company.

Case No. 98-07-037, (7/98), California Public Utilities Commission. Testified on the California Alternative Rates for Energy and the Low Income Energy Efficiency programs regarding the implementation and adoption of revisions to these programs necessitated by the AB 1890 and the Low Income Governing Board.

Case No. U-12613, (3/01), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency regarding the Wisconsin Public Service Corporation application to implement

PA 141 the electricity deregulation law. I reviewed the portions of the filing related to their provision of electric energy efficiency and load management.

Case No. U-12649, (3/01), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency regarding the Wisconsin Electric Power Company and the Edison Sault Electric Company application to implement PA 141 Michigan's electricity deregulation law. I reviewed the portions of the filing related to their provision of electric energy efficiency and load management.

Case No. U-12651, (3/01), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency regarding the Northern States Power Company – Wisconsin application to implement PA 141 the electricity deregulation law. I reviewed the portions of the filing related to their provision of electric energy efficiency and load management.

Case No. U-12652. (3/01), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency regarding the Indiana Michigan Power Company d/b/a American Electric Power application to implement PA 141 the electricity deregulation law. I reviewed the portions of the filing related to their provision of electric energy efficiency and load management.

Case No. U-12725, (4/01), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency regarding the Wisconsin Electric Power Company and the Edison Sault Electric Company application to increase its residential rates. I reviewed the portions of the filing related to their provision of electric energy efficiency and load management and recommended a significant increase in these activities.

Case No. U-13060, (12/01), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency regarding the Michigan Consolidated Gas Company application for Approval of their Gas Cost Recovery Plan and Five-Year gas Forecast. I reviewed the filing and recommended the Commission reject the proposed GCR factor and suggested continuation of the existing GCR factor or adopt an adjusted MCAAA sponsored GCR factor. I also suggested a set-aside allocation be designated for low-income customers to ensure access to alternative gas providers under the applicant's customer choice program.

Case No. 6690-UR-114, (9/02), Wisconsin Public Service Commission. Testified on behalf of the Citizens Utility Board regarding the Wisconsin Public Service Corporation application to increase its electric and natural gas rates. I reviewed the portions of the filing related to their low-income assistance/weatherization and the proposed executive compensation incentive plan.

Case No. U-14401, (04/05), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency regarding the Michigan Consolidated Gas Company application for Approval of their Gas Cost Recovery Plan and Five-Year gas Forecast. I reviewed the filing and recommended the Commission reject the proposed plan and suggested initiation of strategies that would lower the need to acquire expensive and unnecessary gas supplies.

Case No. U-14401-R, (10/05), Michigan Public Service Commission. Testified on behalf of the Michigan Community Action Agency regarding the Michigan Consolidated Gas Company application re-opener Approval of their Gas Cost Recovery Plan and Five-Year gas Forecast. I reviewed the filing and recommended the Commission reject the proposed plan and suggested initiation of strategies that would lower the need to acquire expensive and unnecessary gas supplies.

Case No. U-14701, (02/06), Michigan Public Service Commission. Testified on behalf of the Michigan Environmental Council and The Public Interest Group In Michigan regarding the Consumers Energy Company application for Approval of a Power Supply Cost Recovery Plan and for Authorization of Monthly Power Supply Cost Recovery Factors for Calendar Year 2006. I reviewed the filing including the application, testimony, exhibits, discovery responses and submitted testimony recommending that the Commission not approve the five-year PSCR plan as filed due to the impacts related to the Palisades sale and the absence of alternative resources in the projected five-year resource portfolio.

Case No. U-14702, (02/06), Michigan Public Service Commission. Testified on behalf of the Michigan Environmental Council and The Public Interest Group In Michigan regarding The Detroit Edison Company application for authority to implement a Power Supply Cost Recovery Plan in its rate schedules for 2006-metered jurisdictional sales of electricity. I reviewed the application, testimony, exhibits and submitted testimony that recommended that the Commission not approve the proposed five-year PSCR plan as filed due because it was deficient in its selection of alternative resources in the projected five-year resource portfolio.

Case No. U-14992, (12/06), Michigan Public Service Commission. Testified on behalf of the Michigan Environmental Council and The Public Interest Group In Michigan regarding The Consumers Energy Company application for approval of the proposed Power Purchase Agreement in connection with the sale of the Palisades Nuclear Power Plant and other assets. The purpose of my testimony was to address the overall soundness of this application and proposal. I reviewed the application, testimony,

exhibits and submitted testimony that recommended that the Commission not approve the proposed purchase power agreement and transfer the ownership of the nuclear plant and other assets.

Case No. 06-0800, (3/07), Illinois Commerce Commission. Provided testimony on behalf of the Illinois Citizens Utility Board regarding the Illinois electricity resource auction process. I assessed the existing resource/power supply auction based bidding process and recommended modifications and improvements to the Illinois resource acquisition mechanism.

Case No. 24505-U, (5/07), Georgia Public Service Commission. Testified on behalf of the Georgia Public Service Commission Advocacy staff regarding the demand-side management portions of Georgia Power Company's Integrated Resource Plans. Testimony demonstrated that it is reasonable for the Commission to approve the five proposed DSM programs and expect that Georgia Power can successfully secure considerably more demand-side management resources by working effectively with its customers.

Case No. U-14992, (11/07), Michigan Public Service Commission. Testified on behalf of the Michigan Environmental Council and The Public Interest Group In Michigan regarding The Consumers Energy Company rate application for approval of a rate increase and the recovery of energy efficiency programs and certain costs in connection with the sale of the Palisades Nuclear Power Plant and other assets. I reviewed the application, testimony, exhibits and submitted testimony that recommended that the Commission not approve the recovery of transaction costs involving the transfer the ownership of the nuclear plant and other assets and on various aspects of its proposed energy efficiency programs and proposed incentives.

Case No. 07-0540, (12/07), Illinois Commerce Commission. Provided testimony on behalf of the Environmental Law and Policy Center regarding the Commonwealth Edison Company application for approval of its proposed Energy Efficiency and Demand Response Plan. I assessed the proposed energy efficiency and demand response plan and recommended modifications and improvements to the proposed plan filing.

Case No. 07-0539, (12/07), Illinois Commerce Commission. Provided testimony on behalf of the Environmental Law and Policy Center regarding the Central Illinois Light Company d/b/a and Ameren CIPS CENTRAL ILLINOIS PUBLIC SERVICE COMPANY and Ameren CIPS ILLINOIS POWER COMPANY d/b/a Ameren IP application for approval of its proposed Energy Efficiency and Demand Response Plan. I

assessed the proposed energy efficiency and demand response plan and recommended modifications and improvements to the proposed plan filing.

Case No. U-15415, (2/08), Michigan Public Service Commission. Testified on behalf of the American Association of Retired People regarding The Consumers Power Company application for approval for authority to implement a Purchase Power recovery plan, 5-year forecast, and monthly PSCR factors for the 12-month period calendar year 2008. I reviewed the application, testimony, exhibits and submitted testimony that recommended that the Commission adopt a more effective and less expensive resource acquisition procedure to help keep the cost of energy down in Michigan.

Case No. U-15417, (4/08), Michigan Public Service Commission. Provided testimony on behalf of the American Association of Retired People regarding The Detroit Edison Company for Authority to Implement a Power Supply Cost Recovery Plan in its Rate Schedule for 2008 Metered Jurisdictional Sales of Electricity. I reviewed the application, testimony, exhibits and submitted testimony that recommended that the Commission adopt a more effective and less expensive resource acquisition procedure to help keep the cost of energy down in Michigan.

Case No. U-15244, (7/08), Michigan Public Service Commission. Provided testimony on behalf of the Michigan Environmental Council and The Public Interest Group In Michigan regarding The Detroit Edison Company request for Authority to increase rates, amend its rate schedules and rules governing the distribution and supply of electric energy, and for miscellaneous accounting authority. I reviewed the application, testimony, exhibits and submitted testimony that recommended that the Commission direct DECO to make modifications to its Integrate Resource Planning analysis.

Case No. EEP-08-2, (7-08), Iowa Public Utilities Board. Provided testimony on behalf of the environmental interveners regarding the request of the Mid American Energy Company for approval of an Energy Efficiency Plan. I made an assessment of the proposed energy efficiency and demand response plan and recommended modifications and improvements to the implementation strategy and proposed programs.

Case No. EEP-08-1, (8-08), Iowa Public Utilities Board. Provided testimony on behalf of the environmental interveners regarding the Interstate Power and Light Company request for approval of an Energy Efficiency Plan. I made an assessment of the proposed energy efficiency and demand response plan and recommended modifications and improvements to the proposed programs and implementation strategy.

Case No. 137-CE-147, (2-09), Public Service Commission of Wisconsin. Provided testimony on behalf of PRESERVE OUR RURAL LANDS regarding the Application of American Transmission Company, as an Electric Public Utility, to Construct a new 345 kV Line from the Rockdale Substation to the West Middleton Substation, Dane County, Wisconsin. I suggested modifications of the proposal and rejection of the approval of the line.

Case No. M2009-2093218, (8-09), Pennsylvania Public Utility Commission. Provided testimony on behalf of The Office Of Consumer Advocate regarding the West Penn Power Company d/b/a Allegheny Power Energy Efficiency and Conservation Plan request for plan approval. I analyzed the proposed plan and made an assessment of the proposed energy efficiency and demand response and cost recovery plan. I suggested modifications and improvements to the proposed programs as well as the proposed implementation strategy.

Case No. 09-1947-EL-POR, 09-1948-EL-POR, 09-1949-EL-POR, 09-1942-EL-EEC, 09-1943-EL-EEC, 09-1944-EL-EEC, POR, 09-580-EL-EEC, 09-580-EL-EEC, 09-580-EL-EEC, Public Utilities Commission of Ohio. Provided testimony on behalf of The Office Of The Environmental Law and Policy Center regarding the Ohio Edison Company, The Cleveland Electric Illuminating Company and the Toledo Edison Company for approval of their energy efficiency and peak demand reduction program portfolio and associated cost recovery mechanism and approval of their initial benchmark reports and in the matter of the energy efficiency and peak demand reduction programs. I reviewed, analyzed and assessed the appropriateness of the proposed plans, benchmark reports and proposed peak reduction program portfolio. I suggested modifications and improvements to the proposed programs. I also made recommendations regarding the proposed implementation strategy as well as accounting and program cost tracking.

Case No. U-16412, (10/10), Michigan Public Service Commission. Provided testimony on behalf of the Natural Resources Defense Council, Michigan Environmental Council and The Environmental Law and Policy Center regarding the Consumers Energy Company request to amend its natural gas & energy efficiency Energy Optimization Plan. I reviewed the application, testimony, exhibits, discovery responses and submitted testimony that recommended modifications to the proposed Energy Optimization Plan.

Case No. 10-0570, (11/10), Illinois Commerce Commission. Provided testimony on behalf of the Environmental Law and Policy Center regarding the Commonwealth Edison Company application for

approval of its proposed Energy Efficiency and Demand Response Plan. Assessed the proposed energy efficiency and demand response plan and recommended modifications and improvements to the proposed plan filing.

Case No. 10-0568, (11/10), Illinois Commerce Commission. Provided testimony on behalf of the Environmental Law and Policy Center regarding the Central Illinois Light Company d/b/a and Ameren CIPS CENTRAL ILLINOIS PUBLIC SERVICE COMPANY and Ameren CIPS ILLINOIS POWER COMPANY d/b/a Ameren IP application for approval of its proposed Energy Efficiency and Demand Response Plan. Assessed the proposed energy efficiency and demand response plan and recommended modifications and improvements to the proposed plan filing.

Case No. 10-0564, (11/10), Illinois Commerce Commission. Provided testimony on behalf of the Environmental Law and Policy Center regarding the People's Gas Light and Coke Company and North Shore Gas Company request for approval of its proposed Energy Efficiency Plan. Assessed the proposed energy efficiency and demand response plan and recommended modifications and improvements to the proposed plan filing.

Case No. 10-0567, (11/10), Illinois Commerce Commission. Provided testimony on behalf of the Environmental Law and Policy Center regarding the Northern Illinois Gas Company application for approval of its proposed Energy Efficiency Plan and approval of Rider 30, Energy Efficiency Plan Cost recovery and related changes to Nicor tariffs. Assessed the proposed energy efficiency and demand response plan and recommended modifications and improvements to the proposed plan filing.

Case No. M-2010-2210316, (3/11), Pennsylvania Public Utility Commission. I provided testimony on behalf of The Office Of Consumer Advocate regarding the UGI Utilities, Inc. Electric Division (UGI-Electric) request for Efficiency and Conservation Plan approval. I analyzed the proposed plan and made an assessment of the proposed energy efficiency and demand response and cost recovery plan. I suggested modifications and improvements to the proposed programs and implementation strategy.

Case No. 11-07026 and 11-07027, (11/11), Nevada Public Utilities Commission. I provided testimony on behalf of the Bureau of Consumer Protection regarding both the Sierra Pacific Power Company and Nevada Power Company 2011 Annual Demand Side Management Update reports. I reviewed the filings and made recommendations regarding various aspects of demand response resources and demand side management portfolios.

Case No. M-2012-2320450, M-2012-2320468, M-2012-2320480, M-2012-2320484 (10/12), Pennsylvania Public Utility Commission. I provided testimony regarding FirstEnergy’s petition for adjustments of Phase II Energy Efficiency and Conservation target levels. I addressed West Penn’s petition regarding energy efficiency acquisition costs.

Case No. 12-2190-EL-POR, 12-2191-EL-POR, 12-2192-EL-POR (10/12), Public Utility Commission of Ohio. I provided testimony regarding Ohio Edison, The Cleveland Electric Illuminating Company and the Toledo Edison Company application for approval of the 2013-2015 Energy Efficiency and Peak Reduction Program Portfolio. I addressed the applicant’s petitions regarding the redesign and adjustment to energy efficiency and peak reduction programs for the 2013-2015 period.

Case No. U-16434-R, (10/12), Michigan Public Service Commission. Provided testimony on behalf of the Michigan Community Action Agency Association regarding the Detroit Edison Company’s request to reconcile its power supply costs for the period ending December 31, 2011. I reviewed the application, testimony, exhibits, discovery responses and submitted testimony that recommended modifications and adjustments related to proposed expenses.

In addition, I have served the following public sector clients since 1990.

Client	Nature of Service
Alaska Housing Finance Corporation	Analysis of energy efficiency, system planning and applicability of Energy Policy Act standards to Alaska resource selection process.
California Low Income Governing Board	In conjunction with AB 1890 the state’s restructuring statute provided analyses of options to deliver energy efficiency and assistance programs to low-income households in a restructured utility environment. Assisted the CPUC and Low Income Governing Board in developing low-income energy assistance and energy efficiency programs, implementation methods and procedures under interim utility administration.
Conservation Law Foundation of New England	Provided technical support to the collaborative working groups with Boston Edison, United Illuminating, Eastern Utilities Association, and Nantucket Electric regarding system planning approaches, energy efficiency programs and resource screening.
District of Columbia Public Service Commission	Testimony regarding demand-side management, least cost planning principles.

<p>Germantown Settlement, Philadelphia</p>	<p>Analysis and technical support regarding business structure and market to aggregate load and/or provide energy efficiency and energy assistance services to low-income households.</p>
<p>City of New Orleans</p>	<p>Developed least cost planning rules, guided a public working group to develop demand-side programs, and developed a low income, senior citizens energy efficiency program.</p>
<p>Oak Ridge National Laboratory</p>	<p>Prepared an economic analysis of the customer impact from various electricity restructuring configurations for the State of Ohio</p>
<p>Ohio Office of Consumer Council</p>	<p>Analyzed two utilities' long-range plans and energy efficiency resource options. Analyzed the Dominion East Gas Company application to be relieved of the merchant function.</p>
<p>Ontario Energy Board</p>	<p>Developed demand-side management programs and evaluated need for natural gas integrated resource planning rules.</p>

120 STAT. 2920

PUBLIC LAW 109-431—DEC. 20, 2006

Public Law 109-431
109th Congress

An Act

Dec. 20, 2006
[H.R. 5646]

To study and promote the use of energy efficient computer servers in the United States.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. STUDY.

Deadline.

Not later than 180 days after the date of enactment of this Act, the Administrator of the Environmental Protection Agency, through the Energy Star program, shall transmit to the Congress the results of a study analyzing the rapid growth and energy consumption of computer data centers by the Federal Government and private enterprise. The study shall include—

(1) an overview of the growth trends associated with data centers and the utilization of servers in the Federal Government and private sector;

(2) analysis of the industry migration to the use of energy efficient microchips and servers designed to provide energy efficient computing and reduce the costs associated with constructing, operating, and maintaining large and medium scale data centers;

(3) analysis of the potential cost savings to the Federal Government, large institutional data center operators, private enterprise, and consumers available through the adoption of energy efficient data centers and servers;

(4) analysis of the potential cost savings and benefits to the energy supply chain through the adoption of energy efficient data centers and servers, including reduced demand, enhanced capacity, and reduced strain on existing grid infrastructure, and consideration of secondary benefits, including potential impact of related advantages associated with substantial domestic energy savings;

(5) analysis of the potential impacts of energy efficiency on product performance, including computing functionality, reliability, speed, and features, and overall cost;

(6) analysis of the potential cost savings and benefits to the energy supply chain through the use of stationary fuel cells for backup power and distributed generation;

(7) an overview of current government incentives offered for energy efficient products and services and consideration of similar incentives to encourage the adoption of energy efficient data centers and servers;

(8) recommendations regarding potential incentives and voluntary programs that could be used to advance the adoption of energy efficient data centers and computing; and



INFORMATION SHEET
COLORADO | MINNESOTA

Data Center Efficiency

BUILDING A GREEN DATA CENTER

Running a data center requires a tremendous amount of energy, and usage is on the rise. In fact, the EPA expects energy use to double every 5 years. For every dollar spent on IT energy usage, companies spend another on related systems energy usage. (Source: IBM, US EPA CSC Data Center Seminar, December 2007). If your business is running a data center, this presents a substantial opportunity to align business and environmental interests by making energy efficiency a priority in their technology management strategy.

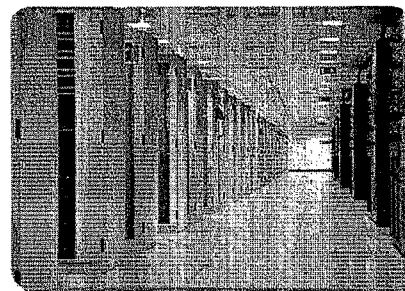
The good news for all businesses is that adopting energy-saving, environmentally friendly data center practices can be both financially attractive and easy to implement. Xcel Energy is offering attractive cash rebates to offset the cost of putting your business on the green path to improving its energy efficiency.

Examples of Energy-Efficient Improvements

Companies are facing huge growth rates in data storage, resulting in a 20–30% increase in energy consumption each year, according to the Environmental Protection Agency (EPA). All this means that energy efficiency is more important than ever.

While the news may seem daunting, there are many things you can do to reduce the energy consumption of your data center – and Xcel Energy can help with the following:

- **High-Efficiency Servers** – Experts estimate that new servers are 25% more efficiency than standard servers, and ENERGY STAR® rated servers can be even more efficient.
- **Server Virtualization/Consolidation** – Historically, software programs have been dedicated on a one-to-one relationship with servers. Virtualization software eliminates the need for dedicated servers. Consolidating allows servers to operate at a much higher load factor. Virtualization and consolidation can increase server load factors from a typical 10% to 50–70% without suffering any loss in reliability and may result in up to an 80% reduction in energy use.
- **Airflow Improvements** – Involve efficiently managing the proper amount of air needed to cool the servers in a data center. Strategies include: optimizing air inlet and return, minimizing the mixing of hot and cold air, and directing air only to where it is needed. All will improve the efficiency of air flow, which has a significant impact on the amount of fan energy needed to direct cooled air to the to the appropriate equipment.
- **Electrical Equipment** – Savings are available from higher efficiency batteries, transformers and inverters; high efficiency power supplies in the IT cabinets and high efficiency storage devices.



ACHIEVE BUSINESS SUSTAINABILITY

The Data Center Efficiency program is designed to help Xcel Energy customers address energy conservation opportunities in both new and existing data centers.

Data Center Efficiency Improvements deliver energy savings and help you:

- Improve ROI of data management
- Manage increasing energy costs
- Improve reliability of data center performance

- **High-Efficiency Cooling Equipment** – Besides high efficiency chillers and roof top units, technology can raise the supply air temp to the racks by improving distribution of the air. This allows greater use of air side and water side economizers, which reduce the need for central plant cooling.
- **Humidification** – Best practices for data center operation have relaxed humidity controls to a range of 25–60%. Also, more efficient methods of humidifying include evaporative and ultrasonic mechanisms.
- **Power Systems** – There are opportunities to save—from transformer to UPS (uninterruptible power supply) to high-efficiency power supply—in some cases up to 15% more efficient than similar systems that are five or more years old.
- **High-Efficiency Lighting Equipment** – Although generally a small portion of the total energy usage in the data center (around five percent), there is opportunity to install higher-efficiency lighting when retrofitting existing or designing new data centers.

How to Evaluate Your Data Center

Whether you are building a new data center, or looking to make energy efficiency improvements to an existing data center, Xcel Energy can help. Our Data Center Efficiency program takes place in two steps: evaluation and implementation. The Data Center Efficiency service provider will conduct an assessment of your facility, identify potential energy savings and prepare a study report that:

- Helps you build a business case for project approval
- Details how to best run your data center at peak efficiency
- Identifies energy savings, cost estimates and rebate amounts for individual energy conservation opportunities

We offer study rebates up to 75 percent, not to exceed \$25,000 and rebates up to \$400 per kilowatt saved for preapproved projects. See your Xcel Energy account manager for details.

Project Option

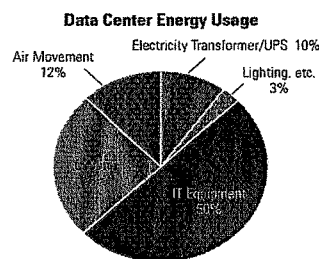
Already have a project in mind without doing a study? Submit your project application for preapproval review today.

Call Now and Save

Contact your Xcel Energy account manager, or call our Business Solutions Center at **1-800-481-4700** for details

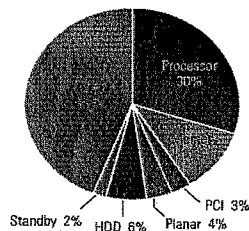
DATA CENTER LOADS

While servers and other IT equipment are the main power users, half the energy consumed is used to simply cool the equipment – which amounts to about 25% of a typical data center’s energy consumption. Xcel Energy can help you find the right ways to reduce your consumption, and your energy bill.



Source: EYP Mission Critical Facilities Inc., New York

IT Equipment Energy Usage



Source: IBM, US EPA CSC Data Center Seminar, December 2007

TAKE CONTROL OF YOUR ENERGY COSTS TODAY

Call your account manager or our **Business Solutions Center** at **1-800-481-4700** for more information or visit xcelenergy.com/rebates



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**Petition of PPL Electric Utilities Corporation
for Approval of An Energy Efficiency and Conservation Plan
Docket No. M-2012-2334388**

**PPL Electric Utilities Corporation's Responses to
Office of Consumer Advocate Interrogatories – Set I**

Q. OCA-17

Regarding the behavior modification programs what is the source and the basis of using a one year life for the program?

A. OCA-17.

The behavior program CSP has not provided any evidence or analysis that savings for this type of behavior program persist for more than 1 year after the program messaging stops.

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Q. OCA-18

Does PPL intend to link the behavior modification programs with rebate and customer incentive programs to enhance savings? If so, how is this going to be accomplished?

A. OCA-18.

PPL Electric's behavior program encourages customers to participate in the Company's other energy efficiency programs and the impact is accounted for as explained in the response to question 16.

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Q. OCA-26

Appendix E indicates that measures offered under programs specific to the residential low income sector, Low Income WRAP and E-Power Wise, are offered at no cost to low-income customers.

- a. Does that mean that the low-income participants in these programs receive the entire cost of the device, or just the entire incremental cost? Please explain.
- b. If a low-income customer participates in a non-low income program that provides a standard incentive (which is equal to part or most of the incremental cost), does that low-income customer receive the standard incentive or is it at no cost to the low-income customer?
- c. If the low-income customer participating in a non-low income program receives only the standard incentive, please explain why the customer would participate in the non-low income program rather than the low-income program.

A. OCA-26

- a. PPL Electric's income-qualified programs have no participant cost. PPL Electric covers the entire cost of the measure. See the response to question 21b for a discussion of incremental cost versus entire cost.
- b. All participants in a general residential program received the same incentive. PPL Electric does not income-qualify participants before issuing a rebate in those programs. The percentage of low-income participants in general residential programs is determined by PPL Electric's independent evaluator during the yearly impact evaluation based on a statistically valid sample.
- c. PPL Electric has not conducted any research to answer this question. PPL Electric believes that many customers may meet the Act 129 low-income income requirements but do not consider themselves as "low-income" (for example, they may be retired, have very little income, but have significant savings or other assets) or do not request to participate in income-qualified programs.

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Q. OCA-21

On page 11, lines 2-4 of Statement No. 2, Dr. Haeri indicates that the cost component of the TRC analysis included the incremental measure costs.

- a. As Dr. Haeri is using the term, is the incremental measure cost the cost of an energy efficiency measure minus the cost of the standard efficiency device it replaces? Please explain.
- b. On page 72, the Plan states that under PPL's Low Income WRAP program, "All services and measures are provided to income-qualified customers at no cost." In light of the statement, does the TRC analysis for measures included in the low income program use the incremental measure cost or the total measure cost? Please explain.

A. OCA-21

- a. Estimates of measure costs used in the calculation of TRC represent either the full or incremental life cycle cost of the measure, depending on whether the measure is a retrofit (early replacement) or a replacement on burnout. Measures such as lighting are generally treated as a retrofit and their full cost is used in calculating TRC. Measures such as heat pumps, heat pump water heaters, and appliances are generally treated a replacement on burnout and their incremental cost (i.e. the additional material and labor costs beyond those of the standard, baseline equipment) is used in calculating TRC. TRC calculations for new construction measures are also based on incremental measure cost.
- b. TRC calculations for measures offered under the Low-Income WRAP program are based on full measure costs. Please note that the TRC perspective takes into account the total (full or incremental) measure cost regardless of the portion paid by the customer or the utility.

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**PPL Electric Utilities Corporation's Responses to
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Q. OCA-23

On page 13, lines 4-5 of Statement No. 1, Ms. Thompson Grassi states that low income savings sector energy reductions include "savings from low-income programs and low-income participation in general residential programs." On page 11, lines 17-18, Ms. Thompson Grassi states that "savings from Low-Income Multifamily Master Metered Program will make up a portion of the GNI reduction target." Since the GNI sector is different than the Residential sector, it would appear that the low-income multi-family housing program reductions would not be included in the overall low-income energy reductions counting toward achieving the 4.5% low-income target.

- a. What specific programs does PPL include in its estimation that total savings from the low-income sector is 71,283 MWh/year?
- b. How much of the 71,283 MWh/year low-income energy reduction is attributable to each of the above specific programs? Please explain.

A. OCA-23.

- a. Savings from the low-income multifamily master metered program are not included in the estimated savings from low-income participation in general residential programs. Participation by low-income customers is expected in the following general residential programs: Appliance Recycling, Residential Retail, and Residential Home Comfort.
- b. Of the 71,283 MWh/year estimated savings for low-income customers, 22,091 MWh/yr are directly from the savings estimates for low-income programs (WRAP, Behavior and Education, EPowerwise). The remaining 49,192 MWh/yr are an estimate of the low-income savings in non-low income programs based on the verified low-income savings from the PY3 evaluation. The following estimated low-income participation in each program is based on the Phase 1 PY3 results. Estimated low-income savings from Appliance Recycling are approximately 2,500 MWh/yr. Estimated low-income savings from audit & weatherization measures (Residential Home Comfort) are approximately 4,000 MWh/yr. Estimated low-income savings from lighting, appliances, HVAC, and other measures are approximately 43,000 MWh/yr.

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**PPL Electric Utilities Corporation's Responses to
Office of Consumer Advocate Interrogatories – Set I**

Q. OCA-4

The Low Income WRAP program includes the replacement of refrigerators, air conditioners, dehumidifiers, and electric water heaters with heat pump water heaters at no cost. The Low Income WRAP program has a TRC benefit cost ratio of 0.74.

- a. Please provide and document the projected costs and benefits for each of the above appliances as considered in the Low Income WRAP program.
- b. What are the appliance-specific TRC ratios for Low Income WRAP refrigerators, air conditioners, dehumidifiers, and electric water heaters?
- c. What would be the overall TRC for the Low Income WRAP program if the electric heat pump water heater was eliminated from the program?
- d. Would replacing a standard electric water heater in a low income household with an electric heat pump water heater be more cost effective for PPL than replacing it with a high efficiency natural gas water heater? Please explain and provide documentation.
- e. Would replacing a standard electric water heater in a low income household with an electric heat pump water heater be more cost effective for the low income customer than replacing it with a high efficiency natural gas water heater? Please explain and provide documentation.
- f. Does PPL intend to offer the electric heat pump option to replace standard electric water heaters in low income households only in areas not served by natural gas? Please explain.

A. OCA-4

- a. Please see the spreadsheet provided as Exhibit 2 "LI Wrap TRC by Appliance.xls" which was sent via secure file transfer protocol.
- b. Same as A4a.
- c. The TRC benefit-cost ratio would be 0.72 if the heat pump water heater was eliminated from the program.
- d. PPL Electric did not conduct a cost-effectiveness evaluation with high efficiency natural gas water heaters instead of heat pump water heaters.
PPL Electric did not consider fuel substitution (converting from electric to gas, oil,

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**PPL Electric Utilities Corporation's Responses to
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propane, or other energy sources) for residential space heating, water heating, cooking, or clothes drying. PPL Electric believes it is more appropriate for a customer, not PPL Electric, to decide whether to heat their home, heat their water, cook, or dry their clothes with gas, electric, oil, propane, or other energy sources. Once the customer decides to use electricity for those purposes, PPL Electric will use its EE&C Programs to encourage the customer to adopt more-efficient electric measures.

The answer to this question also would depend on a variety of facts and circumstances, including whether gas service was available to the customer. Any significant focus on switching from electricity to gas as an energy conservation measure would, in PPL Electric's view, discriminatory against electric customers who do not have access to gas service, regardless of whether this measure is cost-effective. In addition, it would be discriminatory against customers who choose to use oil propane, wood, or an energy source other than gas.

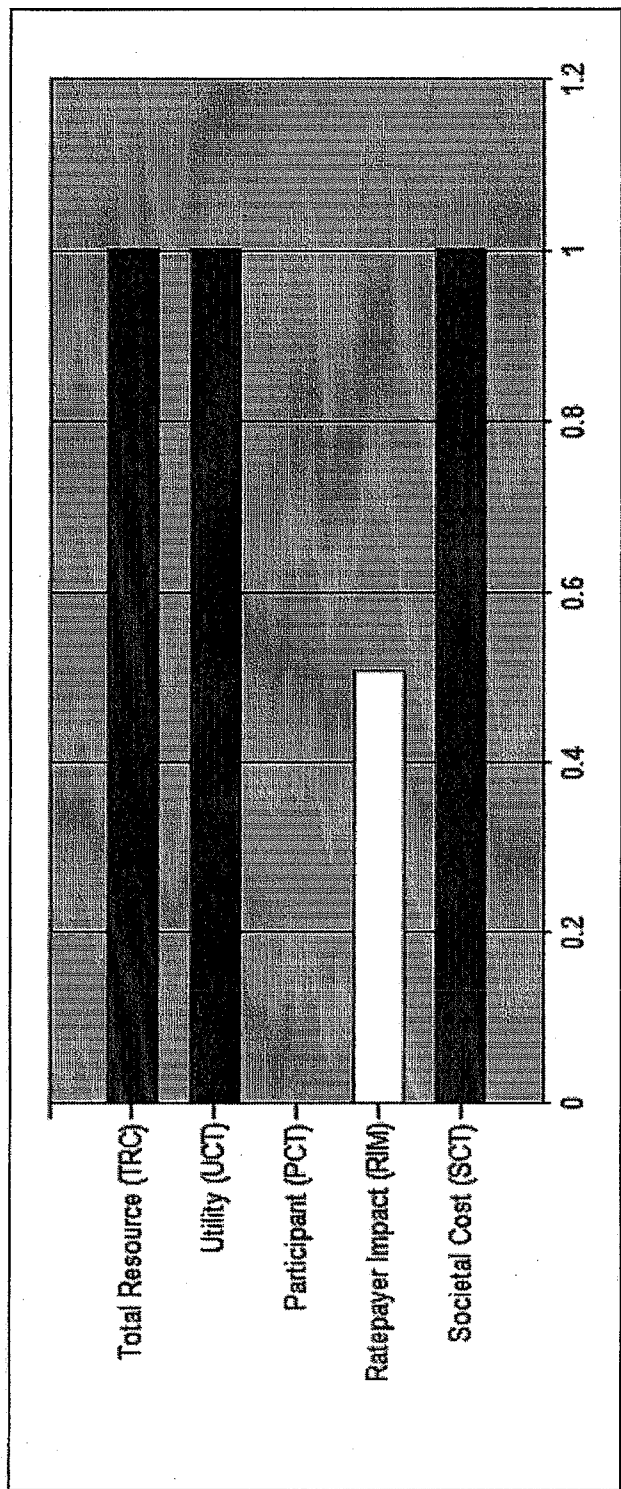
e. Same response as question 4d.

f. PPL Electric will offer the electric heat pump water heater to replace a standard electric water heater regardless of whether natural gas, oil, propane, or other energy source for water heating is available, assuming that the heat pump water heater is technically suitable for that installation (available space, in a non-conditioned space, etc.).

Name	Type	Start Year	End Year	Average Measure
Low Income WRAP - OCA Interrogatories - v5	program	2014	2014	Life 14.00

Cost Effectiveness Summary

	Benefits (NPV)	Costs (NPV)	Net Benefits	B/C Ratio	Electric (\$/kWh)	Gas (\$/Therms)
Total Resource (TRC)	\$1,571	\$1,570	\$1	1.00	\$0.102	
Utility (UCT)	\$1,571	\$1,570	\$1	1.00	\$0.102	
Participant (PCT)	\$1,409	\$0	\$1,409			
Ratepayer Impact (RIM)	\$1,571	\$3,105	-\$1,533	0.51	\$0.201	
Societal Cost (SCT)	\$1,571	\$1,570	\$1	1.00	\$0.102	



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Q. OCA-6

In Table C (page 31) and Table D1 (page 35), the Appliance Recycling program is open to all customer sectors and rate classes. It is considered a Residential Sector program (e.g., Figure 2, page 18). Table 5A (page 27) allocates the entire cost of the Appliance Recycling program to the Residential Sector.

- a. Why did PPL allocate all of the costs of the Appliance Recycling program to the Residential Sector when non-residential customers are eligible to participate in it?
- b. What would be the proper allocation of Appliance Recycling program costs among the customer sectors eligible to participate in it? Please explain.
- c. What would be the proper allocation of Appliance Recycling program savings (MWh/yr reductions) among the customer sectors eligible to participate in it? Please explain.

A. OCA-6

- a. Participation by non-residential customers is expected to be very small so the EE&C Plan estimates that all costs will be associated with the residential class. However, actual costs and savings will be assigned to the non-residential rate class that actually participates in the program. Any difference between the actual cost and the planned cost will be part of the reconciliation process at the conclusion of Phase 2.
- b. As stated in the response to question 6a, actual costs will be assigned to the non-residential rate class that actually participates in the program. In Phase 1 (through Program Year 3), less than 1% of the program's actual costs were for appliances recycled for non-residential customers (Small C&I, Large C&I, and GNI for which some may be in residential rate classes).
- c. As stated in the response to question 6a, actual savings will be assigned to the non-residential rate class that actually participates in the program. In Phase 1 (through Program Year 3), 2% of the program's actual savings were for appliances recycled for non-residential customers.

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Q. OCA-7

In Table C (page 31) and Table E1 (page 41), the Residential Retail program is open to all customer sectors and rate classes. It is considered a Residential Sector program (e.g., Figure 2, page 18). Table 5A (page 27) allocates the entire cost of the Residential Retail program to the Residential Sector.

- a. Why did PPL allocate all of the costs of the Residential Retail program to the Residential Sector when non-residential customers are eligible to participate in it?
- b. What would be the proper allocation of Residential Retail program costs among the customer sectors eligible to participate in it? Please explain.
- c. What would be the proper allocation of Residential Retail program savings (MWh/yr reductions) among the customer sectors eligible to participate in it? Please explain.

A. OCA-7

- a. See OCA - 6a.
- b. PPL Electric expects non-residential costs to be less than 1% of the program's total.
- c. PPL Electric expects non-residential savings to be less than 1% of the program's total.

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Q. OCA-8

Referring to page 67, why are the cost allocations among eligible sectors handled differently for the Appliance Recycling and Residential Retail programs (where the costs are allocated only to the Residential Sector) than for the Small C&I Prescriptive Program which is also available to farmers on residential rates (where some of the costs and savings are allocated to the Residential Sector)?

A. OCA-8.

Non-residential participation in the Appliance Recycling Program and the Residential Retail Program is expected to be small. Residential participation in the Small C&I Prescriptive Program is also expected to be small. PPL Electric could have handled the Small C&I Prescriptive Program similar to the Appliance Recycling and Residential Retail programs by allocating all the estimated costs to non-residential classes, and reconciling the difference between actual costs and estimated costs. However, some farming operations are on a residential rate schedule and PPL Electric wants to make it clear to customers and trade allies that these customers would qualify for the measures in the Small C&I Prescriptive Program.

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Q. OCA-9

Please identify any other programs in PPL's EE&C portfolio for which customers in more than one customer sector are eligible. For each program and sector identified, please provide the allocation of costs and savings by customer sector. Please explain.

A. OCA-9.

The Custom Program is the only other program where a customer sector (residential, including farms with a residential rate class) is eligible but no costs or savings are estimated for that sector in the EE&C Plan. Participation by the residential sector is expected to be small and, as with the Appliance Recycling and Residential Retail programs, actual costs will be assigned to the participating rate class.

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Q. OCA-12

How does PPL propose to recover EE&C program costs associated with the Government/Educational/Non-profit (GNI) sector?

- a. What are the anticipated costs allocated to the GNI sector?

A12a. The estimated GNI costs are \$28,710,196 as shown in Table 6C on page 176 and Table 5a on page 27.

- b. What cost recovery mechanism is PPL proposing to apply to the GNI sector?
- c. If the GNI costs are proposed to be allocated between the Small and Large C&I classes and recovered through their respective C&I mechanisms, please indicate the dollar amounts allocated to each.

A. OCA-12.

- a. The estimated GNI costs are \$28,710,196 as shown in Table 6C on page 176 and Table 5a on page 27.
- b. PPL Electric records the rate class of each participant and the actual costs will be charged to the rate class of the program participant.
- c. PPL Electric records the rate class of each participant and the actual costs will be charged to the rate class of the program participant. For purposes of its cost recovery tariff, PPL Electric estimated 50% of the GNI costs would be for Large C&I rate classes and 50% for Small C&I rate classes. Any differences between the costs recovered and the actual costs incurred will be part of the reconciliation at the end of Phase 2.