BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Petition of PPL Electric Utilities Corporation	:	
for Approval of its Act 129 Phase IV Energy	:	M-2020-3020824
Efficiency and Conservation Plan	:	

REVISED DIRECT TESTIMONY OF
ALICE NAPOLEON
AND
KENJI TAKAHASHI

ON BEHALF OF
NATURAL RESOURCES DEFENSE COUNCIL

January 19, 2021

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1. INTRODUCTION AND QUALIFICATIONS

Q. Please state your name, title, and employer.

A. **Ms. Napoleon:** My name is Alice Napoleon. I am a Senior Associate at Synapse Energy Economics, Inc. ("Synapse Energy Economics") located at 485 Massachusetts Avenue, Suite 3, Cambridge, MA 02139.

A. **Mr. Takahashi**: My name is Kenji Takahashi. I am a Senior Associate at Synapse Energy Economics, Inc. ("Synapse Energy Economics") located at 485 Massachusetts Avenue, Suite 3, Cambridge, MA 02139.

Q. Please describe Synapse Energy Economics.

A. Synapse Energy Economics is a research and consulting firm specializing in electricity and gas industry regulation, planning, and analysis. Our work covers a range of issues, including economic and technical assessments of demand-side and supply-side energy resources, energy efficiency policies and programs, integrated resource planning, electricity market modeling and assessment, renewable resource technologies and policies, and climate change strategies. Synapse works for a wide range of clients, including state attorneys general, offices of consumer advocates, trade associations, public utility commissions, environmental advocates, the U.S. Environmental Protection Agency, U.S. Department of Energy, U.S. Department of Justice, the Federal Trade Commission, and the National Association of Regulatory Utility Commissioners. Synapse has over 30 professional staff with extensive experience in the electricity industry.

Q. Please summarize your professional and educational experience.

A. **Ms. Napoleon:** Since joining Synapse in 2005, I have provided economic and policy analysis of electric and natural gas systems and emissions regulations, with a focus on energy efficiency policies and programs, on behalf of a diverse set of clients throughout the United States and in Canada. On the national level, I led a team that developed tools that help utilities integrate the U.S. Department of Energy's Superior Energy Performance and 50001 Ready strategic energy management platforms into their energy efficiency portfolios. I co-authored seminal works regarding designing performance incentive mechanisms and assessing the benefits of clean energy resources.

At the state level, I was co-author of reports and comments on the role of energy efficiency in New York State in meeting its Reforming the Energy Vision ("REV") objectives, as well as a white paper on natural gas regulatory reforms needed for New York to meet its decarbonization targets. In Colorado, Maryland, and South Carolina, I facilitated and provided expert analysis on program costs and benefits for demand-side resource policy working groups. Since 2009, I have provided extensive and ongoing expert analysis and support for the State of New Jersey regarding its state- and utility-administered energy efficiency and combined heat and power programs. I have also provided expert advice on demand-side management programs in Nova Scotia regarding a range of issues including incentive-setting methodologies, cost-benefit analysis, incentive setting, avoided costs, and locational demand-side management.

Before joining Synapse, I worked at Resource Insight, Inc., where I supported investigations of electric, gas, steam, and water resource issues, primarily in the context of reviews by state utility regulatory commissions.

I hold a Master's in Public Administration from the University of Massachusetts at Amherst and a Bachelor's in Economics from Rutgers University. My resume is attached as Exhibit AN/KT-1.

A. **Mr. Takahashi:** I conduct economic, environmental, and policy analysis of energy system technologies and regulations associated with both supply- and demand-side resources. Over the past 15 years, I have assessed the design and impact of utility energy efficiency and distributed energy resources policies and programs in over 40 jurisdictions across North America for a variety of clients. These include environmental groups, municipal and state governments, and federal agencies such as the U.S. Environmental Protection Agency and the U.S. Department of Energy. For many of these clients, I provided testimony and testimony assistance before public utility commissions. I have also analyzed the performance, costs, benefits, and potential of clean energy measures and resources, including state-of-the-art measures such as cold climate heat pumps, thermal storage demand response, dynamic windows, deep energy retrofits, net zero energy buildings, and strategic energy management. Further, I co-authored several reports and comments on the role and value of energy efficiency in New York State in meeting its Reforming the Energy Vision ("REV") objectives.

Another area of my focus has been technological, resource, economic, and policy assessments of strategic electrification. This includes my analyses for the Northeast region for the Northeast Energy Efficiency Partnerships, New York for New York State Energy Research and Development Authority, Rhode Island for the Office of Energy Resources, the Southwest region for the Southwest Energy Efficiency Partnership, and California for the Natural Resources Defense Council.

In addition, I have in-depth experience with the natural gas distribution planning process, in particular natural gas load forecasts and non-pipeline alternatives. Recently, I co-authored a whitepaper on gas regulatory reforms toward a decarbonized future in New York and wrote chapters on gas load forecast methodology and non-pipeline alternatives screening process. I also assessed the potential of natural gas demand savings measures as solutions to the gas moratorium placed by Berkshire Gas Company and testified before Massachusetts Department of Public Utilities.

I hold a Master's in Urban Affairs and Public Policy with a concentration in Energy and Environmental Policy from the Biden School of Public Policy and Administration at the University of Delaware, and a Bachelor's in Law with a concentration in Public Administration from Kansai University in Osaka, Japan. My resume is attached as Exhibit AN/KT-2.

Q. On whose behalf are you testifying in this case?

A. We are testifying on behalf of the Natural Resources Defense Council ("NRDC").

Q. Have you previously testified before a state or provincial commission?

A. **Ms. Napoleon:** Yes. I have testified before the California Public Utilities Commission, the Nova Scotia Utility and Review Board, the New York Public Service Commission, the New Brunswick Energy and Utilities Board, and the Public Service Commission of South Carolina.

A. **Mr. Takahashi:** Yes. I have testified before the New Jersey Board of Public Utilities, the Massachusetts Department of Public Utilities, the Ontario Energy Board, and the New York Public Service Commission.

Q. Have you testified before the Pennsylvania Public Utility Commission?

A. **Ms. Napoleon:** No.

A. **Mr. Takahashi:** No.

Q. What is the purpose of your testimony?

A. The purpose of our testimony is to review and critique PPL Electric Utilities' ("Company" or "PPL") proposed Act 129 Phase IV Energy Efficiency and Conservation Plan ("Phase IV Plan" or "Plan").

Q. Are you sponsoring any exhibits with your testimony?

A. Yes. We are sponsoring the following exhibits:

- Resume of Alice Napoleon: Exhibit AN/KT-1
- Resume of Kenji Takahashi: Exhibit AN/KT-2

2. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

2.1. Summary of Conclusions

Q. Please summarize your conclusions.

A. Our conclusions are summarized as follows:

- PPL can do more to facilitate customer adoption of more holistic energy saving solutions.
- PPL does not provide financing offerings such as low- or no-interest loans or on-bill repayment options to customers participating in its Act 129 programs, despite that incentives alone may not be sufficient to drive customers to invest in deeper, more comprehensive energy savings.
- PPL does not commit to tiered incentive structures, and those incentives that it is considering are not designed to support comprehensive efficiency investments.
- PPL does not indicate it will monitor its progress towards comprehensive savings goals.
- Promoting fossil fuel-based equipment, even efficient equipment, today will make it harder for the state to achieve its long-term climate goals.
- PPL does not address barriers to the adoption of heat pumps and heat pump water heaters.
- Energy efficiency will likely figure prominently in Pennsylvania's strategy for reducing emissions for Regional Greenhouse Gas Initiative (RGGI) compliance, and it will almost certainly play a larger role than it has in the past.

2.2. Summary of recommendations

Q. Please summarize your recommendations.

A. We recommend the following:

- PPL should provide more comprehensive savings opportunities by doing the following:
  - PPL should seek to provide more energy audits and weatherization measures to residential and non-residential customers;

  - PPL should provide financing opportunities to residential customers to address the cost-barrier to customer adoption of comprehensive energy solutions;
  - PPL should include additional offerings within its Residential and Non-residential programs to provide more opportunities for deeper savings, including pilots for deep energy retrofits and net zero energy buildings;
  - PPL should commit to implementing well-designed tiered incentives to send the appropriate signal to customers to take a more comprehensive whole-building approach and install multiple measures; and,
  - PPL should track its performance related to achievement of comprehensive energy savings.
- PPL should provide more detail on the projected savings and costs for the Energy Efficient Homes program.
- Electric-to-gas fuel switching measures should be removed from PPL's Phase IV Plan.
- PPL should encourage heat pump adoption by doing the following: structuring incentives to adequately address higher upfront costs; creating optimal delivery channels; expanding customer education and outreach channels to increase awareness of the technology and importance of weatherization; providing post-installation training on proper use of heat pumps; and facilitating programs to train installers and builders on right-sizing and proper installation.
- PPL should provide its estimate of Phase IV peak demand reductions, by proposed program component and measure, that it plans to bid into PJM's capacity market, its assumptions about the market, and an estimate of related auction proceeds.
- To the extent that hourly savings profiles and marginal emissions factors have not been analyzed, we recommend that the utilities conduct both of these studies.

- The PUC should consider whether the current energy efficiency and conservation (EE&C) framework can support the expansion in energy efficiency that RGGI is likely to require, and what changes would be needed to better support energy efficiency.

3. PHASE IV PLAN

3.1. Overview

Q. Please describe PPL's proposed Phase IV Act 129 Plan.

A. With its Phase IV EE&C Plan, PPL proposes a portfolio of energy efficiency and energy education initiatives consisting of the programs and components shown in Table 1.

Table 1. PPL's proposed Phase IV programs and components

#	Programs and Components
1. Residential Program	
1.1	Appliance Recycling
1.2	Efficient Lighting – Specialty Bulbs
1.3	Energy Efficient Homes
1.4	Student Energy Efficient Education
2. Low-Income Program	
2.1	Low-Income Assessment
3. Non-Residential Program	
3.1	Small Commercial and Industrial Efficient Equipment Prescriptive Rebate
3.2	Large Commercial and Industrial Efficient Equipment Prescriptive Rebate
3.3	Small Commercial and Industrial Custom
3.4	Large Commercial and Industrial Custom

Source: PPL Plan at 1.

As shown in Table 2, PPL projects that this portfolio would exceed compliance targets set in the Implementation Order.

Table 2. Summary of Compliance Targets and PPL's Plan

	Compliance Target	EE&C Plan
Overall Energy Reductions (MWh/year)	1,250,157	1,540,687
Overall Peak Demand Reductions (MW)	229	248
Low-Income Energy Reductions (MWh/year)	72,509	74,793
Budget Cap (excluding SWE costs)	$307,506,880	$307,491,356
Cost-Effectiveness (per TRC)	1.0	1.17

Source: PPL Plan at 2.

PPL indicates that the primary objectives of the plan are "to meet the requirements of Act 129 and encourage more efficient use of electric power by PPL Electric Utilities' customers." (PPL Plan at 26). PPL proposes to track its progress in meeting these objectives using the set of performance indicators and metrics shown in Table 3.

Table 3. PPL proposed metrics for measuring and tracking efficiency program performance

Key Indicator	Metrics
Market Response	• Number of participants • Number of measures installed per participant • Participation benchmarked against industry norms • Feedback from trade allies
Impacts	• kWh/year savings • kW/year saving • Average project size
Customer and Trade Ally Satisfaction	• Responses to participant surveys administered as part of QA and/or EM&V • Feedback from trade allies
Operating Efficiency	• Application processing time • Incentive processing time • Expenditures in each category • Acquisition cost ($/kWh saved) • Levelized cost ($/kWh saved)
Cost-Effectiveness	• TRC benefit/cost ratio

Source: PPL Plan at 26.

3.2. Assessment and critique

PPL's Plan misses opportunities for cost-effective savings

Q. Please summarize the Commission's recommendation for comprehensive programs in its Phase IV Implementation Order.

A. The Commission requires the electric distribution companies (EDCs) to include at least one comprehensive program for residential customers and at least one comprehensive program for non-residential customers.[1]

Q. Does the Commission define the term "comprehensive"?

A. While the Commission declined to adopt a strict definition of "comprehensive" in its Implementation Order, it does encourage "EDCs to pursue comprehensive portfolios with a greater focus on longer-lived, deeper-savings measures."[2] This implies that Phase IV programs should seek to move beyond incentivizing individual appliances and equipment to offering more comprehensive whole-building solutions where multiple measures are installed in a building in order to maximize energy savings.

Q. How does PPL propose to meet this requirement?

A. PPL indicates its Residential Program and Low-Income Program will provide a comprehensive mix of energy efficiency measures for all building types and these programs will encourage customers to implement multiple measures and to take a comprehensive approach to energy efficiency. Further PPL proposes a Non-Residential Program that will target business customers of all sizes and in every segment,

[1] Energy Efficiency and Conservation Program, Docket No. M-2020-3015228 (Implementation Order Entered June 18, 2020) (Implementation Order) at pgs. 23-24.
[2] Implementation Order at pg. 15.

government and educational institutions, and master metered low-income multifamily buildings with a comprehensive range of prescriptive measures and opportunities to implement custom efficiency projects.[3] PPL also indicates that its redesigned portfolio will offer multiple savings opportunities for each program and promote the benefits of multiple-measure, comprehensive projects (whole-home and whole-building approaches).[4]

Q. Do you find PPL's proposal to be sufficient to encourage the adoption of longer-lived and deeper energy savings?

A. Only in part. While we are encouraged by PPL's commitment to providing each target customer sector with comprehensive solutions, PPL can do more to facilitate customer adoption of more holistic energy saving solutions. We recommend several improvements to PPL's Plan, including:

- PPL should seek to provide more energy audits and weatherization measures to residential and non-residential customers;
- PPL should provide residential financing opportunities to residential customers to address the cost-barrier to customer adoption of comprehensive energy solutions;
- PPL should include additional offerings within its Residential and Non-residential programs to provide more opportunities for deeper savings;

[3] Petition of PPL Electric Utilities Corporation for Approval of its Act 129 Phase IV Energy Efficiency and Conservation Plan - Docket No. M-2020-3020824, November 30, 2020, at pg. 13.
[4] *Id*. Attachment A: PPL Electric Exhibit 1- Phase IV EE&C Plan, at pg. 6.

- PPL should commit to implementing tiered incentives to send the appropriate signal to customers to take a more comprehensive whole-building approach and install multiple measures; and,
- PPL should track its performance related to achievement of comprehensive energy savings.

Q. Why should PPL provide more energy audits and weatherization measures to its customers?

A. Energy audits and weatherization measures are crucial components of a comprehensive energy efficiency program. However, when such comprehensive measures are offered only to a very limited number of customers, the overall portfolio cannot be deemed comprehensive. Our review of PPL's proposed plan finds that it lacks emphasis on comprehensive measures and audits for both the residential and non-residential programs.

In particular, our review found that PPL's projected number of program participants for energy audits and weatherization measures is substantially lower than the level of those measures that leading jurisdictions have been offering. PPL projects to provide approximately 180 in-home energy audits each year with a total of 916 through the five-year term under the Phase IV program (PPL's response to NRDC-I-8 and PPL filing, Table 25). As shown in Table 4, the total number of planned energy audits represents just 0.07 percent of total residential customers, based on a residential customer count of 1.26 million for PPL according to the U.S. Energy Information Administration's (EIA) 861 database on utility customer data.

Table 4. Projected Residential Energy Audits by PPL under Phase IV

	PY13	PY14	PY15	PY16	PY17	Total

In-Home Audit Incentive (Elec Heat + AC)	50	51	52	53	54	260
In-Home Audit Incentive (Elec Heat or Central AC)	26	26	27	27	28	134
Comprehensive Retrofit Bonus- Tier 1	75	77	78	80	81	391
Comprehensive Retrofit Bonus- Tier 2	25	26	26	27	27	131
Total	**176**	**180**	**183**	**187**	**190**	**916**
% of total RES customers	**0.014%**	**0.014%**	**0.014%**	**0.015%**	**0.015%**	**0.07%**

Source: PPL response to NRDC-I-8, EIA 861 database.

In addition, PPL is projecting to provide weatherization measures to about 400 customers per year for a total of 1,992 customers or projects during the Phase IV program period. These total participants represent just about 0.16 percent of the total customers.

In contrast, leading jurisdictions are providing audits and weatherization measures to many more customers. For example, National Grid and Eversource in Massachusetts provided energy audits to between 1.1 to 2.4 percent of residential customers per year from 2014 through 2018 with the five-year total audits ranging from 6.4 percent to 10.4 percent, as shown in Table 5 below. These penetration rates represent over 90 times more residential customers than what PPL is projecting to achieve over the next five years. It is also notable that, at roughly 1.2 million customers, the total residential customer counts for these two utilities are comparable to PPL's customer counts.

Table 5. Historical Residential Energy Audits provided by National Grid and Eversource in Massachusetts

	2014	2015	2016	2017	2018	5-Year Total
Full Home Energy Assessments						
National Grid MA	24,852	26,659	19,094	22,384	28,247	144,428
Eversource MA	16,590	18,542	14,710	13,575	16,459	96,417
% of 2019 customer counts						
National Grid MA	2.1%	2.3%	1.6%	1.9%	2.4%	10.4%
Eversource MA	1.3%	1.5%	1.2%	1.1%	1.3%	6.4%

Source: EIA 861 database; Mass Save Data, "Home Energy Services Report," Available at https://www.masssavedata.com/Public/HESActivity.

As shown in Table 6, these two utilities in Massachusetts also provided weatherization measures to a large number of customers over the past 5 years. The total number of program participants range from roughly 32,000 to 49,000 or 2.2 to 3.6 percent of the total residential customers. On the other hand, PPL is projecting to provide weatherization measures to just about 2,000 customers or 0.16 percent of its residential customers.

Table 6. Historical Weatherization Measures provided by National Grid and Eversource in Massachusetts

	2014	2015	2016	2017	2018	5-Year Total
Unique customers with Weatherization installations						
National Grid MA	9,279	9,520	7,249	6,251	9,475	48,944
Eversource MA	5,810	6,447	5,506	4,322	4,740	32,431
% of 2019 customer counts						
National Grid MA	0.8%	0.8%	0.6%	0.5%	0.8%	3.6%
Eversource MA	0.5%	0.5%	0.4%	0.3%	0.4%	2.2%

Source: EIA 861 database; Mass Save Data, "Home Energy Services Report," Available at https://www.masssavedata.com/Public/HESActivity.

For non-residential programs, PPL stated that "[t]he Non-Residential Program does not include on-site energy audits" in response to our data request (NRDC-I-12-a). PPL does not plan to promote building envelope measures in the Non-Residential program in the early part of Phase IV but may promote these later as Phase IV progresses (NRDC-I-12-c). As mentioned above, these components are essential for comprehensive programs.

Q. What is your recommendation on energy audits and weatherization measures?

A. We recommend PPL increase the number of residential energy audits and weatherization measures. We further recommend PPL provide energy audits and weatherization measures for non-residential customers as well.

Q. Does PPL propose to offer any financing offerings for its residential customers?

A. PPL indicated it does not provide financing offerings such as low- or no-interest loans or on-bill repayment options to customers participating in its Act 129 programs because it finds that financial institutions are better suited to manage the risks and lending laws associated with such offerings.[5]

Q. Do you agree with PPL's determination regarding financing offerings?

A. We do not. There are proven mechanisms in place in other jurisdictions that can increase customer access to financing for energy efficiency improvements while mitigating risk to the utility. One type of mechanism is the use of utility program funds to buy-down interest rates to facilitate customer access to zero or low-interest loans. There are several examples of interest buy-down programs shown to be beneficial and a cost-effective use of program funds.

- National Grid Rhode Island HEAT Loan program: This loan program works in conjunction with National Grid's EnergyWise Program. The EnergyWise program is similar to PPL's Energy Efficient Homes Audit and Weatherization offering. Customers that receive recommendations for weatherization measures,

[5] PPL Response to NRDC 1-17.

efficient heating systems, and domestic hot water systems from their EnergyWise audit can borrow up to $25,000 for a period of up to seven years at zero-percent interest to finance these improvements. To fund the program, National Grid works with six local financial institution partners in Rhode Island and uses program funds to buy down the interest rate to zero percent. A recent evaluation concluded that the HEAT Loan generated energy efficiency savings for National Grid that would not have otherwise occurred and that the availability of the loan was very important in customers' decisions to install measures following their home energy assessment. The evaluation found that without the HEAT Loan, three-quarters of loan recipients would have canceled, postponed, or reduced their home energy project scope.[6]

- Mass Save® HEAT Loan: This HEAT Loan program mirrors the one offered in Rhode Island. The utilities participating in the administration of the Mass Save program use program funds to buy down the interest due on the loan and the cost to administer the loans. The Mass Save HEAT Loan was recently expanded to cover pre-weatherization safety work and battery storage, if customers agree to participate in an active demand program.[7]

[6] Research Into Action, Inc. HEAT Loan Assessment. November 19, 2018. Available at: http://rieermc.ri.gov/wp-content/uploads/2019/05/heat-loan-assessment-final-report_111918.pdf.
[7] D.P.U. 18-110 – D.P.U. 18-119. Three-Year Plan 2019-2021. October 31, 2018.

Q. What is your recommendation for a residential financing program in PPL's Phase IV Plan?

A. Experience indicates that incentives alone are not sufficient to drive customers to invest in deeper, more comprehensive energy savings. The customer contribution required to make the initial investment in more holistic energy solutions can be a significant barrier to participation. Financing programs have shown to be effective in addressing the barrier to lack of upfront capital. For PPL to adequately encourage deeper energy efficiency enhancements per customer, it needs to address this barrier to participation.

We therefore recommend that PPL carve out funding within its Phase IV Residential Program to facilitate customer access to zero-percent interest financing to fund comprehensive improvements as part of its Energy Efficient Homes offering. PPL should commit to reaching out to local financial institutions to examine partnerships to buy-down interest rates to increase access to financing.

Q. Are there other comprehensive savings measures and program offerings that PPL has not included in its Phase IV Plan?

A. Yes. PPL's plan does not include the following offerings and designs:

- Utilization of AMI technology to enhance program offerings;
- Additional measures such as linear LED and troffer LED lights for non-residential buildings and high efficiency clothes dryer (e.g., heat pump dryer) for residential and small commercial customers;
- A deep energy retrofit pilot for residential and non-residential buildings; and
- A zero net energy pilot for new construction.

Q. Does PPL propose to use its advanced metering infrastructure within its Phase IV Plan?

A. PPL states that it will utilize advanced AMI data for evaluation purposes, but any use beyond that has not yet been determined.[8]

Q. Are there additional opportunities for PPL to utilize AMI to drive additional energy savings?

A. Yes. In addition to use for evaluation, AMI is also a valuable tool for enhancing delivery of energy savings to customers. AMI allows for more granular, transparent, and connected energy data that can enable PPL to personalize savings opportunities for its customers.

For residential customers, AMI can help PPL better understand usage patterns and create more personalized energy usage alerts and recommendations for measures. AMI can be used alongside Home Energy Reports to create more real-time customer engagement and can be incorporated with smart home devices. AMI can also be leveraged alongside the Energy Efficient Homes offering to provide energy optimization integrated audits.

For the Non-Residential sector, PPL can use AMI to obtain disaggregated load profiles that can allow for programs that offer customers continuous commissioning of facilities, smart energy management, and offsite energy management.

[8] PPL Response to NRDC 1-19.

Q. What is your recommendation regarding use of AMI?

Due to the fact that AMI technology is already available within PPL's territory, the Company should take advantage of its capabilities to support new efficiency offerings.

Q. Are there other types of programs or measures that PPL is not planning to implement?

A. Yes. PPL does not include advanced energy efficiency measures and programs such as linear LED and troffer LED lights and high efficiency clothes dryer (e.g., heat pump dryer). PPL also does not include offerings for deep energy retrofits or zero net energy homes in its Phase IV proposed plan.

Q. Please describe high efficiency clothes dryer and linear LED and troffer LED lights.

A. Energy efficiency programs are increasingly providing incentives for high efficiency clothes dryers. For example, in Massachusetts, utilities provide rebates on efficient electric clothes dryers.[9] Both the Northwest Energy Efficiency Alliance and the Northeast Energy Efficiency Partnerships launched initiatives to promote advanced clothes dryers in the North American market several years ago.[10,11] We also note the PECO is proposing to offer incentives for heat pump clothes dryers.[12]

LED linear tube and troffers have also become a standard measure in energy efficiency programs in other jurisdictions. This technology can be used to replace linear fluorescent

[9] MassSave. https://www.masssave.com/shop/appliances/clothes-dryers. Accessed January 12, 2021.
[10] Northwest Energy Efficiency Alliance. NEEA Launches Super-Efficient Dryer Initiative. https://neea.org/news/neea-launches-super-efficient-dryer-initiative. Accessed January 12, 2021.
[11] Northeast Energy Efficiency Partnerships. Hanging Underwear Out to Dry? https://neep.org/blog/hanging-underwear-out-dry. Accessed January 12, 2021.
[12] PECO PY 13 – PY 17 Act 129 – Phase IV Energy Efficiency and Conservation Plan, Table 7A.

lighting in commercial buildings and is now readily available in the market.[13] PPL's Phase IV plan does not include this measure for existing buildings, even though the state wide evaluator (SWE) potential study included this measure as "LED Linear Fixtures."[14] The SWE potential study describes this technology as follows:

> **"**LED linear fixtures are an energy efficient alternative to linear fluorescent fixtures. The LED integrated fixtures offer similar light output with a reduction of energy consumption. Integrated LED fixtures also offer controllability beyond capabilities of linear fluorescent technology and integration with many complex control systems."[15]

Q. What is your recommendation regarding high efficiency dryers and LED linear and troffer lights?

A. Because these technologies are readily available in the market, we recommend PPL include these measures in the Phase IV programs.

Q. Please describe deep energy retrofits.

A. A deep energy retrofit is a whole-building approach to energy efficiency and typically creates a reduction in 50 percent or more of a building's total energy usage.[16] While this measure requires a substantial amount of investment on building envelope measures, it could be cost-effective in some instances, such as when a building uses electric resistance heating.

[13] For example, see the lighting offering for Massachusetts and Rhode Island Bright Opportunities Lighting Program, available at https://www.masssave.com/learn/partners/upstream-lighting
[14] SWE potential study, Appendix D1, Table 2.
[15] SWE potential study, Appendix D1, Table 2.
[16] ACEEE. 2014. Residential Deep Energy Retrofits, Available at https://www.aceee.org/sites/default/files/publications/researchreports/a1401.pdf

If a goal of Act 129 Phase IV is to drive more comprehensive energy savings, it is important to test deep energy retrofit approaches in a pilot program so that PPL can consider incorporating such an approach into its portfolio as a standard measure in the future. This pilot can evaluate the cost and performance of such approaches and find ways to improve costs and performance.

Q. What is a zero net energy building?

A. The U.S. Department of Energy defines zero-net energy building as "an energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy."[17] As distributed energy resources and electrification measures such as cold-climate heat pumps and electric vehicles become more economical and widespread it will become increasingly important to create integration of these resources into PPL's new construction programs. A recent report by the American Council for an Energy-Efficient Economy (ACEEE) recently identified 20 programs (13 residential and 7 commercial) that promote zero-energy and zero-energy-ready homes and buildings.[18]

[17] U.S. Department of Energy. September 2015. *A Common Definition for Zero Energy Buildings*.

[18] Nadel, S. 2020. *Programs to Promote Zero-Energy New Homes and Buildings*. American Council for an Energy-Efficient Economy.

Q. What do you recommend with respect to deep energy retrofits and zero net energy offerings?

A. We recommend that PPL include pilots for both deep energy retrofits and zero net energy buildings in its Phase IV Plan that provides incentives for the achievement of a per building savings goal.

Q. Does PPL propose tiered incentives for its Residential Program in its Phase IV Plan?

A. PPL indicates that it may offer tiered incentives that encourage the installation of multiple measures or a more comprehensive, whole-facility approach. For the Residential Program, PPL further describes that it may provide a Comprehensive Retrofit Bonus Incentive in relation to the implementation of multiple measures offered individually under its Energy Efficient Homes component. This Bonus Incentive would involve two tiers; Tier 1 would offer a $250 bonus rebate for customers that have at least two "major measures" and Tier 2 would offer a $350 bonus rebate for installing three or more "major measures." There is also a requirement that one installed measure must be a building envelope measure (Insulation or Air sealing).[19]

Q. Do you support this proposal?

A. Yes. We recommend that PPL commit to implementing the Comprehensive Retrofit Bonus within the Energy Efficient Homes offering.

[19] PPL Response to NRDC 1-9.

Tiered incentive structures send important financial signals to customers to adopt comprehensive energy efficiency strategies during the small windows in time when they are considering improvements to their homes and facilities. Because there are limited opportunities for utilities to create meaningful touchpoints with customers, once a customer invests in a measure it could be years before they consider making another investment. This creates a lost opportunity to engage the customer in more holistic solutions. Structuring utility programs to incentivize the installation of multiple measures can avoid these lost opportunities.

Q. Does PPL propose similar tiered incentives for the Non-Residential Program?

A. While PPL indicates it may offer tiered incentives for its Non-Residential Program, there is no detail regarding the structure or if the Company is committing to fully implementing this structure.

For the reasons stated above, tiered incentives are a critical piece in encouraging customers to install multiple and more comprehensive measures. We recommend that PPL consider tiered incentives similar to those offered in Connecticut and New York.

In Connecticut, Connecticut Light and Power Company and United Illuminating administer the Energy Opportunities Program. This program includes tiered incentives to encourage deeper energy saving retrofits. The per-kWh incentive increases as more measures are bundled together. For example, in 2020 a single non-lighting end-use measure had a per-kWh incentive of $0.50 with a cap of 50 percent of the installed cost. This increased to $0.60 per kWh for two end-use measures with a cap of 60 percent of the

installed cost and to $0.75 per kWh for three or more end-use measures with a cap of 75 percent.[20]

In New York, National Grid offers a Tiered Incentive Program for Large Commercial and Industrial (C&I) customers in its Upstate New York electric and gas service territories. C&I customers can earn bonus incentives above traditional incentive offerings for three tiers. For Tier 1, if a customer completes three projects, the customer receives a 15-percent bonus incentive. Tier 2 pertains to the completion of four projects and includes a 20-percent bonus incentive. Tier 3 is for customers that complete five projects and has a 25-percent bonus incentive. National Grid allows for flexibility in the timing of these programs to also facilitate the adoption of multiple measures. Customers have two years to complete the projects.[21]

Q. Please explain why PPL should track its performance related to achievement of comprehensive energy savings.

A. Throughout its Phase IV Plan, PPL indicates the importance of achieving deeper, more comprehensive savings. For example, on page 4 of its Plan, PPL states that it "recognizes the need to increase the amount of savings per customer interaction to meet its Phase IV goals." Further, PPL indicates that it has tasked its implementation conservation service providers (CSP) with educating customers on the benefits of holistic energy efficiency strategies and with cross-promoting appropriate solutions that result in more complete

[20] https://www.uinet.com/wps/wcm/connect/www.uinet.com-7188/b4cf87e1-541b-4ea2-89a9-496a5a6bbbcc/C0075-Exisiting-Building-Cap-Sheet-Final-6-2020.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE.Z18_J092I2G0N01BF0A7QAR8BK20A3-b4cf87e1-541b-4ea2-89a9-496a5a6bbbcc-nb3yjxC.

[21] https://www.nationalgridus.com/media/pdfs/bus-ways-to-save/ee7198-uny-tiered-incentive-worksheet_fillable.pdf.

retrofits and higher energy and peak demand savings per participant. PPL further states there will be incentives to CSPs for delivery these outcomes.[22] However, PPL does not indicate it will monitor progress towards these goals.

Table 11 of PPL's Plan identifies several performance indicators and metrics it will use to measure program and component success. Given that comprehensive solutions appear to be a new priority within the Company's Phase IV Plan, it would seem critical to track how well this objective is being met.

We recommend that PPL track the following performance indicators: lifetime kWh, per customer kWh savings, and percentage of energy audits resulting in weatherization (air sealing and insulation). Reporting on these metrics will demonstrate the level of effectiveness of PPL's enhanced Phase IV Plan in delivering more comprehensive savings.

PPL's planning and reporting format obscures program performance

Q. Is there an issue with the way PPL summarized its projected savings and costs?

A. Yes. PPL's summary of projected savings and costs for the Energy Efficient Homes program does not allow us to meaningfully review and evaluate the performance of this program because the data for typical home retrofit measures such as insulation and appliance and equipment rebates are combined together.

[22] PPL Plan at page 25.

Q Please explain this issue in detail.

A. The Energy Efficient Homes program component is composed of three distinct energy efficiency measure and delivery types, namely (a) new homes, (b) audit and weatherization, and (c) energy efficient equipment. Combining these elements through one program component channel streamlines the process for consumers to access these different energy efficiency measures. However, in order to assess the performance of this program component, especially the cost-effectiveness of efficiency measures, consumer uptake, and progress to the targets, it is essential to report and track savings and costs separately for those three separate energy efficiency measure categories. This is because the types of measures and consumers uptake of the measures are likely to be markedly different among those three categories.

Q What is your recommendation for Energy Efficient Homes component?

A. We recommend that PPL provide both costs and energy savings estimates separately for (a) new homes, (b) audit and weatherization, and (c) energy efficient equipment under this program component. We further recommend that PPL provide program achievements in its annual program report separately for each of these categories within the Energy Efficient Homes component.

PPL's incentives for equipment that burns gas and delivered fuel are unnecessary and an inefficient use of ratepayer funds

Q. Please summarize the Commission's Implementation Order pertaining to electric-to-fossil fuel switching.

A. The Commission indicated it would not prevent electric-to-fossil fuel switching. The Commission cites the fact that these measures were adopted as part of the 2021 Technical Reference Manual and are therefore eligible for inclusion in Phase IV. The Commission further noted that such measures were rarely adopted in past years, only accounting for less than one-quarter of 1 percent of verified savings through Program Year 10 of Act 129 Phase III.[23]

Q. Does PPL's Phase IV Plan include electric-to-fossil fuel switching measures?

A. Yes. The table below summarizes PPL's planned electric-to-fossil fuel switching measures for Phase IV.

[23] Implementation Order at pg. 99.

Table 7. Summary of PPL Phase IV Electric-to-Fossil Fuel Switching Measures

Measure	Unit	Incremental Cost ($/unit)	Estimated Useful Life	Incentive Amount ($/unit)	Incentive Amount or Incentive Range ($/unit)	Total Phase IV Planned Savings (MWh/year)	Total Phase IV Participation
Efficient Homes							
Fuel Switching - Central Heating (downstream)	Per Project	$8,600	15	$200	Up to $300	1,135	177
Fuel Switching - DHW (downstream)	Per Project	$1,416	11	$200	Up to $300	301	109
Large C&I Efficient Equipment Rebates							
Fuel Switching	Per Product	N/A	N/A	N/A	Up to $0.22/kWh and/or up to $1,200/kWh first year savings	N/A	N/A
Fuel Switching: electric water heaters to gas/propane	Per Product	N/A	N/A	N/A		N/A	N/A

Source: Table 23. Pa PUC Table 7-Energy Efficient Homes Eligible Measures and Incentives

Q. What are your concerns with PPL's Plan related to electric-to-fossil fuel switching measures?

A. While we understand the Commission has determined it is acceptable for these measures to be included in Phase IV and that planned savings are a small percentage of planned total savings for the residential customer segment,[24] we are concerned that the inclusion of such measures is misaligned with Pennsylvania's long-term climate goals and will result in higher costs to ratepayers.

Q. Please summarize Pennsylvania's climate policies.

A. Over the past several years, Pennsylvania has made increasing commitments to addressing climate change through reduction in greenhouse gas ("GHG") emissions. In January 2019, Governor Wolf issued Executive Order 2019-01 that set GHG reduction

[24] There are no values for C&I savings and participation projections for fuel-switching measures so no assessment can be made to the contribution of these measures to planned Phase IV savings.

targets for the Commonwealth of 26 percent reduction of net GHG emissions statewide by 2025 from 2005 levels, and an 80 percent reduction of GHG emissions by 2050.[25]

Later that year, Governor Wolf announced that Pennsylvania would join the U.S. Climate Alliance, which commits the Commonwealth to implementing policies that advance the goals of the Paris Agreement. He also released the Pennsylvania Climate Action Plan 2018. This new state climate plan includes over 100 actions to meet the new statewide GHG emissions targets. These recommendations include the expansion of energy efficiency and the replacement of high carbon and GHG-producing fuels or energy sources with less environmentally impactful options.[26]

Further, in October 2019, the Governor issued Executive Order 2019-07, which directs the Pennsylvania Department of Environmental Protection ("DEP") to join RGGI and develop a rulemaking package to abate, control, or limit carbon dioxide emissions from fossil-fueled electric power generators.[27]

Q. Does investment in electric-to-fossil fuel switching measures align with these state climate goals?

A. No, they do not. The new fossil fuel heating and hot water systems incented by these programs are long-lived measures. While the Act 129 Technical Reference Manual artificially caps measure lives at 15 years, it is not uncommon for such systems to last upwards of 20 years. Therefore, when PPL incentivizes the installation of a new fossil

[25] Executive Order: 2019-01 – Commonwealth Leadership in Addressing Climate Change and Promoting Energy Conservation and Sustainable Governance. January 08, 2019.
[26] Pennsylvania Climate Action Plan 2018 at pg. 56.
[27] Executive Order-2019-07- Commonwealth Leadership in Addressing Climate Change through Electric Sector Emissions Reductions. October 2019.

fuel-based appliance for heating, venting, and air conditioning (HVAC) equipment at a property, that property is essentially locked into using that fuel for the next 10 to 20 years. As indicated by Electric Power Research Institute, consumers only replace their water heater every 10–15 years and their space heating every 20 years.[28] This creates an outcome in which a more carbon-intensive fuel source is used over the long term, compared to a scenario in which these systems were instead replaced by high-efficiency cold climate heat pumps or heat pump hot water heaters. Promoting fossil fuel-based equipment today will make it harder for the state to achieve its long-term climate goals.

Q. Please explain how continued investment in electric-to-fossil fuel switching measures will increase the overall cost of achieving the state's decarbonization goals.

A. Converting a customer from fossil fuel to electric heating and cooling near the end of the gas equipment's useful life is far more cost-effective compared to converting that customer's equipment when it is relatively new. If PPL's programs continue to invest in long-lasting natural gas, oil, and propane measures, this may lead to a scenario where early retirement conversion is needed for Pennsylvania to achieve its GHG goals. This will cost more than if a customer's equipment was converted at the end of its useful life. In essence, Pennsylvania ratepayers could be paying for the same end-use twice: once with the initial in-kind replacement, and again to switch to electric equipment before the end of the in-kind unit's useful life. If the customer does not switch from fossil-fueled equipment to efficient electric equipment, then other potentially more expensive measures will be needed to reduce GHGs. Either way, the costs are higher.

[28] Electric Power Research Institute (EPRI). 2018. U.S. National Electrification Assessment.

Q. What is your recommendation for treatment of electric-to-fossil fuel switching measures?

A. As other parties commented in response to the Commission's Phase IV Tentative Implementation Order, there is significant potential for savings from measures that reduce electricity without having to increase consumption of carbon emitting fuels.[29] Due to the fact these measures are not needed to meet PPL's Phase IV savings goals, are not aligned with Pennsylvania's GHG goals, and can increase the costs of decarbonatization for ratepayers in the state, we recommend these measures be removed from PPL's Phase IV Plan. In their place, PPL should focus its incentives on the deployment of high-efficiency heat pump water heaters and cold climate heat pumps for its electric customers. High-efficiency heat pumps are approximately 1.5 times more efficient than a natural gas furnace in a particularly cold region and up to more than three times as efficient in a warmer region.[30] NYSERDA also reports that cold climate heat pumps can operate down to a temperature of 5 degrees Fahrenheit while also maintaining an efficiency factor of 1.75 or greater."[31] Such measures are highly cost-effective for customers switching from electric resistance heat and should be the first choice for Act 129 programs.

[29] Comments of the Environmental Stakeholders and the Keystone Energy Efficiency Alliance (KEEA) on the Phase IV Tentative Implementation Order.
[30] EPRI at 31.
[31] NYSERDA. 2017. Renewable Heating and Cooling Policy Framework: Options to Advance Industry Growth and Markets in New York. page 15, available at https://www.nyserda.ny.gov/-/media/Files/Publications/PPSER/NYSERDA/RHC-Framework.pdf.

Q. What can PPL do to increase adoption of cold climate heat pumps and other high-efficiency electric measures?

A. Advancements in heat pump technology have improved control and comfort for homeowners.[32]When weatherization is conducted along with installation of heat pumps, customers can reduce the system size and the cost of the heat pump. This will make it easier for heat pumps to serve all or most of the heating load for a building. A recent survey by the American Council for an Energy Efficient Economy (ACEEE) found eight energy efficiency programs require weatherization as part of heat pump installations and encourages such an approach.[33]

Due to the superior performance of cold climate heat pumps mentioned above, several states are creating targets for deployment of heat pumps. Maine has a target of 245,000 homes (48 percent of the housing stock) with heat pumps installed by 2030; Massachusetts is examining the potential for a target of converting one million homes (40 percent of the housing stock) to heat pumps by 2030; and Colorado's GHG Plan has a target of installing heat pumps in 200,000 homes by 2030.[34]

Advancements notwithstanding, PPL customers face barriers to the adoption of heat pumps and heat pump water heaters. PPL can address these barriers in its Phase IV Plan in several ways. PPL can structure incentives to adequately address higher upfront costs and create optimal delivery channels. It can expand customer education and outreach

[32] https://www.aceee.org/sites/default/files/pdfs/programs_to_electrify_space_heating_brief_final_6-23-20.pdf
[33] Steven Nadel. Programs to Electrify Space Heating in Homes and Buildings, ACEEE, available at https://www.aceee.org/sites/default/files/pdfs/programs_to_electrify_space_heating_brief_final_6-23-20.pdf
[34] Gartman, M. and Shah, A. 2020. *Heat Pumps: A Practical Solution for Cold Climates.* Rocky Mountain Institute.

channels to increase awareness of the technology and importance of weatherization. PPL can also provide post-installation training on proper use of heat pumps, and it can also facilitate programs to train installers and builders on right-sizing and proper installation. It can take time for consumers to embrace a new technology and it is therefore critical that PPL seek to increase adoption and market transformation of heat pump measures during its Phase IV Plan.

PPL does not provide clarity on its plans to bid into PJM market

Q. Please describe the Commission's guidance regarding bidding EE&C resources into the PJM capacity market.

A. The Phase IV implementation order calls for the EDCs to nominate a portion of the projected peak demand resources in their EE&C Plans into PJM's capacity market.[35]

Q. Has PPL provided this information?

A. No, although PPL does describe its approach for managing the bidding process. PPL plans to use competitive procurement to select a vendor who can help assist bidding capacity into the PJM market.

Q. Do you have any comments on this approach?

A. Yes. PJM suspended its capacity market auction for the 2022/2023 and 2023/2024 Delivery Years while the Federal Energy Regulatory Commission considers new rules for the PJM capacity market construct.[36] Given the uncertainties around when the next

[35] Phase IV order, page 70.

[36] PJM. PJM Message Regarding Suspension of Reliability Pricing Model Base Residual Auction Activities and Deadlines Until Further Notice. https://www.pjm.com/-/media/markets-ops/rpm/rpm-auction-info/2022-

auction will be held, PPL's approach, i.e., competitive procurement of services to manage bidding, is reasonable. However, we note that the uncertainty regarding the PJM capacity auction does not prevent PPL from providing an estimate of peak reductions to be bid under a reasonable set of assumptions.

Q. What do you recommend?

A. We recommend that PPL provide its estimate of Phase IV peak demand reductions, by proposed program component and measure, that it plans to bid into PJM's capacity market, its assumptions about the market, and an estimate of related auction proceeds. Further, when there is more clarity about the changes to the capacity market, we recommend that PPL consider Reliability Pricing Model (RPM) requirements when it designs its programs, in order to optimize these proceeds.

4. ALIGNING EE&C WITH POLICY GOALS

Q. Please describe recent climate policy developments in Pennsylvania.

A. As noted above, Governor Wolf's EO 19-07 charged the Pennsylvania DEP with developing a proposed rulemaking package to abate, control, or limit carbon dioxide emissions from fossil-fuel-fired electric power generators. EO 19-07 specified that the proposed rulemaking should include auctions of emission allowances and align with RGGI, a cooperative regional cap-and-invest program of 10 participating New England

2023/2022-2023-pjm-message-regarding-suspension-of-rpm-base-residual-auction-activities-and-deadlines-until-further-notice.ashx#:~:text=As%20such%2C%20PJM%20is%20suspending,2024%20Delivery%20Years%20(DYs).&text=ashx)%20directing%20PJM%20not%20to,FERC%20establishes%20the%20new%20rules.

and Mid-Atlantic states. Pursuant to EO 19-07, DEP developed its proposed rulemaking to establish a program to limit carbon dioxide emissions from fossil-fired electric generating units with a nameplate capacity of 25 megawatts or greater starting in 2022.[37,38] DEP presented this proposed rulemaking to the Pennsylvania Environmental Quality Board ("EQB"). The EQB adopted the proposed rulemaking on September 15, 2020.[39]

Q. What is the current status of the proposed rulemaking?

A. The EQB is currently accepting public comments on its proposed rulemaking. The comment period is open through January 14, 2021.[40]

Q. How will Pennsylvania's entering RGGI impact the role of energy efficiency?

A. While it has not been determined how auction proceeds will be used, energy efficiency is likely to play a major role in the Commonwealth's approach to RGGI compliance. It is also likely that energy efficiency will receive RGGI allowance revenues. Energy efficiency is highly cost-effective and one of the lowest cost means of curbing GHG emissions. Consequently, energy efficiency will likely figure prominently in Pennsylvania's strategy for reducing emissions for RGGI compliance, and it will almost

[37] Pennsylvania Environmental Quality Board. Proposed Rulemaking: CO2 Budget Trading Program. [25 PA. CODE CH. 145]. Available at https://www.dep.pa.gov/PublicParticipation/EnvironmentalQuality/Pages/default.aspx.

[38] Pennsylvania Department of Environmental Protection. Proposed Rulemaking Annex A: Title 25. Environmental Protection, Part I. Department of Environmental Protection, Subpart C. Protection of Natural Resources, Article III. Air Resources, Chapter 145. Interstate Pollution Transport Reduction, Subchapter E. CO2 Budget Trading Program. Available at https://www.dep.pa.gov/PublicParticipation/EnvironmentalQuality/Pages/default.aspx.

[39] Environmental Quality Board, Meeting Minutes, September 15 2020. Available at: http://files.dep.state.pa.us/PublicParticipation/Public%20Participation%20Center/PubPartCenterPortalFiles/Environmental%20Quality%20Board/2020/November%2017/9.15.20%20EQB%20Minutes_FINAL.pdf.

[40] Pennsylvania Department of Environmental Protection. Regional Greenhouse Gas Initiative. Available at https://www.dep.pa.gov/Citizens/climate/Pages/RGGI.aspx, accessed January 11, 2021.

certainly play a larger role than it has in the past. The proposed rulemaking calls for establishing a strategic set-aside for funding to "encourage and foster promotion of energy efficiency measures, promote renewable or noncarbon-emitting energy technologies, and stimulate or reward investment in the development of innovative carbon emissions abatement technologies."[41] Moreover, the modeling for the proposed rulemaking assumed that a portion of statewide average annual allowance revenues, estimated at $261 million per year, would be invested in energy efficiency.[42] In the modeling, the investment in energy efficiency ranged from 10 to 31 percent, or $26 million to over $80 million, of annual allowance revenues *every year*. For comparison, if we assume the higher end of the range used in the RGGI modeling and that the share of these funds directed toward PPL's service area will be similar to the service area's share of Act 129 funding, there would be $20 million additional funds every year for energy efficiency in PPL's territory. For comparison, PPL's proposed annual budget for the EE&C programs is ranges from $60.6 million to $64.1 million for the Phase IV period.[43]

[41] Pennsylvania Environmental Quality Board. Proposed Rulemaking: CO2 Budget Trading Program. [25 PA. CODE CH. 145]. Available at https://www.dep.pa.gov/PublicParticipation/EnvironmentalQuality/Pages/default.aspx.

[42] PA DEP and ICF. 2020. Pennsylvania RGGI Modeling Report. Available at http://files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/RGGI/PA_RGGI_Modeling_Report.pdf.

[43] PPL Plan, p. 14.

Q. Should the Commission wait for the next program cycle to consider these issues?

A. No. The Commission rightly notes that some parameters for Pennsylvania's participation have yet to be determined.[44] However, the current timeline for entry into RGGI is before the end of the Phase IV period. As noted above, the DEP's proposed rulemaking calls for carbon dioxide requirements starting in 2022, well before the end of the five-year program period for Phase IV. This timeline calls for proactive, careful planning. The PUC can begin laying the groundwork for these changes now, so that the state is in a better position to implement them once more is known about the specifics. The sooner the state implements changes to address RGGI, the better for ratepayers.

Q. Does the modeling reflect a commitment to provide RGGI auction proceeds to energy efficiency?

A. No. However, such a commitment would be consistent with how other RGGI states use their allowance revenues. Across all RGGI states, 38 percent of 2018 allowance revenues were invested in energy efficiency.[45]

Q. Will the rulemaking process impact how Act 129 EE&C programs should be implemented?

A. Mostly likely. The decision about how to use RGGI funds is under the purview of the DEP. To leverage the existing energy efficiency infrastructure, it is likely that DEP's approach will involve expanding or supplementing the utilities' efforts under the EE&C programs, rather than duplicating or recreating these programs. Whether the utilities'

[44] TRC Test Order, p. 72-72.
[45] Regional Greenhouse Gas Initiative, Inc. 2020. The Investment of RGGI Proceeds in 2018. https://www.rggi.org/sites/default/files/Uploads/Proceeds/RGGI_Proceeds_Report_2018.pdf.

EE&C programs shift in focus or increase under RGGI, the commonwealth's entrance into RGGI will have important implications for the Act 129 programs.

Q. What information will stakeholders need for assessing and developing an approach to energy efficiency under RGGI?

A. The design and mix of energy efficiency programs should be informed by the emissions that they are likely to displace. This requires understanding when energy efficiency measures save energy on an hourly basis throughout the year (typically called hourly savings profiles). Hourly savings profiles would present information for a typical use pattern for participants in relevant efficiency programs. Data on all measures (or groups of measures) currently offered by the EE&C programs and for all technically feasible measures would be needed to shed light on an optimal measure mix.

Optimizing energy efficiency under RGGI also requires understanding whether and to what extent energy efficiency resources are likely to reduce electricity production by fossil-fired power plants. This involves identifying what resources are dispatched to meet the electricity needs of customers in Pennsylvania at different times of the day and of the year, the plants that are highest cost and are therefore most likely to be displaced by energy efficiency, and the emissions of these units. These can be compiled into marginal emissions rates per MWh of energy reduced.

Q. Are there existing studies addressing hourly efficiency savings or emissions rates?

A. We are not aware of such studies for Pennsylvania. While the SWE Potential Study provides a good foundation for planning for an expansion of energy efficiency, it does not appear to have used or developed hourly measure savings profiles.

PJM conducts marginal emissions analyses, which look at the emissions for the PJM system as a whole. To support planning for participation in RGGI, Pennsylvania should study the emissions from units that serve customers in the commonwealth.

If these data have not yet been analyzed, we recommend that PPL, in coordination with the other EDCs, conduct both of these studies.

Q. Does this conclude your direct testimony?

A. Yes, it does.

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PROFESSIONAL EXPERIENCE

Synapse Energy Economics, Inc., Cambridge, MA. *Senior Associate*, June 2013 – present; *Associate*, July 2008 – June 2013; *Research Associate*, April 2005 – July 2008.

- Provide expert analysis, ongoing stakeholder support, and consulting services in regulatory proceedings regarding energy efficiency program design and performance, funding and incentive mechanisms, evaluation, cost-effectiveness screening, avoided costs, potential studies, and plans. Develop and sponsor testimony and formal comments on electric and natural gas energy efficiency plans, advanced metering infrastructure (AMI) proposals, and innovative programs and regulatory structures.
- Develop a cost-effectiveness tool, program designs, and case studies to facilitate incorporating strategic energy management programs into energy efficiency program administrators' portfolios for commercial and industrial customers.
- Design research approach, manage team, and conduct a sweeping analysis of energy efficiency potential studies from utilities, states, and regions across the U.S.
- Conduct extensive research on low-income energy efficiency efforts in U.S. states. Analyze energy burden differences between low-income and non-low-income households, and across factors that can impact participation in and efficacy of energy efficiency programs, to inform efficiency program design and targeting efforts. Provide consulting services and testimony on low-income energy efficiency programs and proposals.
- Facilitate residential, commercial, and industrial policy working groups and manage technical analysis of working group recommendations to reduce greenhouse gas (GHG) emissions in Colorado, South Carolina, and Maryland.
- Research and analyze historical emissions of criteria and hazardous air pollutants, greenhouse gases, and coal combustion wastes. Research and develop potential state and local emissions mitigation strategies, such as strategies for reducing ambient fine particulates in New York City.
- Conduct surveys of regional, state, and utility policies and practices regarding ratemaking for energy efficiency, power procurement, risk management, and fuel diversity. Research federal, regional, and state policies and case histories on integrated resource planning, power procurement, power plant operations, renewable portfolio standards, and market power.
- Conduct research for modelling macroeconomic impacts of policies that reduce oil production.

Resource Insight, Inc., Arlington, MA. *Research Assistant*, 2003-2005.

Responsible for conducting research and analysis of electric, gas, steam, and water resource issues. Conducted discounted cash flow analysis for asset valuation. Developed market-price benchmarks for analysis of power-supply bids including energy, capacity, ancillary services, transmission, ISO services, losses, and adjustment for load shape. Prepared discovery responses, formal objections, comments, and testimony; collaboratively wrote and edited reports; created and formatted exhibits. Participated in drafting an Energy Plan for New York City. Edited solicitation for competitive power supply to serve aggregated municipal load.

University of Massachusetts, Amherst, MA. *Teaching Assistant*, 2001-2002.

Developed and taught lessons on applied math to a diverse group of incoming graduates; tutored students in microeconomic theory and cost benefit analysis; graded problem sets and memoranda.

International Council for Local Environmental Initiatives, Berkeley, CA. *Cities for Climate Protection Intern for the City of Northampton, MA*, 2001.

Compiled primary and secondary source data on energy consumption and solid waste generation by the municipal government, city residents, and businesses; applied emissions coefficients to calculate total GHG emissions; identified current and planned municipal policies that impact GHG emissions; researched the predicted local effects of global warming ; gathered public feedback to provide acceptable and proactive policy alternatives. Composed a GHG emissions inventory describing research findings; wrote and distributed a policy report and press releases; gave newspaper and radio interviews; addressed public officials and the public during a televised meeting.

University of Massachusetts, Amherst, MA. *Research Assistant*, 2000-2001.

Located federal data sources, identified changes, and updated a research database to evaluate the Habitat Conservation Program; proofread articles and white papers; composed a literature review on land use modelling. Collaboratively administered, tested, and proposed interface enhancements for a web-based data warehouse of regional habitat change research; formally presented the system to an independent research group.

Court Square Data Group, Inc., Springfield, MA. *Administration Manager*, 1998-2000; *Project Administrator*, 1996-1998.

As Administration Manager, analysed profitability and diversity of income sources; managed cash flow, expense, and income data; created budgets; devised and implemented procedures to increase administrative efficiency; implemented new accounting system with minimal disruption to workflow.

As Project Administrator, coordinated implementation of software features; identified opportunities for future development; monitored problem resolution; wrote and coordinated production of a user's manual and questionnaires; edited technical proposals and a business plan.

EDUCATION

University of Massachusetts, Amherst, MA
Master of Public Administration, 2002

Rutgers University, New Brunswick, NJ
Bachelor of Arts in Economics, 1995

Syracuse University, Syracuse, NY, 1994

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Napoleon, A., W. Steinhurst, M. Chang, K. Takahashi, R. Fagan. 2010. *Assessing the Multiple Benefits of Clean Energy: A Resource for States.* US Environmental Protection Agency with research and editorial

support from Stratus Consulting, Synapse Energy Economics, Summit Blue, Energy and Environmental Economics, Inc., Demand Research LLC, Abt Associates, Inc., and ICF International.

Napoleon, A., D. Schlissel. 2009. *Economic Impacts of Restricting Mountaintop/Valley Fill Coal Mining in Central Appalachia*. Synapse Energy Economics for Sierra Club, and Appalachian Center for the Economy and the Environment.

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Drunsic, M., A. Napoleon, E. Hausman, R. Hornby. 2007. *Arkansas Electric Generation Fuel Diversity: Implementation of EPAct 2005 Amendments to PURPA Section 111 (d)*. Synapse Energy Economics for Arkansas Public Service Commission Staff.

Hausman, E., R. Fagan, D. White, K. Takahashi, A. Napoleon. 2007. *LMP Electricity Markets: Market Operations, Market Power, and Value for Consumers*. Synapse Energy Economics for American Public Power Association.

Synapse Energy Economics. 2006. *Portfolio Management: Tools and Practices for Regulators*. Prepared for National Association of Regulatory Utility Commissioners.

Steinhurst, W., A. Napoleon, K. Takahashi. 2006. *Energy in the Northern Forest Region: A Situation Analysis*. Synapse Energy Economics for Northern Forest Center and The North Country Council.

Synapse Energy Economics. 2006. *Ensuring Delaware's Energy Future: A Response to Executive Order Number 82*. Synapse Energy Economics for Delaware Public Service Commission Staff by the Delaware Cabinet Committee on Energy and others.

Fagan, R., A. Napoleon, A. Rochelle, A. Sommer, W. Steinhurst, D. White. K. Takahashi. 2006. *Mohave Alternatives and Complements Study: Assessment of Carbon Sequestration Feasibility and Markets.* Sargent & Lundy and Synapse Energy Economics, Inc. for Southern California Edison.

TESTIMONY

New York Public Service Commission (Cases 20-E-0380 and 20-G-0381): Direct testimony of Alice Napoleon and Kenji Takahashi regarding proposed earnings adjustment mechanisms in a proceeding on Rates, Charges, Rules, and Regulations related to Niagara Mohawk Power Corporation d/b/a National Grid for Electric Service and National Grid for Gas Service. On behalf of the Natural Resources Defense Council. November 25, 2020.

California Public Utilities Commission (Application Nos. 19-11-003, 19-11-004, 19-11-005, 19-11-006): Prepared Testimony of Alice Napoleon addressing proposals of Pacific Gas and Electric Company, San Diego Gas & Electric Company, Southern California Edison Company, and Southern California Gas Company related to the Energy Savings Assistance (ESA) Program and Budgets for Program Years 2021-2026. On behalf of The Utility Reform Network. September 4, 2020.

California Public Utilities Commission (Application Nos. 19-11-003, 19-11-004, 19-11-005, 19-11-006, 19-11-007): Comments of The Utility Reform Network on the Energy Division Staff Proposal and Utility Applications. On behalf of The Utility Reform Network. July 24, 2020.

Nova Scotia Utility and Review Board (Matter No. M09096): Evidence of Alice Napoleon regarding EfficiencyOne's 2020-2022 DSM Plan. On behalf of Counsel to the Nova Scotia Utility and Review Board. May 28, 2019.

New York Public Service Commission (Cases 19-E-0065 and 19-G-0066): Direct testimony of Tim Woolf and Alice Napoleon regarding energy efficiency targets and incentives in Con Edison rate case. On behalf of the Natural Resources Defense Council. May 24, 2019.

Nova Scotia Utility and Review Board (Matter No. M08604): Evidence of Alice Napoleon regarding the 2019 Demand Side Management Resource Plan. On behalf of Counsel to the Nova Scotia Utility and Review Board. June 13, 2018.

Nova Scotia Utility and Review Board (Matter No. M08349): Evidence of Alice Napoleon regarding Nova Scotia Power's Advanced Meter Infrastructure Proposal. On behalf of Counsel to the Nova Scotia Utility and Review Board. January 18, 2018.

Nova Scotia Utility and Review Board (Case No. M07767): Direct evidence in the matter of the Nova Scotia Power Advanced Meter Infrastructure Pilot. On behalf of Counsel to the Nova Scotia Utility and Review Board. February 16, 2017.

Public Service Commission of South Carolina (Docket No. 2016-223-E): Direct Testimony of Alice Napoleon regarding South Carolina Electric and Gas Energy Efficiency Efforts. On behalf of South Carolina Coastal Conservation League. September 1, 2016.

Nova Scotia Utility and Review Board (Case No. M06247): Direct evidence in the matter of an application by Efficiency Nova Scotia Corporation for approval of its electricity demand-side management plan for 2015. On behalf of Counsel to the Nova Scotia Utility and Review Board. July 14, 2014.

TESTIMONY ASSISTANCE

Public Service Commission of South Carolina (Docket No. 2017-2-E): Direct Testimony of Thomas Vitolo, PhD regarding Avoided Cost Calculations and the Costs and Benefits of Solar Net Energy Metering for South Carolina Electric & Gas Company. On behalf of South Carolina Coastal Conservation League and Southern Alliance for Clean Energy. March 22, 2017.

State of New Jersey Board of Public Utilities (Docket No. ER16060524): Direct testimony of Tim Woolf regarding the Petition of Rockland Electric Company for Approval of an Advanced Metering Program, and for Other Relief. On behalf of New Jersey Division of the Ratepayer Advocate. September 9, 2016.

Nova Scotia Utility and Review Board (Matter No. M06733): Direct testimony of Tim Woolf regarding EfficiencyOne's 2016-2018 demand-side management plan. On behalf of the Nova Scotia Utility and Review Board. June 2, 2015.

Missouri Public Service Commission (File No. EO-2015-0055): Rebuttal and surrebuttal of Tim Woof on the topic of Ameren Missouri's 2016-2018 Energy Efficiency Plan. On behalf of Sierra Club. March 20, 2015 and April 27, 2015.

State of New Jersey Board of Public Utilities (Docket No. EO14080897): Direct testimony of Kenji Takahashi regarding the Petition of Public Service Electric & Gas Company to continue its Energy Efficiency Economic Extension Program on a Regulated Basis (EEE Extension II). On behalf of New Jersey Division of the Ratepayer Advocate. November 7, 2014.

Kentucky Public Service Commission (Case No. 2014-00003): Direct testimony of Tim Woof regarding Louisville Gas and Electric Company and Kentucky Utilities Company's proposed 2015-2018 demand-side management and energy efficiency program plan. On behalf of Wallace McMullen and the Sierra Club. April 14, 2014.

State of New Jersey Board of Public Utilities (Docket No. GO12050363): Direct testimony of Maximilian Chang regarding South Jersey Gas Company's proposal to extend and modify its energy-efficiency programs. On behalf of New Jersey Division of the Ratepayer Advocate. November 9, 2012.

State of New Jersey Board of Public Utilities (Docket No. GO12070640): Direct testimony of Robert Fagan regarding New Jersey Natural Gas Company's petition for approval of the extension of the SAVEGREEN energy efficiency programs. On behalf of the New Jersey Division of the Ratepayer Advocate. October 26, 2012.

State of New Jersey Board of Public Utilities (Docket No. GO11070399): Direct testimony of Robert Fagan regarding Elizabethtown Gas Company's Proposed Energy Efficiency Program. On behalf of New Jersey Division of the Ratepayer Advocate. December 16, 2011.

State of New Jersey Board of Public Utilities (Docket No. GR11070425): Direct testimony of Robert Fagan regarding New Jersey Natural Gas Company's petition for approval of the extension of the SAVEGREEN energy efficiency programs. On behalf of the New Jersey Division of the Ratepayer Advocate. November 16, 2011.

State of New Jersey Board of Public Utilities (Docket No. GR10030225): Direct testimony of David Nichols regarding New Jersey Natural Gas Company's Proposed Energy Efficiency Program. On behalf of New Jersey Division of the Ratepayer Advocate. July 9, 2010.

Virginia State Corporation Commission (Case No. PUE-2009-00097): Direct testimony of William Steinhurst regarding Appalachian Power Company's Integrated Resource Plan filing pursuant to Va. Code

§ 56-597 et seq. On behalf of the Southern Environmental Law Center, Chesapeake Climate Action Network, Appalachian Voices, and the Virginia Chapter of The Sierra Club. March 23, 2010.

Delaware Public Service Commission (Docket No. 07-20): Jointly authored an expert report, with Robert Fagan, William Steinhurst, David White, and Kenji Takahashi, In the Matter of Integrated Resource Planning for the Provision of Standard Offer Service by Delmarva Power & Light Company Under 26 DEL. C. §1007 (c) & (d). On behalf of the Staff of Delaware Public Service Commission. April 2, 2009.

State of New Jersey Board of Public Utilities (BPU Docket EM05020106): Direct and surrebuttal testimony of Bruce Biewald, Robert Fagan, and David Schlissel regarding the Joint Petition Of Public Service Electric and Gas Company And Exelon Corporation For Approval of a Change in Control Of Public Service Electric and Gas Company And Related Authorizations. On behalf of New Jersey Division of the Ratepayer Advocate. November 14, 2005 and December 27, 2005.

Illinois Commerce Commission (Dockets 05-0160, 05-0161, 05-0162): Direct testimony of William Steinhurst regarding Ameren's proposed competitive procurement auction (CPA). On behalf of Illinois Citizens Utility Board. June 15, 2005 and August 10, 2005.

Illinois Commerce Commission (Docket 05-0159): Direct testimony of William Steinhurst regarding Commonwealth Edison's Proposal to implement a competitive procurement process. On behalf of Illinois Citizens Utility Board and Cook County State's Attorney's Office. June 8, 2005 and August 3, 2005.

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PROFESSIONAL EXPERIENCE

Synapse Energy Economics Inc, Cambridge, MA. *Senior Associate, 2015–present; Associate*, 2004–2015.

Analyzes technologies, policies, and regulations associated with supply- and demand-side energy resources. Assesses the performance, costs, and potential of energy efficiency measures, renewable energy resources, and building decarbonization and electrification measures. Examines economic and environmental implications of clean energy policies and programs associated with energy efficiency, demand response, distributed generation, and renewable energy. Analyzes ratemaking issues such as standby rates and time of use rates for distributed generation, and decoupling rate mechanisms for energy efficiency measures. Investigates electricity and natural gas market price trends and fluctuations. Prepares expert testimony and reports for regulatory proceedings.

Center for Energy and Environmental Policy, University of Delaware, Newark, DE. *Research Associate*, 2002 – 2004.

Researched the market potential of distributed resources under different electric distribution rate designs (report prepared for Conectiv Power Delivery Company). Investigated the potential of the Clean Development Mechanisms (CDM) in Asian developing countries and the Japanese government's policy for CDM. Contributed to a market penetration study for photovoltaic technologies in comparison with the predicted oil production from the oil reservoirs in the Arctic National Wildlife Refuge (report prepared for Astropower, Inc.). Analyzed the installation of PV and generation-set options for the Assateague Beach Coastal Guard Station at the Assateague Island National Seashore in Maryland (report prepared for the U.S. National Park Service).

Delaware Division of Public Advocate, Wilmington, DE. *Research Intern*, 2003.

Researched and wrote reports on states' policies regarding (1) energy efficiency/load management programs in order to identify cost-effective programs for implementation in Delaware; (2) electric standard offer service/default service (rate designs) for those who do not choose alternative suppliers under the deregulation process; (3) electric universal service and system benefit charges for protecting consumers from risks associated with electricity restructuring; and (4) Contributions and Advances-in-Aid-of-Construction for water supply extensions.

Resources for the Future, Washington DC. *Research Intern*, 2002.

Investigated current and planned wind power capacity for the United States. Analyzed the EPA and EIA market models to estimate technical and economic potential of wind power in the United States.

Researched the status of renewable energy supply in Japan's electricity sector for the Economic and Social Research Institute, Cabinet Office, Government of Japan.

Citizens' Alliance for Saving the Atmosphere and the Earth (CASA), Osaka, Japan. *Volunteer and Researcher*, 1999 – 2001.

Worked as a newsletter writer, editor, and event organizer. Wrote a report on the first experimental biomass energy facility in Japan and the photovoltaic system at Yagi Junior High School in Kyoto, Japan. Participated in a research project to investigate renewable energy potential and policies in Japan. Wrote a report on problems of nuclear power plants affecting communities in Fukui prefecture, Japan.

EDUCATION

University of Delaware, **Center for Energy and Environmental Policy, Joseph R. Biden, Jr School of Public Policy and Administration**, Newark, DE
Master of Arts in Urban Affairs and Public Policy with a focus on Energy and Environmental Policy, 2003. Master's thesis: *Policies to Support Distributed Resources under Different Electricity Restructuring Models*. Courses in energy economics, energy and environmental policy, electricity policy and planning, political economy of environment, solar electric technology, cost-benefit and decision-making analyses, and geographic information system.

Kansai University, Osaka, Japan
Bachelor of Arts in Law with a concentration in Public Administration, 2000.

AWARDS AND SCHOLARSHIPS

- Director's Citation, Joseph R. Biden, Jr School of Public Policy and Administration, University of Delaware. May 2003.
- NEC scholarship for an environmental education leader-training program funded by one of the leading Japanese computer companies, NEC. November 2000.

ADDITIONAL SKILLS

Software: MS Office, Minitab, Analytica, RETScreen, and REM/Rate™
Language: Japanese, Cantonese, and Spanish

OTHER RELEVENT WORK

- Currently assessing Puget Sound Energy's Energize Eastside project proposal on behalf of the City of Newcastle. The focus of this assessment is on (a) the reasonableness of the utility's historical loads and load forecasts including energy efficiency, demand response, and distributed energy resources; and (b) whether there is a need to build new

transmission infrastructure as proposed under the company's Energize Eastside project proposal.

- Assisted NYSERDA with developing (a) a database of renewable heating and cooling (RH&C) technologies, (b) an Excel-based tool to analyze benefits and costs of RH&C, and (c) a state RH&C Policy Framework titled "Renewable Heating and Cooling Policy Framework: Options to Advance Industry Growth and Markets in New York."
- Assisted U.S. EPA with its analysis for and preparation for technical support documents on energy efficiency associated with U.S. EPA's Clean Power Plan under 111(d) regulation
- Assisted New Jersey Division of Rate Counsel with reviewing and commenting on various energy related proposals and documents in New Jersey including utility and the state energy efficiency programs and the state's energy plans. 2009 to present.
- Assisted Nova Scotia Utility and Review Board with a review of energy efficiency potential and integrated resource planning for Nova Scotia Power's jurisdiction. 2013
- Assisted the Hawaii Division of Consumer Advocacy in proceedings to develop and review IRPs for three electric companies and to review the state's energy efficiency programs. 2012 to 2014.
- Assisted the Arkansas Public Service Commission staff with (a) reviewing and assessing utility integrated resource planning and energy efficiency program proposals and (b) drafting regulatory orders on comprehensive energy efficiency program designs and reporting methods. 2012 to 2013.
- Assessed on behalf of Sierra Club energy efficiency and demand response potential estimates by the Cadmus Group for Puget Sound Energy, September 2012.
- Assumed a general contractor role for renovating an existing multi-family house into an ultra-low energy use house equipped with state-of-art energy efficiency measures (such as R-7 windows, R-70 roof insulation, a 95 percent efficient energy recovery ventilation system, cold climate heat pumps) and a 5 kW solar photovoltaic system. December 2012.
- Assessed on behalf of Sierra Club energy efficiency goals proposed in the Los Angeles Department of Water and Power's 2010 integrated resource plan.
- Assisted Nova Scotia Utility and Review Board with developing Community Based Feed-In Tariffs (COMFITs) for five different technologies: small wind projects, medium-sized wind projects, small hydro, small tidal, and biomass CHP projects. April 2011.
- Analyzed existing deep energy retrofit (DER) project data and analyzed potential energy savings from model partial DER projects (e.g., attic, above-grade wall, windows, basement wall) using REM/Rate building energy software and Synapse's own spreadsheet building energy model developed for this research project. The results from the analysis were used to project energy savings from and to set incentive levels for partial DER projects as part of National Grid's 2013-2015 efficiency program filing.
- Assisted several states, including Alaska, Colorado, Florida, Maryland, Massachusetts, and South Carolina with developing and analyzing their state climate change action plans;

evaluated costs and benefits of demand and supply-side policy options, including quantifying expected greenhouse emission reductions. 2007 to 2010.

- Arranged meetings for Union Fenosa/Gas Natural, a Spanish electric and gas company, with Japanese and Korean organizations to study energy efficiency technologies, programs and policies in those countries; Visited Japanese organizations with the delegates of Union Fenosa, provided them technical and translation assistance on energy efficiency in Japan. July 26 to July 31, 2009.

PUBLICATIONS

Hopkins, A. S., A. Napoleon, K. Takahashi. 2020. *Gas Regulation for a Decarbonized New York: Recommendations for Updating New York Gas Utility Regulation.* Synapse Energy Economics for Natural Resources Defense Council.

Takahashi, K., A. Napoleon. 2020. *Synapse Comments on EfficiencyOne Performance Alignment Study - M09096.* Questions and comments regarding the EfficiencyOne Performance Alignment Study filed on April 21, 2020. Synapse Energy Economics for the Nova Scotia Utility and Review Board.

Napoleon, A., J. Kallay, K. Takahashi. 2020. *Utility Energy Efficiency and Building Electrification Portfolios Through 2025: A Brief on the New York Public Service Commission's Recent Order.* Synapse Energy Economics for the Natural Resources Defense Council.

Kallay, J., A. Hopkins, J. Frost, A. Napoleon, K. Takahashi, J. Slason, G. Freeman, D. Grover, B. Swanson. 2019. *Net Zero Energy Roadmap for the City of Burlington, Vermont.* Synapse Energy Economics and Resource Systems Group for Burlington Electric Department.

White, D., K. Takahashi, M. Whited, S. Kwok, D. Bhandari. 2019. *Memphis and Tennessee Valley Authority: Risk Analysis of Future TVA Rates for Memphis.* Synapse Energy Economics for Friends of the Earth.

Napoleon, A., T. Woolf, K. Takahashi, J. Kallay, B. Havumaki. 2019. *Comments in the New York Public Service Commission Case 18-M-0084: In the Matter of a Comprehensive Energy Efficiency Initiative.* Comments related to NY Utilities report regarding energy efficiency budgets and targets, collaboration, heat pump technology, and low- and moderate-income customers and requests for approval. Synapse Energy Economics on behalf of Natural Resources Defense Council.

Havumaki, B., J. Kallay, K. Takahashi, T. Woolf. 2019. *All-Electric Solid Oxide Fuel Cells as an Energy Efficiency Measure.* Synapse Energy Economics for Bloom Energy.

Takahashi, K., B. Havumaki, J. Kallay, T. Woolf. 2019. *Bloom Fuel Cells: A Cost-Effectiveness Brief.* Synapse Energy Economics for Bloom Energy.

Napoleon, A., D. Goldberg, K. Takahashi, T. Woolf. 2019. *An Assessment of Prince Edward Island Energy Corporations' 2018 - 2021 Energy Efficiency and Conservation Plan.* Synapse Energy Economics for Carr, Stevenson and MacKay as Counsel to the Island Regulatory and Appeals Commission.

Camp, E., B. Fagan, J. Frost, D. Glick, A. Hopkins, A. Napoleon, N. Peluso, K. Takahashi, D. White, R. Wilson, T. Woolf. 2018. *Phase 1 Findings on Muskrat Falls Project Rate Mitigation.* Synapse Energy Economics for Board of Commissioners of Public Utilities, Province of Newfoundland and Labrador.

Hopkins, A. S., K. Takahashi, D. Glick, M. Whited. 2018. *Decarbonization of Heating Energy Use in California Buildings: Technology, Markets, Impacts, and Policy Solutions*. Synapse Energy Economics for the Natural Resources Defense Council.

Hopkins, A. S., K. Takahashi, L. David. 2018. Challenges and Opportunities for Deep Decarbonization through Strategic Electrification under the Utility Regulatory Structures of the Northeast. Proceedings of the 2018 ACEEE Summer Study on Energy Efficiency in Buildings, August 12, 2018.

Hall, J., J. Kallay, A. Napoleon, K. Takahashi, M. Whited. Locational and Temporal Value of Energy Efficiency and other DERs to Transmission and Distribution Systems. Proceedings of the 2018 ACEEE Summer Study on Energy Efficiency in Buildings, August 12, 2018.

White, D., K. Takahashi, A. Napoleon, T. Woolf. 2018. *Value of Energy Efficiency in New York: Assessment of the Range of Benefits of Energy Efficiency Programs*. Synapse Energy Economics for Natural Resources Defense Council.

Woolf, T., A. Hopkins, M. Whited, K. Takahashi, A. Napoleon. 2018. *Review of New Brunswick Power's 2018/2019 Rate Case Application.* In the Matter of the New Brunswick Power Corporation and Section 103(1) of the Electricity Act Matter No. 375. Synapse Energy Economics for the New Brunswick Energy and Utilities Board Staff.

Hopkins, A. S., K. Takahashi. 2017. *Alternatives to Building a New Mt. Vernon Substation in Washington, DC*. Synapse Energy Economics for the District of Columbia Department of Energy and Environment.

Hopkins, A.S., A. Horowitz, P. Knight, K. Takahashi, T. Comings, P. Kreycik, N. Veilleux, J. Koo. 2017. *Northeast Regional Assessment of Strategic Electrification.* Synapse Energy Economics and Meister Consulting Group for the Northeast Energy Efficiency Partnerships.

Takahashi, K., A. Allison, D. White. 2017. *Renewable Heating and Cooling Policy Framework: Options to Advance Industry Growth and Markets in New York*. Prepared for the New York State Energy Research and Development Authority.

Sierra Club. 2017. *Sierra Club Comments on Portland General Electric Company 2016 Integrated Resource Plan*. Submitted to the Public Utility Commission of Oregon, January 24, 2017.

Cook, R., J. Koo, N. Veilleux, K. Takahashi, E. Malone, T. Comings, A. Allison, F. Barclay, L. Beer. 2017. *Rhode Island Renewable Thermal Market Development Strategy*. Meister Consultants Group and Synapse Energy Economics for Rhode Island Office of Energy Resources.

Woolf, T., M. Whited, P. Knight, T. Vitolo, K. Takahashi. 2016. *Show Me the Numbers: A Framework for Balanced Distributed Solar Policies*. Synapse Energy Economics for Consumers Union.

Fisher, J., P. Luckow, A. Horowitz, T. Comings, A. Allison, E.A. Stanton, S. Jackson, K. Takahashi. 2016. *Michigan Compliance Assessment for the Clean Power Plan: MPSC/MDEQ EPA 111(d) Impact Analysis*. Prepared for Michigan Public Service Commission, Michigan Department of Environmental Quality, and Michigan Agency for Energy.

Woolf, T., A. Napoleon, P. Luckow, W. Ong, K. Takahashi. 2016. *Aiming Higher: Realizing the Full Potential of Cost-Effective Energy Efficiency in New York.* Synapse Energy Economics for Natural Resources Defense Council, E4TheFuture, CLEAResult, Lime Energy, Association for Energy Affordability, and Alliance for Clean Energy New York.

Napoleon, A., K. Takahashi, J. Kallay, T. Woolf. 2016. "Evaluation, Measurement, and Verification in Virginia." Synapse Energy Economics for Clean Energy Solutions Inc., Virginia Energy Efficiency Council, and Virginia Department of Mines, Minerals and Energy.

Stanton, E. A., P. Knight, A. Allison, T. Comings, A. Horowitz, W. Ong, N. R. Santen, K. Takahashi. 2016. *The RGGI Opportunity 2.0: RGGI as the Electric Sector Compliance Tool to Achieve 2030 State Climate Targets.* Synapse Energy Economics for Sierra Club, Pace Energy and Climate Center, and Chesapeake Climate Action Network.

Stanton, E. A., P. Knight, A. Allison, T. Comings, A. Horowitz, W. Ong, N. R. Santen, K. Takahashi. 2016. *The RGGI Opportunity: RGGI as the Electric Sector Compliance Tool to Achieve 2030 State Climate Targets.* Synapse Energy Economics for Sierra Club, Pace Energy and Climate Center, and Chesapeake Climate Action Network.

Kallay, J., K. Takahashi, A. Napoleon, T. Woolf. 2015. *Fair, Abundant, and Low-Cost: A Handbook for Using Energy Efficiency in Clean Power Plan Compliance.* Synapse Energy Economics for the Energy Foundation.

Woolf, T., K. Takahashi, E. Malone, A. Napoleon, J. Kallay. 2015. *Ontario Gas Demand-Side Management 2016-2020 Plan Review.* Synapse Energy Economics for the Ontario Energy Board.

Biewald, B., J. Daniel, J. Fisher, P. Luckow, A. Napoleon, N. R. Santen, K. Takahashi. 2015. *Air Emissions Displacement by Energy Efficiency and Renewable Energy.* Synapse Energy Economics.

Takahashi, K. 2015. "Boost Appliance Efficiency Standards." Ed. John Shenot. In *Implementing EPA's Clean Power Plan: A Menu of Options.* National Associate of Clean Air Agencies.

Takahashi, K., A. Napoleon. 2015. "Pursue Behavioral Efficiency Programs." Ed. John Shenot. In *Implementing EPA's Clean Power Plan: A Menu of Options.* National Associate of Clean Air Agencies.

Takahashi, K., J. Fisher, T. Vitolo, N. R. Santen. 2015. *Review of TVA's Draft 2015 Integrated Resource Plan*. Synapse Energy Economics for Sierra Club.

Comings, T., S. Jackson, K. Takahashi. 2015. *Comments on Indianapolis Power & Light Company's 2014 Integrated Resource Plan*. Synapse Energy Economics for the Sierra Club.

Stanton, E. A., P. Knight, J. Daniel, B. Fagan, D. Hurley, J. Kallay, E. Karaca, G. Keith, E. Malone, W. Ong, P. Peterson, L. Silvestrini, K. Takahashi, R. Wilson. 2015. *Massachusetts Low Gas Demand Analysis: Final Report.* Synapse Energy Economics for the Massachusetts Department of Energy Resources.

Fields, S., E. A. Stanton, P. Knight, B. Biewald, J. Daniel, S. Jackson, E. Karaca, J. Rosenkranz, K. Takahashi. 2014. *Calculating Alabama's 111(d) Target*. Synapse Energy Economics for the Southern Environmental Law Center.

Fields, S., E. A. Stanton, P. Knight, B. Biewald, J. Daniel, S. Jackson, E. Karaca, J. Rosenkranz, K. Takahashi. 2014. *Calculating Georgia's 111(d) Target*. Synapse Energy Economics for the Southern Environmental Law Center.

Fields, S., E. A. Stanton, P. Knight, B. Biewald, J. Daniel, S. Jackson, E. Karaca, J. Rosenkranz, K. Takahashi. 2014. *Alternate Scenarios for 111(d) Implementation in North Carolina*. Synapse Energy Economics for the Southern Environmental Law Center.

Stanton, E. A., P. Knight, J. Daniel, B. Fagan, D. Hurley, J. Kallay, G. Keith, E. Malone, P. Peterson, L. Silverstrini, K. Takahashi. 2014. *Feasibility Study for Low Gas Demand Analysis.* Synapse Energy Economics for the Massachusetts Department of Energy Resources.

Takahashi, K., T. Comings, A. Napoleon. 2014. *Maximizing Public Benefit through Energy Efficiency Investments.* Synapse Energy Economics for Sierra Club.

Vitolo, T., J. Fisher, K. Takahashi. 2014. *TVA's Use of Dispatchability Metrics in Its Scorecard.* Synapse Energy Economics for Sierra Club.

Comings, T., S. Fields, K. Takahashi, G. Keith. 2014. *Employment Effects of Clean Energy Investments in Montana.* Synapse Energy Economics for Montana Environmental Information Center and Sierra Club.

Keith, G., S. Jackson, J. Daniel, K. Takahashi. 2014. *Idaho's Electricity Sources: Current Sources and Future Potential.* Synapse Energy Economics for the Idaho Conservation League.

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