BEFORE THE
MARYLAND PUBLIC SERVICE COMMISSION

IN THE MATTER OF THE	*	
APPLICATION OF POTOMAC	*	CASE NO. 9702
ELECTRIC POWER COMPANY	*	
FOR AN ELECTRIC MULTI-YEAR	*	
PLAN FOR THE DISTRIBUTION OF	*	
ELECTRIC ENERGY	*	
	*	

* * * * * * * * * * * * *

PUBLIC DIRECT TESTIMONY

OF

Kenji Takahashi

ON BEHALF OF THE OFFICE OF PEOPLE'S COUNSEL

December 15, 2023

TABLE OF CONTENTS

Attached Exhibits

DIRECT TESTIMONY OF
KENJI TAKAHASHI

I. INTRODUCTION

Q. Please state your name and business address.

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

Q. Please describe Synapse Energy Economics.

A. Synapse 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 attorneys general, offices of consumer advocates, public utility commissions, environmental advocates, the U.S. Environmental Protection Agency, the U.S. Department of Energy, the U.S. Department of Justice, the Federal Trade Commission, and the National Association of Regulatory Utility Commissioners. Synapse has over 40 professional staff with extensive experience in the electricity industry.

Q. Please describe your educational background and qualifications.

A. I hold a Master's degree 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. I also recently completed the Massachusetts Institute of Technology's professional program "Sustainable Infrastructure Systems: Planning and Operations." My resume is attached as Exhibit KT-1.

Q. Please describe your professional experience.

A. At Synapse, I conduct economic, environmental, and policy analysis of energy system technologies, planning and regulations associated with both supply- and demand-side resources. Over the past 19 years, I have assessed the design, impact, and potential of energy efficiency and distributed energy resource policies and programs in over 40 jurisdictions across North America for a variety of clients. These include environmental groups; municipal, state, and provincial governments; and federal agencies such as U.S. Environmental Protection Agency and U.S. Department of Energy.

Another area of my focus are technological, resource, economic, and policy assessments of building decarbonization and their impacts on gas system planning. I have assessed the potential for building decarbonization in several states including Massachusetts, Rhode Island, Vermont, New York, Minnesota, Maryland, Oregon, and California, as well as in several

U.S. regions, including the northeast and the southwest. For example, I recently conducted a heat pump analysis as a part of a project to assess the financial impact of gas system investments in Maryland due to declining sales. Further, I am currently conducting an electrification impact study on behalf of Maryland OPC, in which we are analyzing the impacts of building and transportation electrification on electric peak loads across six major electric companies in Maryland.

Q. Have you previously testified in regulatory proceedings that concern building electrification?

A. Yes. In Massachusetts, I assessed the potential for natural gas demand savings and electrification measures in connection with Berkshire Gas Company's moratorium on new gas hook-ups in Case No. 16-103. More recently, on behalf of the New Mexico Office of the Attorney General, I examined Public Service Company of New Mexico's application for approval of its 2024–2026 Energy Efficiency and Load Management Plan (which included an electrification program proposal) in Case No. 23-00138-UT and testified on this matter before the New Mexico Public Regulation Commission.

Q. Have you previously testified in proceedings before state utility commissions in other jurisdictions?

A. Yes. In addition to the states I mentioned above, I have also testified and participated in regulatory proceedings before the New York Public Service

Commission, Pennsylvania Public Utility Commission, New Jersey Board of Public Utilities, Ontario Energy Board, and Nova Scotia Utility and Review Board. Details of my testimonies are provided in my resume included as Exhibit KT-1.

Q. On whose behalf are you appearing?

A. I am presenting testimony on behalf of the Maryland Office of People's Counsel.

Q. What is the purpose of your testimony in this proceeding?

A. The purpose of my testimony is to respond to Potomac Electric Power Company's ("Pepco" or "the company") proposed customer-side building electrification and make-ready programs: a residential beneficial electrification program ("BE program") contained within the Buildings Decarbonization Portfolio, and residential and commercial building make-ready programs ("MR programs") contained within the Planning Efficient Electrification portfolio.

Q. What materials did you rely on to develop your testimony?

A. The sources for my testimony are Pepco's MRP application, witness Schatz's direct testimony,[1] responses to discovery requests, public documents, and my personal knowledge and experience.

[1] On October 20, 2023, Pepco filed a notice indicating that witnesses Pearl Donohoo-Vallet and Taiwo O. Alo would substitute for witness David S. Schatz, and that witness Donohoo-Vallet adopted witness Schatz's testimony except for Section VI and Schedule DSS-4, which witness Alo adopted. *See* ML# 305731.

Q. Was this testimony prepared by you or under your direction?

A. Yes. My testimony was prepared by me or under my direct supervision and control.

Q. Are you aware that on November 28, 2023, OPC filed a motion to strike or, alternatively, dismiss Pepco's proposed electrification programs?[2]

A. Yes, I understand that OPC has filed a motion to strike this proposal from Pepco's rate case. My testimony evaluates the substance of Pepco's building electrification proposal and suggests recommendations for the Commission to consider if OPC's motion is denied.

II. SUMMARY AND RECOMMENDATIONS

Q. Please summarize your primary conclusions concerning Pepco's proposed building electrification programs.

A. After reviewing Pepco's proposed building electrification programs, my primary conclusions are as follows:

1. Per-customer incentive amounts Pepco assumed for air-source heat pumps (ASHP), geothermal heat pumps (GSHP), and heat pump water heaters (HPWH) for the proposed Beneficial Electrification (BE) program are too high because they do not take into account available federal tax credits.

[2] ML# 306343.

2. Pepco models higher incentives for hybrid heat pumps with fuel backup (also called dual-fuel heat pumps) than for all-electric heat pumps for the purpose of estimating program budgets. While Pepco states that incentives for hybrid heat pumps will not be higher than incentives for all-electric heat pumps when it designs actual incentives, Pepco's approach as modeled would fail to encourage all-electric heat pumps more than hybrid heat pump installations even though whole-home electric heat pumps would better advance Maryland's policy objectives to reduce dependence on fossil fuels, while also eliminating the need for building owners to further change their heating systems to eliminate on-site emissions at a later time.
3. Per-customer incentive amounts assumed for the proposed Residential Make-Ready (MR) program are too high, and Pepco's filing and analysis on the Residential MR program are poorly organized and not credible.
4. While Pepco's incentive approach for its building electrification program proposal is consistent with EmPOWER's midstream incentive approach for HVAC and HPWH, Pepco's BE program proposal would create two separate HVAC and HPWH midstream incentive programs. This approach would create confusion among

consumers and contractors as well as significant inefficiencies in promoting building electrification.

5. The proposed program budget for program administration is too high.
6. The BE and MR proposals lack sufficient detail. The company fails to include sufficient key information regarding incentive levels, administration budgets, annual participation, and program delivery channels in its testimony.
7. The description of the proposed workforce development program lacks the details required to evaluate and approve this program.

Q. Should Pepco's program be approved by the Commission at this time?

A. No. There are a number of deficiencies that would make approval of Pepco's proposal premature at this time. Before approving Pepco's building electrification incentive program, the Commission should require Pepco to provide more detailed information and supporting analysis up front, including how much incentive it plans to provide, how it developed the proposed budget for incentives and non-incentive program costs, the program delivery mechanisms, and equipment specifications. Additionally, the Commission should require Pepco to file an implementation plan—subject to stakeholder comment and Commission approval—that includes specific details on how it plans to identify customer income levels for program participants and coordinate with other state agencies.

Q. If the Commission were to approve Pepco's electrification programs, do you have recommendations for program modifications?

A. Yes. In such a case, I recommend that the Commission direct Pepco to modify some aspects of the proposed programs as follows:

1. Pepco should increase the target number of participants for residential ASHP, GSHP, and HPWH using the additional funding that would be freed up by reducing measure incentive levels.
2. Pepco should implement the following incentive strategies for heat pumps in the proposed BE program:
    - provide a substantially higher level of incentives for whole-home, all-electric heat pumps (e.g., twice as high) than for hybrid heat pumps that require fossil fuel heating backup;
    - provide higher incentives for cold-climate heat pumps; and
    - make these modifications within the proposed incentive budget estimates.
3. Pepco should recalculate per customer incentives for the Residential Building MR program while accounting for the effects of Inflation Reduction Act (IRA) rebates and tax credits and refile all the analyses concerning customer incentives.
4. Pepco should implement the BE program in close coordination with EmPOWER midstream incentive programs.

5. Pepco should reduce its budget estimates for program administration for the BE program by approximately $7.3 million, the Residential Building MR program by approximately $1 million, and the Commercial Building MR program by approximately $0.8 million.
6. Pepco should provide more details about the workforce development program including descriptions of proposed courses, as well as descriptions of specific issues Pepco and other stakeholders are facing in promoting electrification and how Pepco's proposed program would help address those issues.
7. Pepco should reduce its budget estimates for program administration for the Building Decarbonization programs and residential and commercial building make-ready programs.

Additionally, if the Commission approves Pepco's proposed BE and MR programs, it should require that all program details and incentive structures align with federal IRA rebate requirements and EmPOWER program planning requirements and design process.

Q. What are Maryland's policies regarding building decarbonization that are relevant to your consideration of Pepco's proposals in this case?

A. In 2021, the Maryland Commission on Climate Change (MCCC) issued a "Building Energy Transition Plan" which established four core recommendations: (1) adopt an all-electric construction code; (2) develop a clean heat retrofit program; (3) create a building emissions standard; and (4)

develop utility transition plans.[3] It is also important to note that the clean heat retrofit program recommendation encourages fuel-switching and beneficial electrification through EmPOWER beginning in 2024 and targeting 50 percent of residential heating system, cooling system, and water heater sales to be heat pumps by 2025 and 95 percent by 2030.

In 2022, the General Assembly enacted the *Climate Solutions Now Act of 2022* (CSNA), which established state goals of a 60 percent reduction in greenhouse gas (GHG) emissions by 2031 (from a 2006 baseline) and net zero emissions by 2045.[4] The CSNA also established a clear policy direction that electrification is the most important strategy in the building sector to help the state meet its aggressive GHG reduction mandates. For example, the Act states, "the General Assembly supports moving toward broader electrification of both existing buildings and new construction as a component of decarbonization."[5]

The CSNA further directs the Maryland Department of the Environment (MDE) to develop a state climate plan by December 31, 2023, that reduces statewide GHG emissions by 60 percent by 2030 and "sets the

[3] Maryland Commission on Climate Change ("MCCC"), *Building Energy Transition Plan: A Roadmap for Decarbonizing the Residential and Commercial Building Sectors in Maryland.* at 5 (November 2021), https://mde.maryland.gov/programs/air/ClimateChange/MCCC/Documents/2021%20Annual%20Report%20Appendices%20FINAL.pdf.

[4] 2022 Md. Laws Ch. 38 § 2–1204.1.

[5] *Id*. § 10(a)(1).

state on a path" toward achieving net-zero statewide GHG emissions by 2045.[6] The Act also requires the Building Codes Administration to "develop recommendations for an all-electric building code for the State"[7] as well as to "develop recommendations regarding efficient cost-effectiveness measures for the electrification of new and existing buildings."[8]

Q. Are there any local government policies regarding building decarbonization that are relevant to your consideration of Pepco's proposals in this case?

A. Yes. Montgomery County, which covers approximately half of Pepco's service territory in the state, recently passed Bill 13-22, Buildings – Comprehensive Building Decarbonization. This new law requires the County to issue all-electric building standards for new construction, major renovations, and additions by Dec. 31, 2026. The law includes some exemptions to the standards such as emergency backup systems, commercial kitchen equipment, and certain business types.[9]

Prince George's County, which covers the remaining half of Pepco's service territory, issued its draft Climate Action Plan in early 2022. This plan seeks to reduce community-wide GHG emissions by 50 percent by

[6] *Id*. § 2–1205(c)(2)(I).
[7] *Id.* § 10(b)(i).
[8] *Id.* § 10(b)(v).
[9] Bill 13-22 - Buildings – Comprehensive Building Decarbonization, (December 12, 2022), https://apps.montgomerycountymd.gov/ccllims/BillDetailsPage?RecordId=2754&fullTextSearch=13-22.

2030 (relative to 2005 levels) and carbon neutrality by 2050 along with a total of 26 climate action recommendations to support the county's efforts to achieve the emissions reduction goals.[10]

III. OVERVIEW OF PEPCO'S BUILDING ELECTRIFICATION PROGRAMS

Q. Please summarize Pepco's proposed building electrification programs.

A. Pepco proposes and seeks cost recovery for four new customer-side building electrification and make-ready programs. The first—a residential beneficial electrification program ("BE program")—is contained within the Building Decarbonization Portfolio. The other three programs (each contained within the Planning Efficient Electrification Portfolio), include a residential make-ready program, a commercial make-ready program (collectively "MR programs"), and a workforce development program.[11] The company states that these programs are intended to advance state and local policies and goals, specifically the *Climate Solutions Now Act* (CSNA), Montgomery County's Comprehensive Building Decarbonization legislation (Bill 13-22), and Prince George's County's Climate Action Plan.[12]

[10] Prince George's County Council, *Climate Action Plan – Draft Plan* (Jan 15, 2022), https://e.issuu.com/embed.html?d=draft_climate_action_plan_01-15-2022&hideIssuuLogo=true&showOtherPublicationsAsSuggestions=true&u=environment.mypgc.us.

[11] Direct Testimony of David Schatz ("Schatz Direct") at 6–7, Table 1.

[12] Schatz Direct at 29, lines 3-5 and p. 36, lines 6-9.

Pepco proposes to spend a total of $103 million over the Multi-Year Rate Plan ("MRP") period to support these four programs.[13] The annual budgets for each program are summarized in Table 1 below. For context, Pepco's EmPOWER Residential Energy Efficiency and Conservation program budget for the 2021–2023 program cycle is $78 million.[14] Pepco proposes to defer these expenditures to a regulatory asset to be recovered in base rates over a 12- or 13-year amortization period.[15]

Table 1. Pepco proposed MRP building electrification program budgets

Program Costs	2024	2025	2026	2027	Cycle Total
Beneficial Electrification Program	$6,067,592	$17,401,474	$30,599,948	$33,964,844	$88,033,858
Residential Make-Ready	$822,262	$2,226,964	$3,869,982	$4,292,031	$11,211,239
Commercial Make-Ready	$302,299	$700,322	$1,172,998	$1,297,528	$3,473,147
Workforce Development Program	$225,000	$300,000	$300,000	$300,000	$1,125,000
Total All Programs	$7,417,153	$20,628,760	$35,942,928	$39,854,403	$103,843,244

Source: Schedule DSS-2 at 3, Schedule DSS-3 at 2, 4, 8.

Q. Please summarize Pepco's proposed BE program.

A. The BE program would offer incentives for electrification of space and water heating equipment in residential buildings. Pepco estimates the total budget for this program is $88 million over the proposed four-year MRP.

[13] Schedule DSS-2 at 3 and Schedule DSS-3 at 9

[14] *Potomac Electric Power Company EmPOWER Maryland Report YTD Q3 and Q4 EE&C and DR Programs*, ML# 301351 (Case No. 9648, Feb. 15, 2023).

[15] Schatz Direct at 50, lines 17-18, 20-22.

The annual budgets for the BE program are summarized in Table 2 below. Pepco states that it will target 44 percent of incentive spending towards low- to moderate-income (LMI) customers.[16]

Table 2. Summary of Pepco's proposed Beneficial Electrification program budgets, excluding amortization costs

Total Program Costs	2024	2025	2026	2027	Cycle Total
Beneficial Electrification Program	$6,067,592	$17,401,474	$30,599,948	$33,964,844	$88,033,858

Source: Schedule DSS-2 page 3.

For the BE program, Pepco plans to provide a variety of cash and non-cash incentives. Fuel-switching rebates offered through the BE program are designed to cover a percentage of net total costs after adjusting for available federal rebates, as shown in Table 3. In total, Pepco plans to provide electrification incentives for approximately 13,900 residential customers.[17] While Pepco assumes that some of the incentivized ASHPs are installed alongside fuel backup heating systems, Pepco has no intention to require customers to retain backup gas heating systems or to fully remove backup heating systems.[18]

[16] Schatz Direct at 35, lines 6-7.

[17] Errata to Testimony of Company Witness Donohoo-Vallet ("Donohoo-Vallet Errata") Schedule DSS-2 at 1.

[18] *See* Voluntary DR 1-12 Attachment A; Donohoo-Vallet Errata, Schedule DSS-2 at1; and Exhibit KT-2 (OPC DR 17-10).

Table 3. Pepco's proposed Beneficial Electrification incentive levels

Measure	Markt Rate Incentive Level	LMI Incentive Level	Incentive Cap
GSHP	50%	80%	$15,000
ASHP	60%	85%	$10,000
HPWH	60%	85%	$3,000

Source: Schedule DSS-2 page 1

Q. Please describe Pepco's proposed building make-ready programs.

A. The residential and commercial MR programs offer incentives for non-equipment costs of electrification upgrades.[19] Eligible make-ready costs include electrical service panel upgrades, associated wiring and branch circuitry, scheduled outage costs for upgrades, and associated labor costs.[20] The proposed annual budgets for the MR programs are summarized in Table 4 below.

Table 4. Summary of Pepco's proposed Building Make-Ready Program budgets, excluding amortization costs

Program	2024	2025	2026	2027	Cycle Total
Residential Make-Ready	$822,262	$2,226,964	$3,869,982	$4,292,031	$11,211,239
Commercial Make-Ready	$302,299	$700,322	$1,172,998	$1,297,528	$3,473,147
Total	**$1,124,561**	**$2,927,286**	**$5,042,980**	**$5,589,559**	**$14,684,386**

Source: Schedule DSS-3 at 9.

For the residential MR program, Pepco plans to provide make-ready incentives for 3,200 residential customers. The rebates would cover 100 percent of behind-the-meter costs up to $5,500 for LMI customers and 80

[19] Schatz Direct at 38, lines 13-16.
[20] Schatz Direct at 38, lines 18-20.

percent of behind-the-meter costs up to $3,500 for non-LMI customers.[21] The commercial MR program would provide rebates for 50 percent of eligible make-ready costs up to $8,000 for 150 small- to medium-sized commercial buildings.[22]

Q. Please describe Pepco's proposed building electrification workforce development program.

A. Pepco proposes a Beneficial Electrification Workforce Development program as part of its Planning Efficient Electrification portfolio. The program would provide free training and skill-building programs at local community colleges to support beneficial electrification jobs, such as installers and technicians to perform electrical HVAC retrofits.[23] Pepco plans to help support job placement for program graduates.[24] The program is open to residents of Montgomery and Prince George's Counties and will target approximately 80 individuals each year.[25] Pepco estimates the total budget for this program to be $1.13 million over the MRP period.[26]

[21] Schedule DSS-3 at 1.
[22] Schedule DSS-3 at3.
[23] Schatz Direct at 43, lines 4-7.
[24] Schedule DSS-3 at 7.
[25] *Id.*
[26] Schedule DSS-3 at 8.

IV. PEPCO SHOULD IMPROVE THE DESIGNS FOR ITS PROPOSED BUILDING ELECTRIFICATION PROGRAMS

Q. What are your main concerns with Pepco's proposed building electrification program?

A. As I will explain below, there are a number of informational deficiencies that frustrate a comprehensive review of Pepco's proposed programs. Before approving Pepco's proposal, the Commission should require Pepco to provide additional information about how it plans to develop and implement its program, including more detail regarding the incentive levels, incentive and administration budgets, program delivery channels, participant incentive level eligibility, and coordination with other State agencies.

If the Commission decides to approve Pepco's proposed electrification program, the program designs, incentives, and budgets for some of the proposed electrification programs should be modified. In particular, the proposed programs have the following issues:

- Per-customer incentive amounts assumed for the proposed BE program and the proposed Residential MR program are too high.
- Pepco's approach would fail to encourage whole-home electric heat pumps more than hybrid heat pump installations.
- Per-customer incentive amounts assumed for the proposed Residential MR program are too high, and Pepco's filing and analysis

on the Residential MR program are poorly organized and not credible.

- Pepco's BE program proposal would result in two separate HVAC and HPWH midstream incentive programs, which would create confusion among consumers and contractors as well as significant inefficiencies in promoting building electrification.
- The proposed program budget for program administration is too high.
- The description of the proposed workforce development program lacks the details required to evaluate and approve this program.

A. Pepco should develop and provide more details on BE and MR program and measures.

Q. What are the main issues with the way Pepco provided information for the proposed programs?

A. The company's testimony lacks sufficient detail, particularly the BE and MR proposals. The company fails to include sufficient key information regarding incentive levels, incentive and administration budgets, equipment specifications, and program delivery channels in its testimony. I obtained much of this information only through discovery and the errata to witness Schatz's direct testimony (adopted by witness Donohoo-Vallet). For example, the assumptions in the company's workpapers show higher

incentives for hybrid (fossil fuel backup) systems.[27] However, in discovery Pepco states that rebates for customers for hybrid heat pumps will not be higher than incentives for all-electric heat pumps during program implementation.[28] This information was only revealed through discovery and was not included in the company's testimony or application. It is inappropriate for Pepco to omit such information from its testimony. Further, as I will discuss in Section D below, Pepco provided multiple, contradictory cost estimates for residential make-ready costs, and it is not clear how Pepco estimated the incentive budget. These details make it difficult for the Commission to assess the reasonableness of the proposed programs and to determine key program decisions, such as the treatment of fuel backup systems and incentive structures.

Q. Are there any other aspects of Pepco's program that lack sufficient detail for the Commission to assess?

A. Yes, I am concerned that Pepco does not provide sufficient information about how it plans to identify income levels for program participants in order to determine customer incentive levels.

As I stated in Section A in my testimony, Pepco differentiates incentive amounts based on three different income groups: (a) households with incomes less than 80 percent of area median incomes (AMI); (b)

[27] Voluntary DR 1-12 Attachment A
[28] Exhibit KT-2 (OPC DR 17-10(c)(ii)).

households with incomes from 80 percent to 150 percent of AMI; and (c) the rest of the households, with incomes over 150 percent of AMI.[29] To identify customer eligibility, Pepco just states that "Pepco will coordinate incentive levels using the definitions for LMI as defined in the IRA"[30] and "[t]he company will coordinate application and eligibility tiers with state agencies overseeing federal funding programs whenever feasible."[31] Pepco further states that the "specific details of determining customer eligibility, application streamlining, and other details will be finalized upon guidance and implementation of IRA programs in Maryland."[32]

Q. Why is the information about program eligibility screening process provided by Pepco insufficient?

A. Pepco's statements are only general in nature and provide no detail regarding how it will, in practice, conduct the necessary coordination with state agencies (or use other methods) to complete eligibility screening and determine the incentive offered to each household. Since MEA— the state agency charged with developing and implementing Maryland's IRA programs—has yet to issue any guidance related to the IRA programs, it is impossible to assess the reasonableness of Pepco's administrative approach to identifying and verifying eligible participants. Moreover, Pepco is not a

[29] Exhibit KT0-2 (OPC DR 17-5, Attachment).
[30] Schedule DSS-2, at 1.
[31] Schatz Direct at 32.
[32] Schedule DSS-2, at

state agency, and it may not be able to implement rebate programs in the same manner as Maryland governmental agencies. Finally, there are significant potential issues raised by utilities collecting sensitive customer financial information and a number of open administrative questions about how Pepco plans to coordinate with other state agencies.

Q. Given the informational deficiencies you identify, what do you recommend?

A. I recommend that before approving Pepco's building electrification incentive program, the Commission require Pepco to provide more detailed information and supporting analysis up front, including how much incentive it plans to provide, how it developed the proposed budget for incentives and non-incentive program costs, the program delivery mechanisms, and equipment specifications. Additionally, the Commission should require Pepco to file an implementation plan—subject to stakeholder comment and Commission approval—that includes specific details on how it plans to identify customer income levels for program participants and coordinate with other state agencies. Additionally, if the Commission approves Pepco's proposed BE and MR programs, it should require that all program details and incentive structures align with federal IRA rebate requirements and EmPOWER program planning requirements and design process.

B. Pepco should reduce customer incentives and increase the number of planned program participants for the BE program.

Q. Please explain how Pepco calculates customer incentives for the BE program.

A. Pepco calculates different customer incentive levels by technology for three different customer segments: (a) households with incomes less than 80 percent of area median incomes (AMI); (b) households with incomes from 80 percent to 150 percent of AMI; and (c) the rest of the households, with incomes over 150 percent of AMI.[33] These customer segments align with the customer thresholds for electrification rebates that are provided through the IRA. When calculating customer incentives, Pepco subtracts the available federal rebates from Pepco's estimates of the total installed costs and then applies utility incentive factors (ranging from 50 percent to 85 percent as shown in Table 3 above) to the net installed costs. Pepco also set upper incentive caps for each measure. When the calculated incentives are higher than the incentive caps, Pepco assumed the incentive caps as the final incentive levels.[34] For example, for GSHPs, the incentive level based on a utility incentive factor of 50 percent is $13,366 because the total net project

[33] Exhibit KT-2 (OPC DR 17-5, Attachment).

[34] For the purpose of estimating average project expense limits and incentive budgets, Pepco used lower incentive caps than stated in the program description in Schedule DSS-2 on page 1, which is also shown in Table 3 in my testimony. The incentive caps are $15,000 for GSHP, $10,000 for ASHP, and $3,000 for heat pump water heater according to Schedule DSS-2. On the other hand, the incentive caps Pepco used to estimate average incentives and incentive budgets are $7,500 for GSHPs and ASHPs and $2,000 for HPWHs according to the Model Inputs tab of the "MD 9702 OPC DR 17-5 Electronic Only" workbook.

cost is $26,732 according to Pepco.[35] However, this incentive level exceeds a cost cap of $7,500. Thus, Pepco used $7,500 as the incentive level for GSHP. Table 5 below provides a simple average of Pepco's utility incentive estimates by technology and customer segment.[36] Note that participants in the customer segment with income levels above 150 percent of AMI receive the highest incentives for ASHPs and HPWHs.

Table 5. Average utility incentive estimates by technology and customer segment

	Household income <80% AMI	Household income 80–150% AMI	Household income >150% AMI
GSHP	$ 7,500	$ 7,500	$ 7,500
ASHP	$ 3,011	$ 3,463	$ 6,764
HPWH	$ 1,290	$ 980	$ 1,961

Source: "MD 9702 OPC DR 17-5 Electronic Only" file.

Finally, because there is a limitation on the total available IRA funding, Pepco adjusts the utility rebate estimates over time for this limitation for the purpose of estimating the total incentive funding. Pepco made this adjustment by combining the three customer segments and then calculating the average incentives for all measure use cases from 2024 to 2026. Pepco's final average incentive estimates by technology type and year are presented in Table 6.

[35] The total net project cost of a GSHP is equal to the total project cost because IRA rebates are not applicable to a GSHP.

[36] Pepco estimates customer incentives for three different use cases for GSHPs, eight different use cases for air-source heat pumps, and one use case for heat pump water heaters.

Table 6. Final average utility incentive estimates by technology and year

	2024	2025	2026
GSHP	$ 7,500	$ 7,500	$ 7,500
Air Source Heat Pump	$ 5,982	$ 7,148	$ 7,348
Heat Pump Water Heaters	$ 1,784	$ 2,076	$ 2,126

Source: "MD 9702 OPC DR 17-5 Electronic Only" file, Model Inputs tab.

Q. Please summarize available federal IRA rebates for electrification measures.

A. IRA's High-Efficiency Electric Home Rebate program provide rebates for LMI households for various electrification measures including heat pumps, HPWHs, electric wiring, and electric panel upgrades.[37] Households with income levels less than 80 percent AMI can receive incentives equal to 100 percent of the total measure costs up to certain incentive caps. Households with income levels from 80 to 150 percent AMI can receive incentives equal to 50 percent of the total measure costs up to certain incentive caps. Incentive caps for several selected measures are as follows:[38]

- heat pumps: $8,000;
- HPWH: $1,750;
- electric wiring: $2,500; and
- electric panel: $4,000.

[37] Steven Nadel, *How Utility Energy Efficiency Programs Can Use New Federal Funding*, American Council for an Energy-Efficient Economy ("ACEEE") (Feb. 2023), https://www.aceee.org/sites/default/files/pdfs/home_energy_upgrade_incentives_2-1-23_1.pdf.
[38] *Id.*

Q. Please elaborate on why the per-customer incentive amounts assumed by Pepco are too high for the BE program.

A. Pepco's customer incentive estimates are too high for the high-income household segment for two main reasons:

- the incentive amounts estimated by Pepco do not take into account the available federal tax credits; and
- the total measure incentives including incentives from Pepco and the federal government exceed the incremental measure costs for some of the measures.

Q. Please explain in detail your first point about federal tax credits.

A. Geothermal (ground source) heat pumps are now eligible for 30 percent tax credits.[39] Both heat pumps and heat pump water heaters are eligible for federal tax credits of 30 percent up to $2,000, and electrification make-ready investments (i.e., electrical panel upgrades) are eligible for up to $600 in tax credits.[40] These federal tax credits will reduce the costs of electrification measures and thus should reduce the level of utility incentives that could be provided by Pepco, if customers can claim the tax credits. Pepco confirmed in its response to OPC DR 25-13 that it did not incorporate these available federal tax credits when calculating customer incentive levels. Pepco argues

[39] U.S. EPA, *Geothermal Heat Pumps Tax Credit*, https://www.energystar.gov/about/federal_tax_credits/geothermal_heat_pumps.

[40] Rewiring America, *25C Residential Energy Efficiency Tax Credit and 25D Residential Clean Energy Tax Credit*, https://www.rewiringamerica.org/ira-fact-sheets.

that the main reason for this decision is "because they would take up to a year to vest to customers and may not alleviate the upfront financial burden of major electrification upgrades."[41] While the potential delay in receiving the value of the tax credit may have some effect on customer decision-making, it is not appropriate to completely dismiss the impact of tax credits on customer economics. Low-income customer decisions are more likely to be affected by the potential delay, but these customers are also less likely to be taking advantage of the tax credits.

According to a recent analysis by the Tax Policy Center, most lower-income households do not owe taxes.[42] This means that most of those households cannot claim the IRA tax credits.[43] On the other hand, most households with higher incomes owe taxes and thus can take advantage of the IRA tax credits. This means that Pepco should reduce utility incentives for the amount of available federal tax credits for these higher income households.

[41] Exhibit KT-2 (OPC DR 25-13).

[42] Tax Policy Center, *T22-0132 - Distribution of Tax Units with Zero or Negative Individual Income Tax, By Expanded Cash Income Percentile* (2022), https://www.taxpolicycenter.org/model-estimates/tax-units-with-zero-or-negative-federal-individual-income-tax-oct-2022/t22-0132.

[43] Unlike other tax credits, the IRA tax credit is nonrefundable. *See* IRS, *Q&A on Tax Credits for Sections 25C and 25D*, https://www.irs.gov/pub/irs-drop/n-13-70.pdf.

Q. How will the federal tax credits change the utility incentive levels?

A. I estimate that if Pepco were to incorporate the federal tax credits into its incentive calculation structure, Pepco would reduce its proposed utility incentives for higher-income households by approximately 29 percent for GSHPs, 27 percent for ASHPs, and 50 percent for HPWHs, as shown in Table 7 below.

Note that I estimate that the available tax credit for a GSHP is approximately $8,000; this reflects a credit of 30 percent of the total installed cost of approximately $26,700 assumed by Pepco.[44] However, the reduction in assumed utility incentive for a GSHP is approximately $2,150 ($7,500 minus $5,347). This is because Pepco calculates the total incentive to be 50 percent of the total installed cost of $26,700 (which is $13,370) or $7,500 per project for higher-income households, whichever is smaller, as I mentioned above. My revised utility incentive calculation subtracts the available ~$8,000 tax credit from the total net installed cost of about $13,370 (reflecting Pepco's incentive calculation mentioned above), which enables the incentive to fall under $7,500. Also note that the incentive costs for ASHPs vary because Pepco's measure costs differ across eight different ASHP use cases (e.g., a mini-split ASHP with fuel backup is the most

[44] "MD 9702 OPC DR 17-5 Electronic Only" file, Model Inputs tab.

expensive use case and an ASHP with electric backup is the least expensive use case).

Table 7. Customer incentives calculated using Pepco's methodology, with and without federal tax credits by technology for higher-income households

	Incentive w/o tax credits	Incentive with tax credits	Incentive reduction (%)
GSHP	$7,500	$5,347	29%
ASHP	$6,244 to $7,500	$4,244 to $6,704	27%
HPWH	$1,961	$980	50%

Q. Please explain in detail your second point about incremental measure costs.

A. Utilities typically set customer incentives for energy efficiency measures based on a certain percentage of the measure costs. A measure cost is often defined as the cost difference between a standard baseline measure and a high efficiency measure. This is also called the incremental cost of a high efficiency measure. Utilities often use this approach to set incentives for non-low-income participants.[45]

Q. Do utilities typically put a limit on incentives, based on the incremental cost?

A. Yes, utilities typically cap incentives at 100 percent of the incremental cost. When designing measure incentives to aggressively promote customer participation or modeling an aggressive energy efficiency program scenario,

[45] For low-income participants, utilities often assume that the incremental cost is equal to the total installed cost of a measure (instead of the cost difference between a baseline measure and an energy-efficient measure) because low-income households tend to keep using old equipment beyond its economic life.

the standard practice is to assume 100 percent of the total incremental cost for utility incentives. For example, a 2019 energy efficiency potential study for New Jersey stated as follows:

> "The primary scenario for the study was the maximum achievable [scenario], which reflects what could theoretically be accomplished by aggressive efficiency programs offering incentives equal to 100 percent of measure incremental costs."[46]

Pepco should use this incentive-setting practice to estimate measure incentives for higher-income households with income levels above 150 percent of AMI. This means the total customer incentives that include Pepco's incentives and federal tax credits should not exceed the incremental cost of electrification measures. For example, Pepco assumes that the incremental cost of an ASHP with electric backup is $5,662 for a house currently heated with a gas furnace. In this case, the combined (Pepco plus federal) customer incentive should not exceed $5,662. Pepco's incentive should therefore not exceed $3,662 ($5,662 - $2,000 = $3,662) since the available federal tax credit is $2,000.

[46] New Jersey Board of Public Utilities, *Energy Efficiency Potential in New Jersey* at 44 (2019), https://s3.amazonaws.com/CandI/NJ+EE+Potential+Report+-+FINAL+with+App+A-H+-+5.24.19.pdf.

Q. Please provide your estimates of adjusted incentives that reflect both federal tax credits and the incremental costs of electrification measures for higher income households.

A. After adjusting Pepco's customer incentives downward to reflect federal tax credits for higher-income households (with incomes above 150 percent AMI), I found that the total customer incentives exceed incremental costs for several ASHP measures. Table 8 below shows the incremental costs, the total customer incentives, and excessive incentives for these measures.[47] Excessive incentives represent the difference between the incremental costs and the total customer incentives. Table 9 below compares Pepco's incentives, adjusted incentives with tax credits, and final revised utility incentives that are adjusted further downward by the excessive incentives calculated in Table 8.

Table 8. Calculations of excessive incentives beyond the incremental costs for selected measures for higher income households

Electrification Measure	Baseline Fuel	Incremental costs	Total customer incentives	Excessive incentives
ASHP - Electric Backup	Natural Gas	$5,662	$6,244	$581
ASHP - Electric Backup	Heating Oil	$5,201	$6,244	$1,042
ASHP - Electric Backup	Propane	$5,662	$6,244	$582
Mini-Split ASHP - Electric Backup	Natural Gas	$6,407	$6,794	$387
Mini-Split ASHP - Electric Backup	Heating Oil	$6,119	$6,794	$675
Mini-Split ASHP - Electric Backup	Propane	$6,580	$6,794	$215

[47] The incremental costs are provided in the "MD 9702 OPC DR 17-5 Electronic Only" file, Model Inputs tab.

Table 9. Comparison of Pepco's incentives, adjusted incentives with tax credits, and final revised utility incentives for higher income households

Electrification Measure	Baseline Fuel	Pepco's incentives	Utility incentives with tax credits	Final revised utility incentives
ASHP - Electric Backup	Natural Gas	$6,244	$4,244	$3,662
ASHP - Electric Backup	Heating Oil	$6,244	$4,244	$3,201
ASHP - Electric Backup	Propane	$6,244	$4,244	$3,662
Mini-Split ASHP - Electric Backup	Natural Gas	$6,794	$4,794	$4,407
Mini-Split ASHP - Electric Backup	Heating Oil	$6,794	$4,794	$4,119
Mini-Split ASHP - Electric Backup	Propane	$6,794	$4,794	$4,580

Q. How do these revised utility incentives impact the total incentive budget estimate for Pepco's BE program?

A. Pepco is proposing to spend about $74.9 million for measure incentives for the entire BE program from 2024 through 2027.[48] Pepco provides proposed upfront incentives per participant and annual participation for all measures in the Voluntary DR 1-12 Attachment B workbook. Based on these data, I calculated the proposed budget by year and technology in Table 10.

Table 10. Pepco's projected incentive budget by year and technology

Original Budget	2024	2025	2026	2027	Total
GSHP	$50,211	$79,936	$102,481	$76,861	$309,490
ASHP	$5,235,619	$15,106,354	$24,900,825	$18,675,618	$63,918,416
HPWH	$447,609	$2,373,115	$4,444,565	$3,333,424	$10,598,714
Total	$5,733,440	$17,559,406	$29,447,871	$22,085,903	$74,826,620

Source: "MD 9702__Voluntary DR 1-12_DR 1-12 Attachment B_Errata" workbook.

I recalculated projected incentive budgets in Table 11 below, using the adjusted incentive amounts discussed above. More specifically, I modified

[48] Schatz Direct at 35, Table 3.

Pepco's original calculation of incentives in Pepco's "MD 9702 OPC DR 17-5 Electronic Only" workbook and applied the revised incentive values from this file to the Voluntary DR 1-12 Attachment B workbook. In sum, I estimate that the total incentive budget is about $67 million, representing a reduction of about $7.5 million or 10 percent of the original incentive budget.

Table 11. Revised projected incentive budget by year and technology

Revised Budget	2024	2025	2026	2027	Total
GSHP	$45,886	$73,051	$93,654	$70,241	$282,832
ASHP	$4,681,201	$13,690,014	$22,629,454	$16,972,091	$57,972,760
HPWH	$373,822	$2,036,885	$3,829,658	$2,872,244	$9,112,609
Total	$5,100,909	$15,799,950	$26,552,767	$19,914,575	$67,368,200

Q. What is your recommendation based on your analysis of customer incentive levels?

A. If the Commission decides to approve Pepco's building decarbonization program plan, I recommend that Pepco reduce the incentive levels for higher-income households as I described above. However, instead of reducing the total incentive budget, I recommend that Pepco use the freed-up budget of approximately $7.5 million to support more program participants and further promote building electrification.

Q. Do you have specific recommendations about the number of additional participants for the BE program?

Yes. Table 12 presents my estimates of additional program participants based on the additional incentive budget of $7.5 million and average per-

customer incentive estimates across all participant types, reflecting the per-customer incentive revisions for higher-income participants I discussed above.[49] These additional participants represent a 9 percent increase for GSHP, a 10 percent increase for ASHP, and a 16 percent increase for HPWH, relative to the original participation forecasts. I recognize that these participation numbers are recommended targets—Pepco cannot force its customers to participate in programs (if the programs are approved by the Commission). However, by accounting for the value of federal tax credits when assessing customer economics, I believe that Pepco would be able to attract this higher level of participation, even when offering the smaller incentives I recommend.

Table 12. Additional program participants for the BE program

Additional Participants	2024	2025	2026	2027	Total
GSHP	1	1	1	1	4
ASHP	101	217	338	254	910
HPWH	50	189	336	252	826

[49] As I mentioned above, Pepco adjusts the utility rebate estimates over time for the limitation of IRA funding, which is provided in the "MD 9702 OPC DR 17-5 Electronic Only" file. I estimated the average per-customer incentive estimates across all participant types by adjusting the per-customer incentive estimates for the higher-income participants using this file.

C. Pepco should provide higher incentives for whole-home, all-electric heat pumps and lower incentives for hybrid heat pumps with fuel backup heating.

Q. Are there any other concerns about the proposed customer incentives?

A. Yes. Pepco models higher incentives for heat pumps with fuel backup in order to develop a budget estimate for customer incentives.[50] In its response to OPC DR 17-10, Pepco noted that "costs associated with fuel backup were slightly higher than electric backup measures, and thus, the resulting modeled incentive was higher."[51] For example, the modeled incentives for LMI customers are $5,531 per participant for the "Mini-Split ASHP – Fuel Backup" measure and $2,825 per participant for the "Mini-Split ASHP – Electric Backup" measure.[52] Pepco noted that this is because "[s]ome replace-on-burnout scenarios included a portion of the costs related to replacement of fossil fuel equipment, which raised the estimated costs of heat pumps with fuel backups."[53] However, Pepco also noted in its response to OPC DR 17-10 that "[d]uring program implementation, rebates for customers with fuel backup systems will not be higher than all-electric systems."[54] While it is heartening that Pepco does not propose to offer larger incentives for fuel backup systems than for all-electric systems, this

[50] "MD 9702 OPC DR 17-5 Electronic Only" workbook.
[51] Exhibit KT-2 (OPC DR 17-10(c)(i)).
[52] "MD 9702 OPC DR 17-5 Electronic Only" workbook, the Model Inputs tab, rows 30 and 31.
[53] Exhibit KT-2 (OPC DR 35-1(a)).
[54] Exhibit KT-2 (OPC DR 17-10(c)(ii)).

statement implies that Pepco may set customer incentives for heat pumps with fuel backup (also called hybrid or dual-fuel heat pumps) equal or similar to incentives for all-electric heat pumps. I am concerned that this approach does not fully recognize the benefits of all-electric heat pumps: they are more effective for reducing dependence on fossil fuels from the building sector than heat pumps with fossil fuel backup heating. By providing incentives for hybrid heat pumps, I believe that Pepco's incentive approach does not fully support the major findings in a 2021 report by the Maryland Commission on Climate Change ("MCCC"), which supports aggressive building electrification that displaces almost all fossil-fuel-based heaters.[55]

Q. Please explain in detail why all-electric heat pumps are more beneficial in supporting the state's greenhouse gas reduction policy than hybrid heat pumps?

A. Hybrid heat pumps are not as effective as all-electric heat pumps in reducing greenhouse gas emissions for two primary reasons. First, hybrid heat pumps are not likely to be sized to meet all space heating needs because such systems can rely on the backup heating systems when temperatures are very low; this motivates customers to install a smaller-scale heat pump system to

[55] Maryland Commission on Climate Change ("MCCC"), *Building Energy Transition Plan: A Roadmap for Decarbonizing the Residential and Commercial Building Sectors in Maryland* (November 2021), https://mde.maryland.gov/programs/air/ClimateChange/MCCC/Documents/2021%20Annual%20Report%20Appendices%20FINAL.pdf.

reduce the upfront capital costs. As a result, emissions reductions from hybrid heat pumps are not as large as the emissions reductions we expect from heat pumps without fossil fuel backup. I am also concerned that customers with fossil fuel backup may operate the "backup" system as their primary heater, use the heat pump primarily for cooling, and not actually reduce net emissions. Secondly, hybrid heat pumps will keep customers on the gas system, which potentially increases customer exposure to future significant rate increases resulting from customers departing that system. Moreover, keeping customers on the gas system would slow the transition away from fossil fuels to clean electricity for heating end uses.

Q. Please describe in detail the major findings in the 2021 report by the Maryland Commission on Climate Change.

A. The Mitigation Working Group (MWG) of the MCCC released a *Building Energy Transition Plan* report in 2021.[56] This plan included two major components: (a) major findings from a study conducted by E3 ("the Statewide E3 study") that analyzed scenarios for achieving reductions in emissions to near net-zero level for Maryland's residential and commercial buildings by 2045, and (b) recommendations based on the study findings and stakeholder feedback. The Statewide E3 study modeled four scenarios, including the MWG Policy Scenario, and found that the MWG Policy

[56] *Id.*

Scenario was the lowest-cost scenario of all the decarbonization scenarios. This scenario incorporates the following four core concepts and objectives:

- ensure an equitable and just transition, especially for low-income households;
- replace almost all fossil fuel heaters with heat pumps in existing homes by 2045;
- construct new buildings to meet space and water heating demand without fossil fuels; and
- implement a flexible Building Emissions Standard for commercial buildings.

Based on these study findings, the MCCC's Building Energy Transition Plan established four core recommendations: (1) adopt an all-electric construction code; (2) develop a clean heat retrofit program; (3) create a building emissions standard; and (4) develop utility transition plans.[57] It is also important to note that the second core recommendation—the clean heat retrofit program—encourages fuel-switching and beneficial electrification through EmPOWER beginning in 2024 and sales targets for residential heating systems, cooling systems, and water heaters of 50 percent by 2025 and 95 percent by 2030.

[57] *Id.* at 5.

Q. Are there building electrification programs that encourage whole-home electrification of space heating in other jurisdictions?

A. Yes. I am aware of several utility energy efficiency programs that offer large incentives for whole-home heat pumps—more than the base level incentives provided to all efficient heat pumps—to encourage the installation of whole-home heat pumps and the removal of existing fossil-fuel-based heating systems in colder climate regions than Maryland. I provide a short summary of these programs as follows:

- **Mass Save Residential Whole-Home Heat Pump Rebates**: the statewide energy efficiency provider in Massachusetts, Mass Save, offers larger rebates ($10,000 to $16,000 per home) for "whole-home" heat pumps and $1,250 per ton for partial-home heat pumps.[58] The high-end rebate amount for whole-home heat pumps is provided for income-qualified customers. Assuming a 4-ton system, a partial-home rebate would total $5,000, which is half of the whole-home heat pump rebate. To classify as "whole-home," heat pumps must be used as sole source of heating for the heating season and be sized to meet 90 to 120 percent of the total heating load at the outdoor design temperature.[59] To be eligible for these rebates, customers must fill out

[58] Mass Save, *Air Source Heat Pump Rebates,* https://www.masssave.com/residential/rebates-and-incentives/air-source-heat-pumps.

[59] Mass Save, *Heat Pump Program Offers,* http://ceere.org/MassSave2023HeatPumpProgramOverview.pdf.

a verification form confirming that the heat pump will be the sole source of heating and that the pre-existing heating system will be removed or disconnected.[60]

- **New York State Clean Heat Program**: The New York State ("NYS") Clean Heat Program began in 2020 and is one of the largest electrification programs in the country in terms of annual budget and energy savings.[61] The program offers rebates for cold climate air source heat pumps (ccASHP), with higher incentives for whole-home heat pumps sized to meet at least 90 percent of the building heat load.[62] In addition, NYS Clean Heat offers specific, higher incentives for optimizing use of the whole-home heat pump system by adding integrated controls or for decommissioning the pre-existing fossil fuel heating system.[63]

Q. Is there any other important aspect regarding whole-home, all-electric heat pumps?

A. Yes. Efficiencies and heating capacity of standard heat pumps tend to decline substantially as outdoor temperatures drop below freezing

[60] Mass Save, *2023 Whole-home heat pump verification form*, https://www.masssave.com/-/media/Files/PDFs/Save/Residential/rebate-forms/Mass-Save-Whole-Home-Heat-Pump-Verification-Form.pdf.

[61] Charlotte Cohn and Nora Wang Esram, *Building Electrification: Programs and Best Practices*, American Council for an Energy Efficient Economy (Feb. 2022), https://www.aceee.org/research-report/b2201.

[62] Joint Energy Efficiency Providers, *NYS Clean Heat: Statewide Heat Pump Program Manual* (Sept. 2022.), https://cleanheat.ny.gov/assets/pdf/NYS-Clean-Heat-Program-Manual.pdf.

[63] *Id.*

temperatures. On the other hand, ccASHPs can provide comfortable heating very efficiently and maintain high heating capabilities even in frigid temperature conditions. Thus, ccASHPs are more suitable than standard heat pumps for whole-home heating.

Q. Are there any utility programs that encourage ccASHPs in other jurisdictions?

A. I am aware of several utility energy efficiency or electrification programs that encourage ccASHPs in colder climate regions than Maryland. I offer a short summary of these programs as follows:

- As mentioned above, the NYS Clean Heat program offers rebates for ccASHPs. In fact, the NYS Clean Heat program *only* offers residential air-source heat pump incentives for ccASHPs.[64] Eligible equipment must be listed on the Northeast Energy Efficiency Partnerships' ("NEEP") Cold Climate Air Source Heat Pump Product List.[65]
- Xcel Energy Colorado offers higher rebates for residential ccASHPs and mini-split heat pumps. Rebates for ccASHPs are $500 more than the incentives provided for baseline high efficiency heat pumps.[66]

[64] The Joint Energy Efficiency Providers, *NYS Clean Heat: Program Manual for Central Hudson Gas & Electric Corporation, National Grid, New York State Electric & Gas Corporation, Orange and Rockland Utilities, Inc., and Rochester Gas and Electric Corporation* (Sept. 2023.), https://cleanheat.ny.gov/assets/pdf/NYS%20CH%20PM_September%2001,%202023_FINAL.pdf.

[65] NEEP, *NEEP's Cold Climate Air Source Heat Pump List*, https://neep.org/heating-electrification/ccashp-specification-product-list.

[66] Xcel Energy Colorado, *Heat Pump Rebates*, https://co.my.xcelenergy.com/s/residential/heating-cooling/heat-pumps.

- Burlington Electric Department offers two tiers of heat pump rebates: Standard and High Performance. High-performance systems must be listed on NEEP's Cold Climate Air Source Heat Pump List and are eligible for an additional $1,000–$3,000 in incentives depending on the system size.[67]

Q. How would ccASHPs perform in Maryland's climate?

In mild climates like Maryland's, ccASHPs do not require backup heating if sized properly to meet the full heating load. NEEP developed and has been maintaining a Cold Climate Air Source Heat Pump list over the past several years.[68] NEEP establishes ccASHP specifications with minimum requirements for manufacturers to list their heat pumps as ccASHP.[69] One key requirement is a coefficient of performance ("COP") of 1.75 or above at 5°F, which means that heat pumps need to be at least 175 percent efficient at 5°F.[70] Further, the U.S. Environmental Protection Agency's Energy Star certification program now offers a Cold Climate designation to high-

[67] Burlington Electric Department. *Heat Pump Rebates*, https://www.burlingtonelectric.com/heatpumps#modal-tc-centrally-ducted-heat-pump.

[68] *See supra* n. 65.

[69] Currently the NEEP ccASHP list has over 80,000 models of ccASHPs from over 200 HVAC brands.

[70] A COP represents a ratio of useful heating or cooling to the total energy input. Electric resistance heating has a COP of approximately 1; fossil fuel heating systems such as gas furnaces have a COP of approximately 0.7 to 0.9.

performing heat pumps that meet high-performance standards that closely align with NEEP's ccASHP specifications.[71]

Space heating systems are typically sized based on winter design temperatures. A system sized to meet the load at the design temperature is expected to meet the full building load during 99 percent of the hours of the year, and part of the load for the remaining few hours.[72] The design day temperature in Baltimore, Maryland is 17°F.[73] This means that ccASHPs perform much more efficiently at this temperature and have a higher COP than at the minimum performance condition specified by NEEP's ccASHP requirements.

Q. Have there been any in-field evaluation studies of ccASHP? If so, what have those studies found about the actual performance of ccASHPs?

A. Yes. Many in-field studies demonstrated the superior performance of ccASHPs over the past several years. For example, a 2016 study conducted by Cadmus Group on behalf of the Electric and Gas Program Administrators

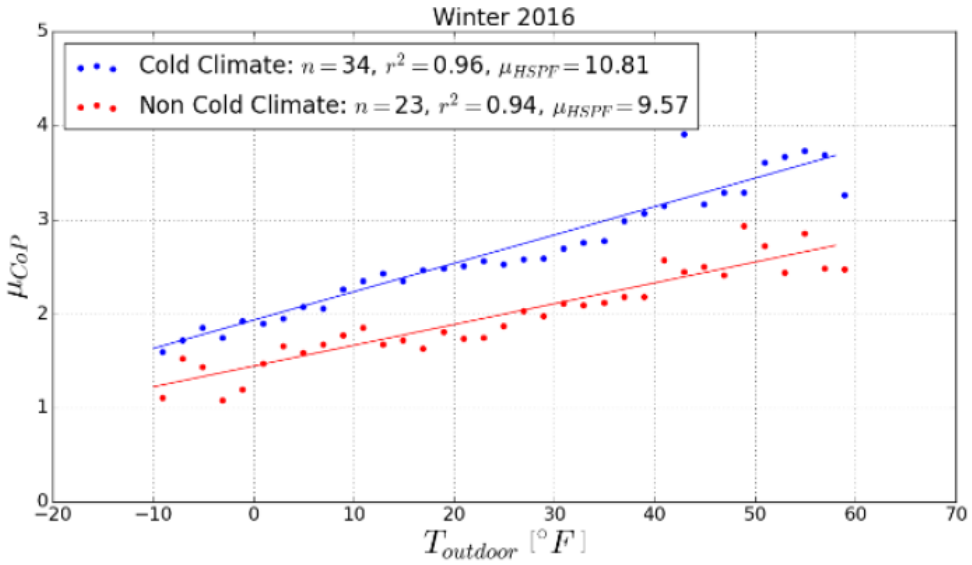
[71] U.S. Environmental Protection Agency, *Heat Pump Equipment and Central Air Conditioners Key Product Criteria*, https://www.energystar.gov/products/heating_cooling/heat_pumps_air_source/key_product_criteria.

[72] Green Building Advisor, *Design Temperature vs. Degree Days*, https://www.greenbuildingadvisor.com/article/design-temperature-vs-degree-days; Air Conditioning Contractors of America, *ACCA Manual J® Residential Load Calculation Eighth Edition* (Aug. 2014), https://higherlogicdownload.s3.amazonaws.com/ACCA/8e4cf5b4-e984-4971-bb79-7889082c7cf2/UploadedImages/MJ8-Adden-E-Updated-Weather-Data-11Aug2014.pdf.

[73] U.S. EPA, *ENERGY STAR Certified Homes Design Temperature Limit Reference Guide (2019 Edition)* (April 2021), https://www.energystar.gov/partner_resources/residential_new/working/hvac/hvac_designers/design_temp_limits.

of Massachusetts and Rhode Island evaluated the performance of mini-split heat pumps in numerous homes in Massachusetts and Rhode Island.[74] The figure below presents the average COP values (at Y-axis) across varying outdoor temperatures (at X-axis) for 34 cold-climate units and 23 regular units during the winter of 2016. As shown in this figure, the average COP values for ccASHPs are very favorable even in frigid temperatures: a COP of about 2.5 at Baltimore's design temperature of 17°F and a COP of 2 even at 0°F.

Figure 1. Average Heating COP vs. Outdoor Air Temperature for Cold-Climate and Non-Cold-Climate Systems – Winter 2016

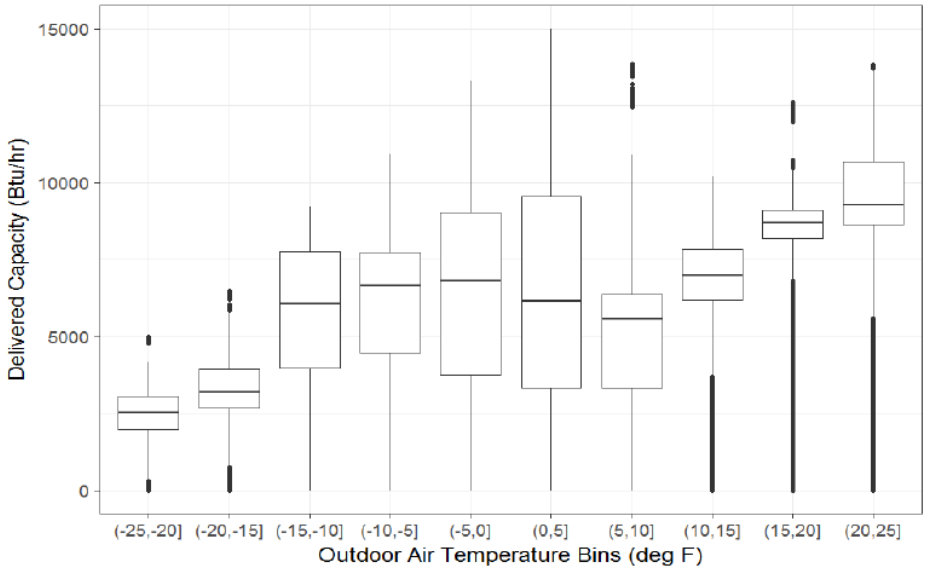


Source: Cadmus 2016 Ductless Mini-Split Heat Pump Impact Evaluation.
Note: μCoP represents the mean COP of the population studied.

[74] Electric and Gas Program Administrators of Massachusetts and Rhode Island, *Ductless Mini-Split Heat Pump Impact Evaluation* (Dec. 2016), https://ripuc.ri.gov/sites/g/files/xkgbur841/files/eventsactions/docket/4755-TRM-DMSHP-Evaluation-Report-12-30-2016.pdf.

Some evaluation studies also investigated heating capacities of ccASHPs. For example, a 2019 study conducted by the Center for Energy and Environment in Minnesota demonstrated that a mini-split heat pump "delivered a consistent median capacity from 10 ºF to -15 ºF," as shown in Figure 2 below.[75]

Figure 2. Capacity of a Mini-Split Heat Pumps vs. Outdoor Temperature



Source: Ben Shoenbauer et al., Field Assessment of Ducted and Ductless Cold Climate Air Source Heat Pumps (2018).

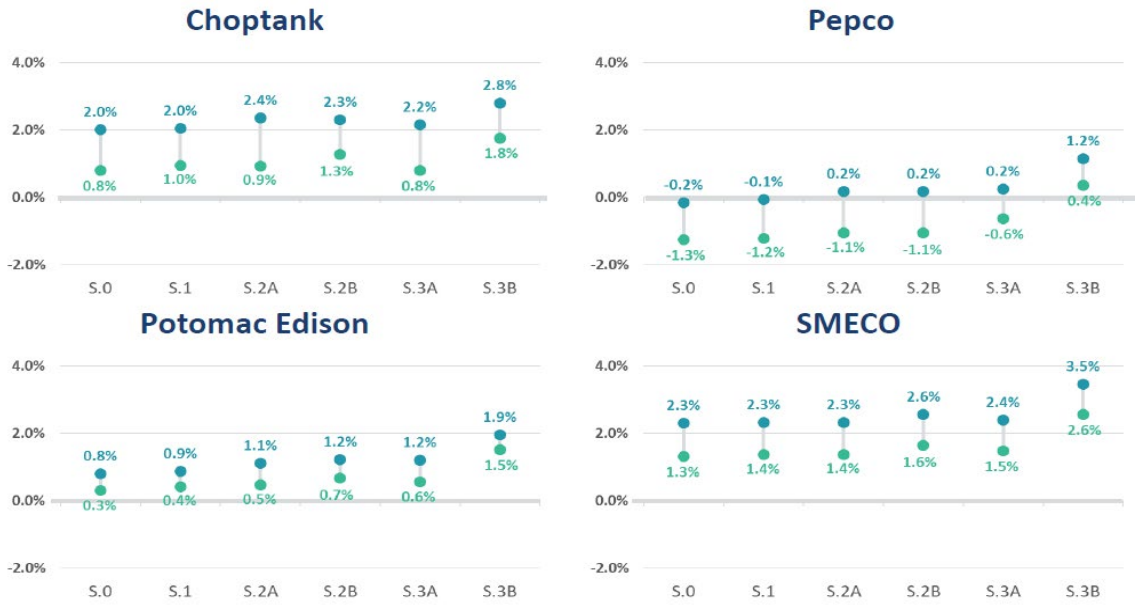
Q. Is there any study that analyzes the impacts of ccASHPs for Maryland?

A. Yes. The *Climate Solutions Now Act* required the Commission to conduct a study to assess "the capacity of each company's gas and electric distribution systems to successfully serve customers under a managed transition to a

[75] Ben Shoenbauer *et al.*, *Field Assessment of Ducted and Ductless Cold Climate Air Source Heat Pumps*, Center for Energy and Environment (2018), https://www.mncee.org/field-assessment-ducted-and-ductless-cold-climate-air-source-heat-pumps.

highly electrified building sector."[76] On behalf of the Commission, The Brattle Group is currently conducting this study in consultation with the Electrification Working Group. Though The Brattle Group and the working group's efforts are ongoing, draft findings show that an electrification scenario dominated by ccASHPs (S.3A) with aggressive energy efficiency and demand-response program efforts would see substantially lower peak load growth rates than another electrification scenario (S.3B) that relies on conventional heat pumps, as shown in the figure below. This analysis clearly shows the benefits of ccASHPs in terms of mitigating potential electric system impacts.

Figure 3. 2022–2031 annual peak load growth rate by scenario for selected Maryland utilities



Source: The Brattle Group. Electrification Study Working Group November Update. November 13, 2023. Slide 13. Attached as Exhibit KT-3.

[76] 2022 Md. Laws Ch. 38. § 10(c)(1).

Q. How should Pepco design customer incentive levels for heat pumps?

A. To fully recognize the benefits of whole-home, electric heat pumps that do not require any fuel backup heating, I strongly recommend that Pepco provide substantially higher incentive levels for those heat pumps and lower incentive levels for hybrid heat pumps. Based on Mass Save's incentive approach, I recommend that Pepco design incentives for whole-home heat pumps twice as large as hybrid heat pumps with fuel backup heating.

Further, Pepco should provide higher incentives for ccASHPs. These heat pumps do not require electric resistance backup heating systems and can reduce winter peak load contributions from heat pumps substantially relative to electric resistance backup, thereby reducing system costs.

I recommend Pepco make these modifications within the proposed incentive budget estimates.

D. Pepco should reduce customer incentives and increase the number of program participants for the Residential Building Make-Ready program.

Q. What are your main concerns about Pepco's proposed Residential Make-Ready (MR) program?

A. My primary concerns on Pepco's Residential MR program are as follows:

- Pepco's assumed per-customer incentive for this program is too high.
- The proposed customer incentives do not take into account available IRA rebates or federal tax credits.

Q. Please elaborate on your first concern about the per-customer incentive amount.

A. The total budget for the proposed Residential MR program is $11.2 million, of which approximately $8.9 million (or 80 percent of the total budget) is allocated to customer incentives.[77] This means that Pepco assumes an average customer incentive of $2,775 per customer. This estimate is too high based on the project cost estimates provided by Pepco.

More specifically, as shown in Table 13 below, Pepco assumes 47 percent of participating homes need to upgrade branch circuitry with an average cost of $800 per project and 17 percent of participating homes need to upgrade both branch circuitry and electric panels with an average cost of $5,000.[78] I obtained the data in this table from the Pepco workbook titled "OPC DR 12-6 Attachment Electronic Only." My interpretation of Pepco's intention of the participation percentages is that approximately 64 percent of Pepco's program participants would need branch circuit upgrades and/or panel upgrades. Based on these assumptions, Pepco estimates that the average MR cost is $1,226 per project. This cost estimate is less than half of the average customer incentive of $2,775 for the Residential MR program.

[77] Schatz Direct at 45, Table 4.
[78] "OPC DR 12-6 Attachment Electronic Only" workbook, Projections tab.

Table 13. Pepco's MR cost estimates

Upgrade Type	Cost Estimate	% of Participating Homes with Upgrade Needs
Branch Circuitry Only	$800	47%
Branch Circuitry + Panel Upgrade	$5,000	17%
Average MR Cost Per Project (spread over all projects)	$1,226	

Source: "OPC DR 12-6 Attachment Electronic Only" workbook, Projections tab.

On the other hand, Pepco also provided a few different estimates for MR costs in the "OPC DR 12-6 Attachment Electronic Only" workbook. In one place, Pepco estimates a $3,500 cost for panel and branch circuit upgrades and a $800 cost for branch circuit upgrades.[79] The average project cost of these cost estimates would be even lower than the first average cost estimated by Pepco that I mentioned above. Finally, Pepco uses another average cost estimate of $3,500 to estimate incentive budgets in the same workbook.[80] Pepco assumes 50 percent of this cost to represent the average incentive cost and estimates the total incentive budget.[81] This assumption results in $1,750 per participant incentives, which is about $1,000 lower than the average incentive of $2,775 per customer Pepco assumed for its incentive budget as I mentioned above.

[79] "OPC DR 12-6 Attachment Electronic Only" workbook, Projections tab, I88 to I89 cells.
[80] "OPC DR 12-6 Attachment Electronic Only" workbook, Projection tab, cell M96.
[81] *Id.*

Q. Please elaborate on your second concern about IRA rebates and federal tax credits.

As I mentioned above, electric wiring and panel upgrades are eligible for both IRA rebates and federal tax credits. Households with income levels less than 150 percent AMI can now receive up to $2,500 for electric wiring and up to $4,000 for electric panel upgrades through the IRA's High-Efficiency Electric Home Rebate program. In addition, make-ready investments such as electrical panel upgrades are eligible for up to $600 of federal tax credits.[82]

My review of Pepco's proposed incentive calculations and budget analysis revealed that Pepco did not incorporate the effects of the IRA rebates or the federal tax credits. While Witness Schatz did mention the IRA rebates for electric panel upgrades and wiring within the program description for the Residential Building Make-Ready program,[83] I did not find any indication of the rebates or federal tax credits in Pepco's calculation of the incentive budget for the Residential MR program in the "OPC DR 12-6 Attachment Electronic Only" workbook that I mentioned above.

[82] Steven Nadel, *How Utility Energy Efficiency Programs Can Use New Federal Funding*, ACEEE (2023), https://www.aceee.org/sites/default/files/pdfs/home_energy_upgrade_incentives_2-1-23_1.pdf; Rewiring America, *The Inflation Reduction Act: Electrification Rebates*, https://www.rewiringamerica.org/ira-fact-sheets; Rewiring America,*25C Residential Energy Efficiency Tax Credit and 25D Residential Clean Energy Tax Credit*, Available at: https://www.rewiringamerica.org/ira-fact-sheets.

[83] Schedule DSS-3 at 1.

Q. What is your conclusion about the proposed Residential Building MR program?

A. I conclude that Pepco's assumed per-customer incentives for the Residential Building MR program are too high. This is especially true if Pepco properly takes into account the effects of the IRA rebates on utility incentives. As I explained above, if we assume that LMI customers need to upgrade electric panels and wiring, the total cost would be $3,500 to $5,000 according to Pepco's estimates. The total combined IRA rebates would be $6,500 for electric panel and wiring upgrades. Thus, LMI customers would not require any additional incentives from Pepco.

I also conclude that Pepco's filing and analysis are poorly organized and not credible as they present multiple MR cost estimates that contradict each other.

Q. What is your recommendation about the proposed Residential MR program?

A. I recommend that, before approving Pepco's Residential MR program, the Commission require Pepco to refile all the analyses concerning incentives for residential building MR investments and recalculate per-customer incentives while accounting for the effects of the IRA rebates and tax credits.

Q. Do you have any concerns about the proposed Commercial Building MR program?

A. No. For the Commercial Building MR program, Pepco is proposing to offer rebates up to 50 percent of eligible costs up to an $8,000 cap. This incentive design proposal is reasonable. First, providing rebates up to or around 50 percent of project costs is a common practice we see in many utility energy efficiency programs.[84] Pepco also noted that this incentive design is consistent with some of the existing EmPOWER Maryland programs.[85] The incentive cap of $8,000 for commercial MR costs also appears reasonable based on my review of several data sources. One study indicates that the cost of panel upgrades for small- to medium-sized buildings range from $10,000 to $20,000.[86] Another study indicates that electrical modifications cost $3,000 for medium-sized office buildings.[87]

[84] U.S. EPA, *Customer Incentives for Energy Efficiency Through Program Offerings* (Feb. 2010), https://archive.epa.gov/epa/statelocalclimate/customer-incentives-energy-efficiency-through-program-offerings.html.

[85] Exhibit KT-2 (OPC DR 34-9 (b)).

[86] Betony Jones, *Los Angeles Building Decarbonization: Community Concerns, Employment Impacts, Opportunities* at 13, Inclusive Economics (June 2021), https://www.nrdc.org/sites/default/files/los-angeles-building-decarbonization-jobs-impacts-report-20211208.pdf.

[87] Group 14 Engineering, *Electrification of Commercial and Residential Buildings* at 13 (Nov, 2020), https://www.communityenergyinc.com/wp-content/uploads/Building-Electrification-Study-Group14-2020-11.09.pdf.

E. Pepco should substantially reduce the BE and MR program's administrative budgets.

Q. Please elaborate on why Pepco's proposed administrative budget is too high.

A. To assess whether a budget estimate is reasonable, I evaluated the average budget per program participant. This approach indicates how much money Pepco is planning to spend to reach and acquire each program participant and deliver/install measures on average. I then compared Pepco's residential BE program and MR non-incentive budgets (total budgets minus customer incentives) to Pepco's reported 2022 EmPOWER expenditures for the residential HVAC and Home Performance with ENERGY STAR programs.[88]

On a per-customer basis, Pepco assumes a much higher budget for program administration and customer education and outreach, as shown in Table 14 below. In fact, administration costs are nearly two times higher than Pepco's EmPOWER administration costs, and per-participant customer education and outreach costs are three times higher. Pepco states that customer education and outreach is a key part of overcoming electrification barriers, and it plans to work with trade allies to promote the electrification programs.[89] However, Pepco does not justify why the non-incentive costs

[88] My use of EmPOWER as a benchmark for comparing Pepco's BE and MR program administrative costs does not mean I agree that the EmPOWER administrative costs are at the appropriate level.
[89] Schatz Direct at 31, lines 15-18.

are multiples of two to three higher than the EmPOWER program, especially when the BE and MR programs are intended to utilize existing program delivery channels and EmPOWER infrastructure.[90]

Table 14. Comparison of cost per participant for Pepco's residential BE and MR programs and EmPOWER's residential HVAC and Home Performance programs

Budget Category	BE Residential Program 2024-2027 Total	MR Residential Program 2024-2027 Total	EmPOWER HVAC & Home Performance 2022 Reported
Administrative Costs	$556.95	$429.19	$300
Customer Education and Outreach Costs	$388.25	$299.19	$126
Total (excluding incentives)	$945.20	$728.37	$426.45

Source: Schatz Direct at 35, 45; Schedule DSS-3 at 1 and 3; Schedule DSS-2 at 1; Pepco EmPOWER Maryland Report YTD Q3 and Q4 2022[91]

Similarly, the per-participant administrative costs for Pepco's commercial MR program are higher than comparable EmPOWER programs. Based on estimated participation of 150 commercial buildings,[92] the per-participant non-incentive costs are $8,967, as shown in Table 15. In comparison, the per-participant administrative costs for EmPOWER's commercial Efficient Buildings and Small Business programs are more than twice as high, based on 2022 reported participation and spending.[93] Customer education and outreach costs for the commercial MR program are over six times as high as the EmPOWER programs.

[90] Schedule DSS-2 at 2.
[91] ML# 301351 (Case No. 9648, Feb. 15, 2023).
[92] Schedule DSS-3 at 3.
[93] ML# 301351.

Table 15. Comparison of cost per participant for Pepco's commercial MR programs and EmPOWER's commercial Small Business and Efficient Buildings programs

Budget Category	MR Commercial Program 2024-2027 Total	EmPOWER Small Business & Efficient Buildings 2022 Reported
Administrative Costs	$5,284	$3,281
Customer Education and Outreach Costs	$3,683	$592
Total (excluding incentives)	**$8,967**	**$3,873**

Source: Schatz Direct at 45; Schedule DSS-3 at 3; Power Company EmPOWER Maryland Report YTD Q3 and Q4 2022

Q. If we assume the same per-customer budget estimate based on EmPOWER Maryland's recent spending for Pepco's BE program, how would this affect the overall budget?

A. Table 16 below shows an estimated budget for Pepco's residential BE and commercial and residential MR programs based on the EmPOWER HVAC per-customer budget in Table 14 and Table 15 above. If I assume EmPOWER's cost-per-participant estimate, the total costs of Pepco's proposed residential BE Program and MR program would be reduced by about $7.2 million and nearly $1 million, respectively. Similarly, the commercial MR program non-incentive budget could be reduced by approximately half ($0.8 million). In total, these adjustments would reduce the cost of the BE and MR programs by almost $9 million. However, I expect that Pepco could reduce the non-incentive budget further if the company offers its electrification programs within EmPOWER. It is not

clear why these administrative costs are so much higher than EmPOWER administrative costs.

Table 16. Adjusted non-incentive budget for Pepco residential BE program

Budget Category	BE Program Adjusted Non-incentive Budget	Res MR Program Adjusted Non-incentive Budget	Com MR Program Adjusted Non-incentive Budget
Administrative Costs	$4,191,180	$959,835.13	$492,139
Customer Education & Outreach Costs	$1,767,567	$404,795.93	$88,813
Total Excluding Incentives	**$5,958,747**	**$1,364,631**	**$580,952**
Reduction from original non-incentive budget	$7,248,490	$966,161	$764,048

Q. What is your recommendation for the administrative budgets for the BE program, Residential MR program, and Commercial MR program?

A. I recommend Pepco reduce its budget estimates for program administration for the BE program by approximately $7.3 million, the Residential Building MR program by approximately $1 million, and the Commercial Building MR program by approximately $0.8 million.

Q. Do you have any concerns about the administrative costs for the Workforce Development program?

A. No. Pepco states its proposed Workforce Development program will enroll 80 participants each year in the program, with a total budget of $1,250,000 over the MRP period.[94] Based on these values, I calculate the cost per participant for the Workforce Development program to be $3,516. In response to OPC DR 34-12, Pepco provided program costs for the HVAC

[94] Schedule DSS-3 at 7.

and building maintenance programs at Prince George's Community College, Montgomery College, North American Trade Schools, and Lincoln College of Technology.[95] The program cost per participant for these programs ranges from $3,775 to $25,705 per student, with an average of $9,978 per student. In comparison to these other workforce development programs, Pepco's proposed Workforce Development budget seems reasonable.

F. Pepco should implement the Beneficial Electrification program in close coordination with EmPOWER midstream incentive programs.

Q. Please summarize Pepco's incentive approach for the proposed building electrification programs.

A. Pepco proposes to provide prescriptive "midstream" incentives offered through the utility to contractors, using EmPOWER delivery channels.[96] The term "midstream" refers to incentives delivered in the middle of the supply chain to vendors or contractors. In contrast, "downstream" incentives go to end-use customers.

Q. Do you support a midstream incentive approach?

Yes. Midstream incentives provide several benefits. Rather than requiring the customer to claim a rebate, which can take time and effort and may delay reimbursement periods, midstream incentive programs apply incentives

[95] Exhibit KT-2 (OPC DR 34-12, Attachment).
[96] Exhibit KT-2 (OPC DR 25-9 (a)).

before they reach the customer. Midstream incentives thus require no effort from the customer, since rebates are applied "behind the scenes." Distributors pass price discounts directly to contractors or vendors, who in turn pass the discounts to customers. Midstream incentives can also help with market transformation when incentives are provided to distributors and retailers because such incentives will encourage them to keep newer and more efficient products in stock, rather than having them as special-order items.

Efficiency Vermont offers an example of a successful midstream incentive structure. Incentives are applied as an instant discount to contractors at the point of purchase through wholesale distributors, rather than as an end-use customer rebate.[97] A study on electrification in the northeast found that Efficiency Vermont's midstream program model achieves the highest annual installation rate (1.26 percent of homes) out of the 10 programs surveyed, most of which offer downstream incentives.[98]

Q. Do you have any concerns about Pepco's proposed midstream incentive approach?

[97] Steven Nadel, *Programs to Electrify Space Heating in Homes and Buildings*, ACEEE (June 2020), https://www.aceee.org/sites/default/files/pdfs/programs_to_electrify_space_heating_brief_final_6-23-20.pdf.

[98] Emily Levin, *Driving the Heat Pump Market: Lessons Learned from the Northeast*, Vermont Energy Investment Corporation (Feb. 2018), https://www.veic.org/Media/default/documents/resources/reports/veic-heat-pumps-in-the-northeast.pdf.

A. Yes. Pepco states that the BE program will operate alongside the existing EmPOWER HVAC program.[99] The HVAC programs offered through EmPOWER have largely transitioned to a midstream model that targets incentives at equipment distributors and installation contractors.[100] HPWHs fall under EmPOWER's Appliance program and use the same midstream delivery channel. OPC has previously expressed concerns with the EmPOWER HVAC and midstream HPWH programs.[101] The EmPOWER HVAC programs have consistently underperformed in recent years. Market data on HVAC sales suggests that the majority of heat pumps sold in Maryland do not receive incentives through EmPOWER.[102] Furthermore, the 2024–2026 EmPOWER plans offer inconsistent incentives and savings goals, potentially creating market confusion due to the multiple, utility-specific program designs.[103] OPC's recent comments on the 2024–2026 EmPOWER plans highlight the need for improved midstream program designs to support Maryland's decarbonization and electrification goals. In these comments OPC recommended the Commission direct the utilities to refile their midstream HVAC and HPWH programs with the inclusion of a

[99] Schedule DSS-2 at 2.

[100] Md. OPC, *Comments to the Maryland Public Service Commission on EmPOWER Semi-Annual Reports for Q3-Q4 2022*, ML# 302522 (Case No. 9648, April 21, 2022).

[101] *Id.*

[102] VEIC (of behalf of Md. OPC), *Comments on EmPOWER Maryland 2024-2026 Program Plans* at 50 ("OPC EmPOWER Comments"), ML# 305649 (Case No. 9705, Oct. 16, 2023).

[103] *Id.*

single, statewide implementer.[104] I agree with this concern. Offering incentives outside of EmPOWER is not streamlined and creates greater confusion. Pepco's proposal for a separate electrification program complicates the implementation of these programs and may create inefficiencies in promoting building electrification.

Q. What do you recommend for the delivery mechanism of the BE program?

A. Ideally, electrification programs in Maryland would be offered through a single, statewide implementer. However, I recognize that is outside the scope of this docket. If Pepco's BE and MR programs are approved, at minimum Pepco should implement the BE program in close coordination with the EmPOWER programs.

Q. Have you reviewed the cost-effectiveness results for the proposed customer-side electrification programs? If so, do you have any concerns on the cost-effectiveness results or methodologies?

A. Yes. PEPCO has conducted a detailed cost-effectiveness analysis of its proposed building programs. This is a good start, but the Commission should not take the results of the cost-effectiveness analysis at face value at this point for a number of reasons. First, there are many issues to resolve before implementing the programs. Such issues include but are not limited to:

[104] OPC EmPOWER Comments at 6-7.

- how to estimate peak load impacts from heat pumps;
- how to conduct cost-effectiveness tests on electrification programs;
- what benefits and costs should be used; and
- the appropriate level of benefits and costs.

Second, if OPC's motion to strike Pepco's electrification program is granted, Pepco may seek to implement the program within EmPOWER Maryland, and I expect that program designs and resulting cost-effectiveness numbers for such programs will be different from what Pepco is proposing in this filing.

Q. Have you reviewed Pepco's proposed Workforce Development program? If so, do you have any concerns about the program?

A. Yes, I have reviewed the proposed Workforce Development program and have some concerns. As Maryland increases the pace of electrification to advance the state's climate and clean energy goals, there is likely to be a shortage of skilled workers to support these efforts. Thus, I generally support workforce development programs for advancing building electrification, and I support Pepco's efforts to develop a new workforce development program. As I discussed in detail at the end of Section E above, I found that the proposed budget is reasonable.

However, the description of the proposed Workforce Development program lacks details. Pepco merely provides a list of specific courses it

plans to offer. The plan lacks details about what specific challenges Maryland faces in advancing building electrification, what solutions are available to address some of challenges, and how workforce development can play a role in addressing the challenges.

There are new technologies that can help support building electrification for which a workforce development program could play an important role. For example, there are several important electrification technologies that are new to the market in Maryland, such as ccASHPs, 120-volt HPWHs, [105] and smart circuit switches (that allow switching between two high-voltage devices such as an induction range and an EV charger).[106] I expect that these technologies will play a critical role in reducing winter peak loads, thereby reducing the cost of distribution system upgrades for all ratepayers. In addition, these technologies could allow consumers to substantially save on the costs cost of electrification as they could avoid expensive panel upgrades. Trade allies such as contractors and vendors need to learn these new technologies to help consumers electrify their space and

[105] Hot Water Solutions, *120V Heat Pump Water Heater Product Overview*, https://hotwatersolutionsnw.org/partners/news/120-volt-heat-pump-water-heater-product-overview; Jeff St. John, *Finally, a heat-pump water heater that plugs into a standard outlet*, Canary Media (August 29, 2022). https://www.canarymedia.com/articles/heat-pumps/finally-a-heat-pump-water-heater-that-plugs-into-a-standard-outlet.

[106] Redwood Energy, *A Pocket Guide to All-Electric Retrofits of Single-Family Homes* at 76 (April 2022), https://www.redwoodenergy.net/research/a-pocket-guide-to-all-electric-retrofits-of-single-family-homes.

water heating end uses. A new workforce development program should help trade allies to learn these new technologies.

Q. What is your recommendation for Pepco's Workforce Development program?

A. I recommend Pepco provide more details about the program including descriptions of proposed courses, as well as descriptions of specific issues Pepco and other stakeholders are facing in promoting electrification and how Pepco's proposed program would help address those issues.

Q. Please summarize your key recommendations concerning Pepco's customer-side electrification program proposal?

A. Before approving Pepco's building electrification incentive program, I recommend the Commission require Pepco to provide more detailed information and supporting analysis up front, including how much incentive it plans to provide, how it developed the proposed budget for incentives and non-incentive program costs, the program delivery mechanisms, and equipment specifications. Additionally, the Commission should require Pepco to file an implementation plan—subject to stakeholder comment and Commission approval—that includes specific details on how it plans to identify customer income levels for program participants and coordinate with other state agencies.

If the Commission decides to approve Pepco's proposed electrification programs, I recommend that the Commission direct Pepco to modify some aspects of the proposed programs as follows:

1. Pepco should reduce incentive levels for ASHP, GSHP, and HPWH in the proposed BE program. The additional funding resulting from these reduced incentive levels should be used to expand the number of program participants.
2. Pepco should modify its incentive strategies for heat pumps in the proposed BE program as follows:
    - provide a substantially higher level of incentives for whole-home, all-electric heat pumps (e.g., twice as high) than for hybrid heat pumps that require fossil fuel heating backup.
    - Provide higher incentives for ccASHPs.
    - Make these modifications within the proposed incentive budget estimates.
3. Pepco should recalculate per-customer incentives for the Residential Building MR program while accounting for the effects of the IRA rebates and tax credits and refile all the analyses concerning customer incentives.
4. Pepco should implement the BE program in close coordination with EmPOWER midstream incentive programs.

5. Pepco should reduce its budget estimates for program administration for the BE program by approximately $7.3 million, the Residential Building MR program by approximately $1 million, and the Commercial Building MR program by approximately $0.8 million.
6. Pepco should provide more details about the Workforce Development program, including descriptions of the proposed courses as well as descriptions of the specific issues Maryland is facing in promoting electrification and how Pepco's proposed program would help address those issues.

Q. Does this conclude your testimony?

A. Yes.

Exhibit KT-1

Kenji Takahashi, Principal Associate

Synapse Energy Economics I 485 Massachusetts Avenue, Suite 3 I Cambridge, MA 02139 I 617-453-7038
ktakahashi@synapse-energy.com

PROFESSIONAL EXPERIENCE

Synapse Energy Economics Inc, Cambridge, MA. *Principal Associate,* April 2023 – Present*; Senior Associate,* 2015–April 2023*; 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.

ADDITIONAL EDUCATION

Massachusetts Institute of Technology, Cambridge, MA
Professional Education Course: Sustainable Infrastructure Systems: Planning and Operations, 2022.

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, IMPLAN, AVoided Emissions and geneRation Tool (AVERT), CO–Benefits Risk Assessment (COBRA), RETScreen, BEopt™, REM/Rate™
Language: Japanese, Spanish, and Cantonese

TESTIMONY

New Mexico Public Regulation Commission (Case No. 22-00138-UT): Direct Testimony regarding Public Service Company of New Mexico's application for approve of its 2024 Electric Energy Efficiency Program Plan. On behalf of the Office of the Attorney General, September 18, 2023.

Maryland Public Service Commission (Case No.9692): Direct Testimony of Kenji Takahashi in the matter of the application of Baltimore Gas and Electric Company for an Electric and Gas Multi-Year Plan. On behalf of the Office of People's Counsel. June 20, 2023.

Maryland Public Service Commission (Case No.9692): Surrebuttal Testimony of Kenji Takahashi in the matter of the application of Baltimore Gas and Electric Company for an Electric and Gas Multi-Year Plan. On behalf of the Office of People's Counsel. August 25, 2023.

New Mexico Public Regulation Commission (Case No. 22-00232-UT): Direct Testimony regarding New Mexico Gas Company's application for approve of its 23023-2025 Energy Efficiency Program. On behalf of the Office of the Attorney General, November 2022.

Nova Scotia Utility and Review Board (M10473): Evidence of Alice Napoleon and Kenji Takahashi regarding EfficiencyOne's 2023-2025 DSM Resource Plan, with a focus on the Settlement Plan. On behalf of Counsel to Nova Scotia Utility and Review Board, May 2022.

Pennsylvania Public Utility Commission (Docket No. M-2020-3020824): Revised Direct Testimony of Alice Napoleon and Kenji Takahashi regarding PPL Electric Utilities' proposed Act 129 Phase IV Energy Efficiency and Conservation. On behalf of the Natural Resources Defense Council. January 19, 2021.

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.

Massachusetts Department of Public Utilities (D.P.U. 16-103): Direct testimony regarding Berkshire Gas Company's Forecast and Supply Plan. On behalf of the Town of Montague. March 8, 2017.

Ontario Energy Board (EB-2015-0049 and EB-2015-0029): Testimony on *Ontario Gas Demand-Side Management 2016-2020 Plan Review,* expert report on Enbridge Gas Distribution Inc.'s and Union Gas Limited's proposed gas DSM plans. On behalf of the Ontario Energy Board. September 2-3, 2015.

New Jersey Board of Public Utilities (Docket No. EO14080897): Direct testimony regarding Public Service Electric and Gas Company's petition to continue its Energy Efficiency Economic Extension program. On behalf of the New Jersey Division of Rate Counsel. November 7, 2014.

TESTIMONY ASSISTANCE

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.

Maine Public Utilities Commission (Docket No. 2015-00175): Direct testimony of Tim Woolf on Efficiency Maine Trust's petition for approval of the Triennial Plan for Fiscal Years 2017-2019. On behalf of the Natural Resources Council of Maine and the Conservation Law Foundation. February 17, 2016.

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

Florida Public Service Commission (Docket No. 130199-EI – No. 130205-EI): Testimony of Tim Woolf regarding setting goals for increasing the efficiency of energy consumption and increasing the development of demand-side renewable energy systems in Florida utilities. On behalf of Sierra Club. May 19, 2014.

Colorado Public Utilities Commission (Docket No. 13A-0686EG): Testimony of Tim Woolf regarding setting energy efficiency goals for the Public Service Company of Colorado's demand-side management plan. On behalf of Sierra Club. October 16, 2013.

Kentucky Public Service Commission (Case No. 2012-00578): Testimony of Tim Woolf regarding Kentucky Power Company's economics analysis of the proposed purchase of the Mitchell Generating Station. On behalf of Sierra Club. April 1, 2013.

State of New Jersey Board of Public Utilities (Docket No. GO11070399): 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. GR10030225): Testimony of David Nichols before the New Jersey Natural Gas Company's Proposed Energy Efficiency Program. On behalf of New Jersey Division of the Ratepayer Advocate. July 9, 2010.

Pennsylvania Public Utility Commission (Docket Nos. R-2009-2139884 and P-2009-2097639): Testimony of David Nichols regarding Philadelphia Gas Works' Proposed Energy Efficiency Plan. On behalf of Pennsylvania Office of Consumer Advocate. March 26, 2010.

Florida Public Service Commission (Docket NO. 080407-EG et al.): Testimony of William Steinhurst regarding Florida Demand Side Management Policy and Planning. On behalf of Natural Resources Defense Council (NRDC) and Southern Alliance for Clean Energy. July 6, 2009.

Iowa Utilities Board (Docket No. EEP-08-01): Testimony of Chris James regarding Interstate Power and Light Company's Proposed Energy Efficiency Program. On behalf of Community Coalition and Plains Justice. August 29, 2008.

Nova Scotia Utility and Review Board (Case No. M00208): Testimony of Bruce Biewald and David Nichols regarding Nova Scotia Power Inc's Demand Side Management Plan. Oh behalf of The Utility and Review Board Staff f. March 17, 2008.

Public Utilities Commission of Nevada (Docket No. 06-06051): Testimony of Tim Woolf regarding the review of the Nevada Power Company's Demand Side Management Plan in the 2006 Integrated Resource Plan. On behalf of Nevada Bureau of Consumer Protection. September 13, 2006.

Public Utilities Commission of California (Application A.04-06-024): Testimony of Amy Roschelle regarding the review of Pacific Gas and Electric's Application to Establish a Demonstration Climate Protection Program and Tariff Option. On behalf of The Utility Reform Network (TURN). May 5, 2006.

Public Service Commission of Nevada (Docket No. 05-10021): Testimony of Tim Woolf regarding the Sierra Pacific Power Company's Gas Demand-Side Management Plan. On behalf of Nevada Bureau of Consumer Protection. February 22, 2006.

PUBLICATIONS

Hopkins, A. S., A. Napoleon, J. Litynski, K. Takahashi, J. Frost, S. Kwok. 2022. *Climate Policy for Maryland's Gas Utilities: Financial Implications*. Synapse Energy Economics for Maryland Office of the People's Counsel.

Kwok, S., K. Takahashi, J. Litynski, A. S. Hopkins. 2022. Memo: Massachusetts DPU Docket-2080: Proposed "Common Regulatory Framework." Synapse Energy Economics for Conservation Law Foundation.

Hopkins, A. S. S. Kwok, J. Litynski, A. Napoleon, K. Takahashi. 2022. Memo: Evaluation of Draft Consultant Reports in Massachusetts DPU Docket 20-80. Synapse Energy Economics for Conservation Law Foundation.

Takahashi, K., S. Kwok, J. Tabernero, F. Frost. 2022. *Toward Net Zero Emissions from Oregon Buildings*. Synapse Energy Economics for Sierra Club.

Takahashi, K., T. Woolf, B. Havumaki, D. White, D. Goldberg, S. Kwok, A. Takasugi. 2022. *Missed Opportunities - The Impacts of Recent Policies on Energy Efficiency Programs in Midwestern States.* Presented at the 2022 ACEEE Summer Study of Energy Efficiency in Buildings.

Hopkins A. S., P. Eash-Gates, J. Frost, S. Kwok, J. Litynski, K. Takahashi. "Decarbonization of Buildings." In *San Diego Regional Decarbonization Framework*, edited by SDG Policy Initiative, School of Global Policy and Strategy, University of California San Diego. March 2022.

Frost, J. S. Kwok, K. Takahashi, A.S. Hopkins, A. Napoleon. 2021. *New York Heat Pump Trajectory Analysis*. Synapse Energy Economics for NRDC.

Hopkins, A. S., A. Napoleon, K. Takahashi. 2021. *A Framework for Long-Term Gas Utility Planning in Colorado*. Synapse Energy Economics for the Colorado Energy Office.

Kallay, J., A. Napoleon, K. Takahashi, E. Sinclair, T. Woolf. 2021. *Opportunities for Evergy Kansas to Address Energy Equity Within its Integrated Resource Plan and Other Planning Processes*. Synapse Energy Economics for Union of Concerned Scientists.

Takahashi, K., T. Woolf, B. Havumaki, D. White, D. Goldberg, S. Kwok, A. Takasugi. 2021. *Missed Opportunities: The Impacts of Recent Policies on Energy Efficiency Programs in Midwestern States.* Synapse Energy Economics for the Midwest Energy Efficiency Alliance.

Takahashi, K., E. Sinclair, A. Napoleon, A.S. Hopkins, D. Goldberg. 2021. *Evaluation of EnergyWise Low-Income Energy Efficiency Program in Mississippi – Program Performance, Design, and Implications for*

Low-Income Efficiency Programs. Synapse Energy Economics for Sierra Club and Gulf Coast Community Foundation.

Wilson, R., I. Addleton, K. Takahashi, J. Litynski. 2021. *Clean, Affordable, and Reliable – A Plan for Duke Energy's Future in the Carolinas*. Synapse Energy Economics for North Carolina Sustainable Energy Association, Carolinas Clean Energy Business Alliance, Southern Alliance for Clean Energy, Natural Resources Defense Council and the Sierra Club.

Eash-Gates, P., K. Takahashi, D. Goldberg, A.S. Hopkins, S. Kwok. 2021. *Boston Building Emissions Performance Standard: Technical Methods Overview.* Synapse Energy Economics for the City of Boston.

Shipley, J., Hopkins, A., Takahashi, K., & Farnsworth, D. 2021. *Renovating regulation to electrify buildings: A guide for the handy regulator*. Regulatory Assistance Project.

Goldberg, D., J. Frost, D. Hurley, K. Takahashi. 2020. *New England Electrification Load Forecast*. Synapse Energy Economics for E4TheFuture.

Camacho, J., K. Takahashi, A. S. Hopkins, D. White. 2020. *Assessment of Proposed Energize Eastside Project*. Synapse Energy Economics and MaxETA Energy for the City of Newcastle, WA.

Lane, C., K. Takahashi. 2020. *Rate and Bill Impact Analysis of Rhode Island Natural Gas Energy Efficiency Programs*. Synapse Energy Economics for National Grid.

Takahashi, K., A. S. Hopkins, D. White, S. Kwok, N. Garner. 2020. *Assessment of National Grid's Long-Term Capacity Report – Natural gas capacity needs and alternatives*. Synapse Energy Economics for the Eastern Environmental Law Center.

Takahashi, K., J. Frost, D. Goldberg, A. S. Hopkins, K. Nishio, K. Nakano. 2020. *Survey of U.S. State and Local Building Decarbonization Policies and Programs.* Presented at the 2020 ACEEE Summer Study of Energy Efficiency in Buildings.

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.

Hopkins, A. S., K. Takahashi, Nadel, S. 2020. "Keep warm and carry on: Electrification and efficiency meet the 'polar vortex'." Proceedings of the 2020 ACEEE Summer Study of Energy Efficiency in Buildings.

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.

Camp, E., B. Fagan, J. Frost, D. Glick, A. Hopkins, A. Napoleon, N. Peluso, K. Takahashi, D. White, R. Wilson, T. Woolf. (2019). *Phase 2 Report on Muskrat Falls Project Rate Mitigation: Newfoundland and Labrador Hydro Rate Mitigation Approaches: Options for Cost Savings and Revenue Opportunities through Export Market Sales, Energy Efficiency, In-Province Electrification and Rate Design Approaches After In-Service of the Muskrat Falls Project*. Synapse Energy Economics for Board of Commissioners of Public Utilities, Province of Newfoundland and Labrador.

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.

Takahashi, K, T. Woolf, J. Kallay, E. Malone, A. Napoleon, M. Whited. 2016. *Starting Energy Efficiency Off on the Right Foot–Regulatory Policies to Support Successful Program Planning and Design.* Synapse Energy Economics for Prince Edward Island Regulatory & Appeals Commission.

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.

Malone, E. T. Woolf, K. Takahashi, S. Fields. 2013. "Appendix D: Energy Efficiency Cost-Effectiveness Tests." *Readying Michigan to Make Good Energy Decisions: Energy Efficiency*. Synapse Energy Economics for the Council of Michigan Foundations.

Takahashi, K. et al. 2013. *Economic and Environmental Analysis of Residential Heating and Cooling Systems: A Study of Heat Pump Performance in U.S. Cities*. Proceeding of the 7th International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL'13), September 12, 2013.

Comings, T., K. Takahashi, G. Keith. 2013. *Employment Effects of Investing in Select Electricity Resources in Washington State.* Synapse Energy Economics for Sierra Club.

Woolf, T., E. Malone, J. Kallay, K. Takahashi. 2013. *Energy Efficiency Cost-Effectiveness Screening in the Northeast and Mid-Atlantic States.* Synapse Energy Economics for Northeast Energy Efficiency Partnerships, Inc. (NEEP).

Stanton, E. A., T. Comings, K. Takahashi, P. Knight, T. Vitolo, E. Hausman. 2013. *Economic Impacts of the NRDC Carbon Standard.* Synapse Energy Economics for the Natural Resources Defense Council (NRDC).

Woolf, T., W. Steinhurst, E. Malone, K. Takahashi. 2012. *Energy Efficiency Cost-Effectiveness Screening: How to Properly Account for 'Other Program Impacts' and Environmental Compliance Costs.* Synapse Energy Economics for Regulatory Assistance Project and Vermont Housing Conservation Board.

Woolf, T., M. Whited, T. Vitolo, K. Takahashi, D. White. 2012. *Indian Point Energy Center Replacement Analysis: A Plan for Replacing the Nuclear Plant with Clean, Sustainable, Energy Resources.* Synapse Energy Economics for National Resources Defense Council and Riverkeeper.

Keith, G., T. Woolf, K. Takahashi. 2012. *A Clean Electricity Vision for Long Island: Supplying 100% of Long Island's Electricity Needs with Renewable Power.* Synapse Energy Economics for Renewable Energy Long Island.

Fisher, J., K. Takahashi. 2012. *TVA Coal in Crisis: Using Energy Efficiency to Replace TVA's Highly Non-Economic Coal Units*. Synapse Energy Economics for Sierra Club.

Woolf, T., E. Malone, K. Takahashi, W. Steinhurst. 2012. *Best Practices in Energy Efficiency Program Screening: How to Ensure that the Value of Energy Efficiency is Properly Accounted For*. Synapse Energy Economics for National Home Performance Council.

Takahashi, K., W. Steinhurst. 2012. A Preliminary Analysis of Energy Impacts from Partial Deep Energy Retrofit Projects in National Grid's Jurisdiction. Synapse Energy Economics for National Grid, USA.

Synapse Energy Economics. 2012. *Economic and Environmental Analysis of Residential Heating and Cooling Systems: A Study of Heat Pump Performance in US Cities.* Prepared for a HVAC manufacture company.

Hornby, R., D. White, T. Vitolo, T. Comings, K. Takahashi. 2012. *Potential Impacts of a Renewable and Energy Efficiency Portfolio Standard in Kentucky*. Synapse Energy Economics for Mountain Association for Community Economic Development and The Kentucky Sustainable Energy Alliance.

Keith, G., B. Biewald, E. Hausman, K. Takahashi, T. Vitolo, T. Comings, P. Knight. 2011. *Toward a Sustainable Future for the US Power Sector: Beyond Business as Usual 2011.* Synapse Energy Economics for Civil Society Institute.

Synapse Energy Economics. 2011. *Electricity Scenario Analysis for the Vermont Comprehensive Energy Plan 2011.* Prepared for Vermont Department of Public Service.

Bourgeois, T., D. Hall, W. Steinhurst, K. Takahashi. 2011. *Deployment of Distributed Generation for Grid Support and Distribution System Infrastructure: A Summary Analysis of DG Benefits and Case Studies***.** Pace Energy and Climate Center and Synapse Energy Economics for New York State Energy Research and Development Authority (NYSERDA).

Peterson, P., V. Sabodash, K. Takahashi. 2010. *Demand Side Resource Potential: A Review of Global Energy Partners' Report for Midwest ISO.* Synapse Energy Economics for Project for Sustainable FERC Energy Policy.

Keith, G., B. Biewald, E. Hausman, K. Takahashi, T. Vitolo, T. Comings, P. Knight. 2010. *Beyond Business as Usual: Investigating a Future Without Coal and Nuclear Power in the US.* Synapse Energy Economics for Civil Society Institute.

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.

James, C., K. Takahashi, W. Steinhurst. 2009. *North Dakota Energy Efficiency Potential Study Report.* Synapse Energy Economics for Plains Justice.

James, C., K. Takahashi, W. Steinhurst. 2009. *South Dakota Energy Efficiency Potential Study Report.* Synapse Energy Economics for Plains Justice.

James, C., J. Fisher, K. Takahashi, B. Warfield. 2009. *No Need to Wait: Using Energy Efficiency and Offsets to Meet Early Electric Sector Greenhouse Gas Targets*. Synapse Energy Economics for Environmental Defense Fund.

Takahashi, K., D. Nichols. 2009. *The Costs of Increasing Electricity Savings through Utility Efficiency Programs: Evidence from US Experience*. Proceeding of the 5th International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL'09), June 24, 2009.

Hurley, D., K. Takahashi, B. Biewald, J. Kallay, R. Maslowski. 2008. *Cost and Benefits of Electric Utility Energy Efficiency in Massachusetts*. Synapse Energy Economics for Northeast Energy Efficiency Council.

Takahashi, K., D. Nichols. 2008. *The Sustainability and Costs of Increasing Efficiency Impacts: Evidence from Experience to Date*. Proceedings of the 2008 ACEEE Summer Study on Energy Efficiency in Buildings, August 20, 2008.

Hornby, R., C. Salamone, S. Perry, D. White, K. Takahashi. 2008. *Advanced Metering Infrastructure-Implications for Residential Customers in New Jersey*. Synapse Energy Economics for New Jersey Division of the Ratepayer Advocate.

Hornby, R., C. James, K. Takahashi, D. White. 2008. *Increasing Demand Response in Maine.* Synapse Energy Economics for the Maine Public Utilities Commission.

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

Zalcman, F., K. Takahashi, G. Keith, W. Steinhurst. 2006. *A Comprehensive Process Evaluation of Early Experience under New York's Pilot Program for Integration of Distributed Generation in Utility System Planning.* Synapse Energy Economics and Pace Law School Energy Project for New York State Energy Research and Development Authority (NYSERDA).

Chernick, P., J. Wallach, W. Steinhurst, T. Woolf, A. Sommer, and K. Takahashi. 2006. *Integrated Portfolio Management in a Restructured Supply Market*. Resource Insight, Inc. and Synapse Energy Economics for Ohio Consumers' Counsel.

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. *Ensuring Delaware's Energy Future: A Response to Executive Order Number 82*. Technical assistance for Delaware Cabinet Committee on Energy.

Hausman, E., K. Takahashi, D. Schlissel, B. Biewald. 2006. *The Proposed Broadwater LNG Import Terminal - An Analysis and Assessment of Alternatives*. Prepared for Connecticut Fund for the Environment and Save the Sound.

Synapse Energy Economics. 2006. *The Glebe Mountain Wind Energy Project: Assessment of Project Benefits for Vermont and the New England Region*. Prepared for Glebe Mountain Wind Energy, LLC.

Hausman, E., K. Takahashi, B. Biewald. 2006. *The Deerfield Wind Project: Assessment of the Need for Power and the Economic and Environmental Attributes of the Project*. Synapse Energy Economics for Deerfield Wind, LLC.

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.

Johnston, L., K. Takahashi, F. Weston, and C. Murray. 2005. *Rate Structures for Customers with Onsite Generation: Practice and Innovation*. Synapse Energy Economics and Regulatory Assistance Projects for National Renewable Energy Laboratory.

Woolf, T., K. Takahashi, G. Keith, A. Rochelle, P. Lyons. 2005. *Feasibility Study of Alternative Energy and Advanced Energy Efficiency Technologies for Low-Income Housing in Massachusetts*. Synapse Energy Economics for Low-Income Energy Affordability Network (LEAN) and Action for Boston Community Development, and Action Inc.

Steinhurst, W., R. McIntyre, B. Biewald, C. Chen, K. Takahashi. 2005. *Economic Impacts and Potential Air Emission Reductions from Renewable Generation & Efficiency Programs in New England.* Prepared for Regulatory Assistance Project.

Keith. G., B. Biewald, K. Takahashi. 2004. *The Searsburg/Readsboro Wind Project: An Analysis of Project Economics and an Analysis of Need*. Synapse Energy Economics for enXco Inc.

Takahashi, K. 2003. "The Clean Development Mechanism and Energy Efficiency Upgrades in Developing Countries: The Case of the Residential Sector in Selected Asian Countries." Proceedings of the 3rd International Conference on Energy Efficiency in Domestic Appliances and Lighting, October 1-3, 2003.

PRESENTATIONS

Hopkins, A. S., S. Kwok, A. Napoleon, K. Schultz, K. Takahashi. "Massachusetts Clean Heat Standard: Policy and Regulatory Analysis" presented with Conservation Law Foundation, February 2023.

Takahashi, K. 2022. "Toward Net Zero Emissions from Oregon Buildings – Emissions and Cost Analysis of Efficient Electrification," presentation at LBNL Webinar: End-Use Load Profiles for the U.S. Building Stock: Data Access and Use Cases, December 2022.

Takahashi, K. 2022. "Missed Opportunities - Impacts of Recent Policies on Energy Efficiency Programs in Midwestern States" Presentation at the ACEEE 2022 Summer Study on Energy Efficiency in Buildings, August 24, 2022.

Shipley, J., Hopkins, A., Takahashi, K., & Farnsworth, D. "Renovating regulation to electrify buildings: A guide for the handy regulator," presented with Regulatory Assistance Project, January 2021.

Takahashi, K. 2019. "Non-Wires Alternatives to Building a New Substation in Washington, D.C. – Key Takeaways for Other Jurisdictions" Presentation at the ACEEE 2019 National Conference on Energy Efficiency as a Resource, October 16, 2019

Titus, E., K. Takahashi. 2019. "Strategic Electrification: What does the promised land of information look like?" Presentation at the AESP 2019 Conference, January 24, 2019.

Hopkins, A., K. Takahashi. 2019. "What's Available and What's Needed for Strategic Electrification Planning and Forecasting in the Northeast Slides" Presentation on behalf of the Northeast Energy Efficiency Partnerships, September 20, 2018.

Hall, J., J. Kallay, A. Napoleon, K. Takahashi, M. Whited. 2018. "Locational and Temporal Values of Energy Efficiency and other DERs to T&D Systems." Presentation at the 2018 ACEEE Summer Study on Energy Efficiency in Buildings, August 15, 2008.

Hopkins. A., K. Takahashi, D. Lis. 2018. Deep Decarbonization through Strategic Electrification in the Northeast. Presentation at the 2018 ACEEE Summer Study on Energy Efficiency in Buildings, August 13, 2008.

Takahashi, K. 2017. "Using Demand-Side Resources to End a Moratorium on New Customers for a Local Natural Gas Company in Massachusetts." Presentation at the ACEEE 2017 National Conference on Energy Efficiency as a Resource, October 31, 2017.

Takahashi, K., R. Cook, T. Comings, A. Allison, E. Malone. 2017. *Rhode Island Renewable Thermal Market Development Strategy – An Analysis of Energy, Environmental, Economic, Energy Bill, and Local Job Impacts of an Alternative Renewable Thermal Energy Future for Rhode Island*. Synapse Energy Economics and Meister Consultants Group. Paper presented by K. Takahashi at the 9th International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL), September 15, 2017.

Napoleon, A., K. Takahashi. 2016. "Assessing Strategic Energy Management Cost Effectiveness." Presentation at NEEP Northeast Strategic Management Collaborative Workshop, November 15, 2016.

Takahashi, K. 2016. "Progress and Prospect of U.S. Electricity Policies." Presentation at the Citizen's Alliance for Saving the Atmosphere and the Earth (CASA) seminar in Osaka, Japan on July 5, 2016.

Takahashi, K. and J. Kallay. 2015. "Energy Efficiency and the Clean Power Plan." Webinar presentation on December 15, 2015.

Takahashi, K. 2015. "Searching for Best Practices for Modeling Energy Efficiency in Integrated Resource Planning." Presentation at the 2015 ACEEE National Conference on Energy Efficiency as a Resource, September 21, 2015.

Takahashi, K. 2014. "Expected U.S. Climate and Environmental Policy: The Future of Coal Power and Clean Energy." Presentation at the Citizen's Alliance for Saving the Atmosphere and the Earth (CASA) seminar in Osaka, Japan on July 10, 2014.

Takahashi, K. and J. Fisher. 2013. "Greening TVA: Leveraging Energy Efficiency to Replace TVA's Highly Uneconomic Coal Units." Presentation at the 2013 ACEEE National Conference on Energy Efficiency as a Resource, September 23, 2013.

Takahashi, K. 2013. "Economic and Environmental Analysis of Residential Heating and Cooling Systems: A Study of Heat Pump Performance in U.S. Cities." Presentation at the 7th International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL'13), September 12, 2013.

Takahashi K. 2011. "Jiyuka-dakedenai-america-no-denryokuseisaku-no-saishin-doukou (Recent Trends in U.S. Electric Power Regulation and Policy)." Presentation at CASA and Hinodeya Eco-life Research Institute in Osaka, Japan Workshop to discuss (1) US electricity regulation, (2) the impact of the Fukushima nuclear event on the US nuclear power industry, and (3) energy efficiency policies and programs in the US, November 21, 2011.

Takahashi, K. 2010. "Review of Utility-Owned Distributed Generation Models for New York." Presentation at the Northeast CHP Initiative Meeting, April 13, 2010.

Takahashi, K. and D. Nichols. 2009. "The Costs of Increasing Electricity Savings through Utility Efficiency Programs: Evidence from US Experience." Presentation at the 5th International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL'09), June 24, 2009.

Takahashi, K. 2008. "The Sustainability and Costs of Increasing Efficiency Impacts: Evidence from Experience to Date." Presentation at the 2008 ACEEE Summer Study on Energy Efficiency in Buildings, August 21, 2008.

Takahashi, K. 2005. Discussant at the World Bank Expert Workshop on CDM methodologies and Technical Issues Associated with Power Generation and Power Saving Activities, December 3, 2005.

OTHER RELEVENT WORK

- 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 2020.
- 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.
- 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.
- 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.

CONFERENCES

- 2022 ACEEE Summer Study on Energy Efficiency in Buildings, August 24, 2022.
- 2019 ACEEE National Conference on Energy Efficiency as a Resource, October 15, 2019
- 2019 Electrification U.S. Symposium Series – Pathways to Decarbonization in the Northeast, August 27-29, 2019.
- 2019 AESP Annual Conference, January 24, 2019.
- 2018 ACEEE Summer Study on Energy Efficiency in Buildings, August 12, 2018.
- 2017 ACEEE National Conference on Energy Efficiency as a Resource, October 30, 2017.
- 9th International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL'17), September 13-15, 2017.
- NEEP Northeast Strategic Energy Management Collaborative Workshop, November 15, 2016.
- NEEP 2016 EM&V Forum Annual Public Meeting: the Future of Evaluation, March 30, 2016.
- 2015 ACEEE National Conference on Energy Efficiency as a Resource, September 21, 2015.
- EUCI Conference on Utility Integrated Resource Planning (IRP), May 13-15, 2015.
- 2013 ACEEE National Conference on Energy Efficiency as a Resource, September 22-24, 2013.
- 7th International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL'13), September 11-13, 2013.
- Energy Measure Verification Workshop (sponsored by Massachusetts Department of Energy Resources), September 2013.
- Smart Building: High Performance Homes - Workshop for building professionals, June 22, 2011.
- NESEA Building Energy 11 Conference, March 8-10, 2011.
- Build Boston 2010 on Residential Design and Construction, November 17, 2010.
- ACI New England Conference 2010, October 6, 2010.
- 2010 ACEEE Summer Study on Energy Efficiency in Buildings, August 18-20, 2010.

- NESEA Building Energy 10 Conference, March 8-10, 2010.
- 5th International Conference on Energy Efficiency in Domestic Appliances and Lighting (EEDAL'09), June 24, 2009.
- 2008 ACEEE Summer Study on Energy Efficiency in Buildings, August 21, 2008.
- Tufts University Clean Distributed Energy Workshop, June 8, 2006.
- The 2006 Northeast Energy Efficiency Summit, May 17.
- The 2006 Distributed Generation & Interconnection Conference held by DTE Energy, April 26-28, 2006.
- United Nations Climate Change Conference at its eleventh session / Twenty-third sessions of the Subsidiary Bodies and COP/MOP 1, December 2005.

Resume updated December 2023

Potomac Electric Power Company's Application for Adjustments to its Retail Rates for the Distribution of Electric Energy

Case No. 9702

Data Responses Referenced in the Direct Testimony of Kenji Takahashi

OPC DR 12-6

OPC DR 17-5

OPC DR 17-10

OPC DR 25-9

OPC DR 25-13

OPC DR 34-9

OPC DR 34-12

OPC DR 35-1

POTOMAC ELECTRIC POWER COMPANY
MARYLAND CASE NO. 9702
RESPONSE TO OPC DATA REQUEST NO. 12

QUESTION NO. 6
Refer to the Voluntary DR 1-12 Attachment B Excel file "Updated Voluntary Data Response No. 1_MD Case 9702 Voluntary DR 1-12 Att B Confidential_Schatz" and electrification measure data, please answer the following questions:

(a) This file does not contain any formulas in the PHI Measure Inputs" tab. Please provide a file including all the formulas intact.

(b) Please provide the company's calculations for estimating the incremental measure cost for each measure provided in the "PHI Measure Inputs" tab.

(c) Please provide the data sources Pepco used to determine the estimated useful lifetime for each measure provided in the "PHI Measure Inputs" tab.

(d) This file includes $10,966 for a ducted heat pump and $12,119 for a ductless heat pump/boiler in cells J40 to K40 and E63 to E64 in the "Projections" tab. Please describe how the Company developed these values and provide the original data sources.

(e) Please explain why the costs of heat pumps in cells J40 to K40 and E63 to E64 in the "Projections" tab in the Voluntary DR 1-12 Attachment B Excel file are so much higher the cost estimates for heat pumps provided in the "Updated Voluntary Data Response No. 1_MD Case 9702 Voluntary DR 1-12 Att A Confidential_Schatz.xlsx" file.

RESPONSE:

(a) See OPC DR 12-6 Attachment Electronic Only.

(b) See response to OPC DR 12-5 b.

(c) As the MidAtlantic TRM did not have specific fuel-switching measure methodologies at the time of the MYP filing, existing resources from other states were used to inform the EUL development such as the Massachusetts, New York, and California TRMs.

(d) The Company's consultant ICF developed the costs included in the cells referenced in this question in the manner described in 12-6(b).

(e) Costs in the "Projections" tab are meant to capture full project costs, not incremental costs, and thus include the full cost of equipment, installation, and removal of old systems when appropriate, as well as any make-ready electrical upgrades. The incremental costs used in the cost effectiveness model subtract from these numbers the costs associated with similar replacement but with a baseline fossil fuel equipment.

SPONSOR: Pearl Donohoo-Vallett

POTOMAC ELECTRIC POWER COMPANY
MARYLAND CASE NO. 9702
RESPONSE TO OPC DATA REQUEST NO. 17

QUESTION NO. 5
Please refer to the proposed incentive designs for the Residential Building Make-Ready program described on page 1 of Schedule DSS-3 of Schatz direct testimony.

(a) Are all available federal incentives and rebates subtracted from the calculation of utility rebates for eligible participants under this program? (If not, please explain why.)

(b) Please provide Pepco's calculations of per-customer incentives for the Residential Building Make-Ready program in MS Excel files with original formulas intact well as any written documents associated with the calculations, if any.

RESPONSE:

a. Yes, available federal incentives and rebates are subtracted from the calculation of utility rebates for eligible participants under this program.
b. Please refer to OPC DR 17-5 attachment electronic only.

SPONSOR: Pearl Donohoo-Vallett

This workbook demonstrates the process used to develop unit level incentives based on impact of IRA funding. This workbook may not result in exact matching with filed MYP budgets.

Annual federal IRA incentive availablity (based on estimations of rollout and total funding caps)

PY1	PY2	PY3
50%	15%	9%

		<80%	80-150	Weighted share of utility vs customer cost burden
IRA Funding Av	100.0%	43%	57%	
	BGE	0.85	0.6	0.71
	Customer	0.15	0.4	0.29

Estimations of AMI Breakouts

<80% AMI	80%-150% AM	>150% AMI
30%	40%	30%

Index	Fuel	Sector	Category		Baseline Measure Name	Baseline Measure Life	Measure	Measure Life (Years)	Total Costs	Incremental Costs	Federal Equipment Reb	<80% AMI incentive level federal funding	80%-150% AMI incentive level federal funding	>150% fed funding
1	Natural Gas	Residential	GSHP	Residential	Natural Gas Furna	25	Ground Source Heat Pump	25	$ 26,732	$ 21,816	$ -	$ -	$ -	$ -
2	Heating Oil	Residential	GSHP	Residential	Heating Oil Furna	25	Ground Source Heat Pump	25	$ 26,737	$ 21,993	$ -	$ -	$ -	$ -
3	Propane	Residential	GSHP	Residential	Propane Furnace	25	Ground Source Heat Pump	25	$ 26,737	$ 21,993	$ -	$ -	$ -	$ -
4	Natural Gas	Residential	Heat Pumps	Residential	Natural Gas Furna	15	Air Source Heat Pump - Electric Backup	15	$ 10,406	$ 5,662	$ 8,000	$ 8,000	$ 5,203	$ -
5	Heating Oil	Residential	Heat Pumps	Residential	Heating Oil Furna	15	Air Source Heat Pump - Electric Backup	15	$ 10,406	$ 5,201	$ 8,000	$ 8,000	$ 5,203	$ -
6	Propane	Residential	Heat Pumps	Residential	Propane Furnace	15	Air Source Heat Pump - Electric Backup	15	$ 10,406	$ 5,662	$ 8,000	$ 8,000	$ 5,203	$ -
7	Natural Gas	Residential	Heat Pumps	Residential	Natural Gas Furna	15	Air Source Heat Pump - Fuel Backup	15	$ 12,645	$ 7,901	$ 8,000	$ 8,000	$ 6,322	$ -
8	Natural Gas	Residential	Heat Pumps	Residential	Natural Gas Furna	15	Mini-Split ASHP - Electric Backup	15	$ 11,324	$ 6,407	$ 8,000	$ 8,000	$ 5,662	$ -
9	Heating Oil	Residential	Heat Pumps	Residential	Heating Oil Furna	15	Mini-Split ASHP - Electric Backup	15	$ 11,324	$ 6,119	$ 8,000	$ 8,000	$ 5,662	$ -
10	Propane	Residential	Heat Pumps	Residential	Propane Furnace	15	Mini-Split ASHP - Electric Backup	15	$ 11,324	$ 6,580	$ 8,000	$ 8,000	$ 5,662	$ -
11	Natural Gas	Residential	Heat Pumps	Residential	Natural Gas Furna	15	Mini-Split ASHP - Fuel Backup	15	$ 14,507	$ 9,590	$ 8,000	$ 8,000	$ 7,253	$ -
12	Natural Gas	Residential	Heat Pump W	Residential	Natural Gas Stora	20	HPWH	20	$ 3,268	$ 2,284	$ 1,750	$ 1,750	$ 1,634	$ -

Note: this cap is for modeling purposes to estimate average project expense limits, and does not represent the absolute incentive cap. Modeling the full cap would lead to unrealistically high budget estimations.

										Participation			**Total Federal Incentives, without considering IRA rollout and total funding availability**						**Total Federal**
PHI Rebate Modeled Upper limit Cap	Utility funding - LMI (<80% AMI)	funding - Non-LMI (80%-150 AMI)	Utility funding - Non-LMI (>150 AMI)	MR Incentive level	LMI Incentive Level	Total Eqpt Costs (<80% AMI)	Total Eqpt Costs (80%-150% AMI)	Total Eqpt Costs (>150% AMI)	2024	2025	2026	Total	2024	2025	2026	Total	2024
$ 7,500	$ 7,500	$ 7,500	$ 7,500	50%	80%	$ 61,060	$ 123,071	$ 123,626	8	12	15	35	$ -	$ -	$ -	$ -	$ -
$ 7,500	$ 7,500	$ 7,500	$ 7,500	50%	80%	$ 12,393	$ 24,979	$ 25,091	2	2	3	7	$ -	$ -	$ -	$ -	$ -
$ 7,500	$ 7,500	$ 7,500	$ 7,500	50%	80%	$ 4,483	$ 9,037	$ 9,077	1	1	1	3	$ -	$ -	$ -	$ -	$ -
$ 7,500	$ 2,045	$ 3,122	$ 6,244	60%	85%	$ 819,064	$ 3,258,949	$ 4,094,977	262	783	1,312	2,357	$ 1,175,704	$ 3,508,482	$ 5,878,030	$ 10,562,215	$ 587,852
$ 7,500	$ 2,045	$ 3,122	$ 6,244	60%	85%	$ 503,638	$ 2,003,911	$ 2,517,980	161	481	807	1,449	$ 722,953	$ 2,157,403	$ 3,614,463	$ 6,494,819	$ 361,476
$ 7,500	$ 2,045	$ 3,122	$ 6,244	60%	85%	$ 182,201	$ 724,956	$ 910,931	58	174	292	524	$ 261,543	$ 780,484	$ 1,307,606	$ 2,349,633	$ 130,771
$ 7,500	$ 3,948	$ 3,793	$ 7,500	60%	85%	$ 1,990,454	$ 3,959,882	$ 4,975,721	525	783	1,312	2,619	$ 2,586,292	$ 3,858,948	$ 6,465,193	$ 12,910,433	$ 1,293,146
$ 7,500	$ 2,825	$ 3,397	$ 6,794	60%	85%	$ 199,866	$ 795,241	$ 999,246	59	176	294	529	$ 274,448	$ 818,994	$ 1,372,125	$ 2,465,567	$ 137,224
$ 7,500	$ 2,825	$ 3,397	$ 6,794	60%	85%	$ 122,902	$ 489,013	$ 614,461	36	108	181	191	$ 168,765	$ 503,620	$ 843,753	$ 1,516,137	$ 84,382
$ 7,500	$ 2,825	$ 3,397	$ 6,794	60%	85%	$ 44,462	$ 176,910	$ 222,294	13	39	65	63	$ 61,054	$ 182,195	$ 305,245	$ 548,493	$ 30,527
$ 7,500	$ 5,531	$ 4,352	$ 7,500	60%	85%	$ 512,095	$ 2,037,560	$ 2,560,261	118	351	588	788	$ 623,804	$ 1,861,528	$ 3,118,761	$ 5,604,093	$ 311,902
$ 2,000	$ 1,290	$ 980	$ 1,961	60%	85%	$ 357,019	$ 2,059,682	$ 2,951,385	364	1,576	3,011	10,986	$ 429,214	$ 1,857,138	$ 3,548,205	$ 5,834,558	$ 214,607

$ -

incentives, considering IRA rollout and availability			Total utility incentives (with unconstrained IRA funding)				Total Utility incentives accounting for limited IRA funding				Unit Incentives		
2025	2026	Total	**2024**	**2025**	**2026**	**Total**	2024	2025	2026	**Total**	2024	2025	2026
$ -	$ -	$ -	$ 57,104	$ 86,323	$ 115,616	$ 259,042	$ 57,104	$ 86,323	$ 115,616	$ 259,042	$ 7,500.00	$ 7,500.00	$ 7,500.00
$ -	$ -	$ -	$ 11,588	$ 17,517	$ 23,461	$ 52,566	$ 11,588	$ 17,517	$ 23,461	$ 52,566	$ 7,500.00	$ 7,500.00	$ 7,500.00
$ -	$ -	$ -	$ 4,192	$ 6,337	$ 8,488	$ 19,017	$ 4,192	$ 6,337	$ 8,488	$ 19,017	$ 7,500.00	$ 7,500.00	$ 7,500.00
$ 526,272	$ 529,023	$ 1,643,147	$ 980,055	$ 2,924,637	$ 4,899,869	$ 8,804,561	$ 1,395,751	$ 5,033,485	$ 8,682,381	$ 15,111,617	$ 5,320.00	$ 6,429.12	$ 6,619.26
$ 323,610	$ 325,302	$ 1,010,389	$ 602,615	$ 1,798,297	$ 3,012,825	$ 5,413,737	$ 858,231	$ 3,095,050	$ 5,338,732	$ 9,292,013	$ 5,319.69	$ 6,428.78	$ 6,618.91
$ 117,073	$ 117,685	$ 365,529	$ 218,008	$ 650,570	$ 1,089,951	$ 1,958,530	$ 310,482	$ 1,119,697	$ 1,931,395	$ 3,361,575	$ 5,319.69	$ 6,428.78	$ 6,618.91
$ 578,842	$ 581,867	$ 2,453,856	$ 2,598,259	$ 3,876,802	$ 6,495,106	$ 12,970,166	$ 3,512,698	$ 6,196,305	$ 10,655,457	$ 20,364,460	$ 6,694.45	$ 7,914.36	$ 8,123.49
$ 122,849	$ 123,491	$ 383,564	$ 249,729	$ 745,229	$ 1,248,539	$ 2,243,497	$ 346,766	$ 1,237,503	$ 2,131,502	$ 3,715,770	$ 5,893.87	$ 7,048.39	$ 7,246.30
$ 75,543	$ 75,938	$ 235,863	$ 153,564	$ 458,259	$ 767,757	$ 1,379,581	$ 213,235	$ 760,971	$ 1,310,712	$ 2,284,918	$ 5,893.87	$ 7,048.39	$ 7,246.30
$ 27,329	$ 27,472	$ 85,328	$ 55,555	$ 165,785	$ 277,752	$ 499,092	$ 77,142	$ 275,297	$ 474,177	$ 826,615	$ 5,893.87	$ 7,048.39	$ 7,246.30
$ 279,229	$ 280,689	$ 871,820	$ 664,829	$ 1,983,953	$ 3,323,869	$ 5,972,651	$ 885,389	$ 3,102,864	$ 5,330,792	$ 9,319,044	$ 7,524.34	$ 8,836.42	$ 9,061.34
$ 278,571	$ 319,338	$ 812,516	$ 497,964	$ 2,154,605	$ 4,116,540	$ 6,769,109	$ 649,721	$ 3,270,878	$ 6,399,810	$ 10,320,409	$ 1,784.00	$ 2,075.69	$ 2,125.69
						$ -						t	

POTOMAC ELECTRIC POWER COMPANY
MARYLAND CASE NO. 9702
RESPONSE TO OPC DATA REQUEST NO. 17

QUESTION NO. 10
Refer to Voluntary DR 1-12 Attachment A Confidential / Electronic Only, tab "XB Measure Information."

(a) In column AA on the tab "XB Measure Information", please answer the following questions:

(i) The "Total Participation" for all measures sums to 16,072. This includes 4,714 participants for the measure "Air Source Heat Pump - Fuel Backup" and 1,057 participants for the measure "Mini-Split ASHP - Fuel Backup." Please explain Pepco's rationale for including incentives for systems that retain gas backup.

(ii) In total, heat pumps with fuel backup are 36% of total program participation (5,771 out of 16,072). How did Pepco determine the number of fuel backup participants?

(iii) For fuel-backup participants, did Pepco account for any assumed costs for maintaining backup gas heating in the BCA?

(b) Column J on the tab "XB Measure Information" lists incremental measure costs for each measure. Please describe how these were calculated for each measure, and provide these analyses in MS Excel files with original formulas intact as well as any written documents associated with the analyses, if any and all the data sources used to develop the incremental costs.

(c) Columns Q through S the tab "XB Measure Information" lists proposed upfront incentives for each measure by program year.

(i) Please explain why Air Source Heat Pump - Fuel Backup incentive is higher than the electric backup air source heat pump incentives.

(ii) Please explain why Mini-Split ASHP - Fuel Backup incentive is higher than the electric backup air source heat pump incentives.

(iii) Please explain why the incentives increase over time.

(d) Refer to the following statement on page 1 of Schedule DSS-2: "Pepco has modeled its budgets based on a participation of approximately 10,000 total electrification equipment upgrades over the MYP period."

(i) The total number of electrification measures provided in the XB Measure

Information tab is 16,072. Please explain the discrepancy between this estimate and the number in the above-mentioned statement on page 1 of Schedule DSS-2.

(ii) Please confirm that the budgets presented on page 3 of Schedule DSS-2 include the costs of the 16,072 measures including heat pumps with fuel backup. If not, please explain Pepco's rationale.

(e) Refer to the following statement on page 1 of Schedule DSS-2: "Providing electrification incentives for approximately 10,000 equipment electrification conversions, Pepco forecasts a total lifetime GHG emissions reduction of over 500,000 short tons over the MYP Period." Does the 500,000 short tons of GHG emissions reductions account for continued GHG emissions from fuel backup systems?

RESPONSE:

a. See below for answers to sub-questions.
   i. Pepco's goal in the Building Electrification program design is to enable wide program participation and create opportunities for greenhouse gas savings for customers with different consumer preferences.
   ii. Due to an input value error, the Company will be filing an errata to the testimony of Company Witness Donohoo-Vallett (Schatz) with updated calculations and workbooks.

   The Company developed this estimate to be used for modeling purposes. It is based on input from ICF's experience in other markets. This will be an important data point for the Company to gather Maryland-specific market data to analyze and further refine the program.
   iii. No costs were assumed for maintaining backup gas heating. The costs associated with maintaining the natural gas system already exist.

b. Please refer to the response to OPC DR 12-5.

c. See below for answers to sub-questions.
   i. For the purposes of creating program budgets, incentives were developed as a percentage of costs for these measures. Costs associated with fuel backup were slightly higher than electric backup measures, and thus, the resulting modeled incentive was higher.

   During program implementation, rebates for customers with fuel backup systems will not be higher than all-electric systems.
   ii. For the purposes of creating program budgets, incentives were developed as a percentage of costs for these measures. Costs associated with ductless systems were slightly higher than central air source heat pumps.

   During implementation, rebates for customers with fuel-backup systems will not be higher than electric backup systems.
   iii. Incentive increases over time relate to assumptions on the distribution of IRA funding. The Company expects that in early periods, significant

portions of participation will be supported by both federal and utility funding sources, but that rapid growth in the program could exhaust IRA funding. If this occurs, then a higher percentage of projects could utilize only utility incentives and the per project average incentive increases.

The Company will encourage customers to take advantage of available federal funds where possible and adjust utility incentives accordingly.

d. See below for answer to sub-questions.
    i. Due to an input value error, the Company will be filing an errata to the testimony of Company Witness Donohoo-Vallett (Schatz) with updated calculations and workbooks.
    ii. The budgets on page 3 of Schedule DSS-2 are accurate, but the measure count is incorrect. Due to an input value error, the Company will be filing an errata to the testimony of Company Witness Donohoo-Vallett (Schatz) with updated calculations and workbooks.
e. Yes, it does. However, the 500,000 short tons figure is incorrect. Due to an input value error, the Company will be filing an errata to the testimony of Company Witness Donohoo-Vallett (Schatz) with updated calculations and workbooks.

SPONSOR: Pearl Donohoo-Vallett

POTOMAC ELECTRIC POWER COMPANY
MARYLAND CASE NO. 9702
RESPONSE TO OPC DATA REQUEST NO. 25

QUESTION NO. 9
Please refer to Schedule DSS-2 and Schedule DSS-3.

(a) Please describe how Pepco will provide the residential equipment electrification incentives to customers as part of the Beneficial Electrification program.

(i) Does Pepco propose to provide incentives directly to customers or through contractors?

(ii) Please explain the rationale for the proposed incentive delivery channel.

(iii) If Pepco proposes to provide incentives directly to customers and not through contractors (i.e., midstream delivery), please explain how Pepco is planning to coordinate the delivery of the proposed program with the existing EmPOWER Midstream programs. Please also explain how this proposal is consistent with the findings of successful heat pump and heat pump water heater programs surveyed by the EmPOWER Midstream Work Group?

(b) Please describe how Pepco will provide the make-ready incentives to customers as part of the Residential Building Make-Ready and Commercial Building Make-Ready programs.

(i) Does Pepco propose to provide incentives directly to customers or through contractors?

(ii) Please explain the rationale for the proposed delivery channel.

(iii) If Pepco proposes to provide incentives directly to customers and not through contractors (i.e., midstream delivery) please explain how this proposal is consistent with the findings of successful heat pump and heat pump water heater programs surveyed by the EmPOWER Midstream Work Group?

RESPONSE:

(a)

(i) Pepco proposes to provide incentives through contractors but requires flexibility in implementation to match any changes to the EmPOWER midstream HVAC programs, in order to align delivery channels.

(ii) The proposed incentive delivery channel is based on the recommendations from the Future Programming Working Group, which recommended a midstream delivery channel. The language of this filing is intentionally designed to allow for any flexibility

necessary to coordinate with IRA rebate delivery to ensure a seamless customer journey that prioritizes access to federal funds.

(iii) Pepco is proposing a midstream delivery, in line with the recommendation from this working group.

(b)

(i) Please refer to OPC DR 25-9(a)(i).

(ii) Pepco intends to align the delivery channel between equipment and make-ready electrification incentives by offering both incentive types through contractors. This will reduce any confusion for customers to avoid dealing with multiple incentive channels.

(iii) Pepco proposes to provide incentives through contractors.

SPONSOR: Pearl Donohoo-Vallett

POTOMAC ELECTRIC POWER COMPANY
MARYLAND CASE NO. 9702
RESPONSE TO OPC DATA REQUEST NO. 25

QUESTION NO. 13
Refer to the following statement on page 30 of Schatz's Direct Testimony: "Eligibility for this program will be complementary with federal funds offered through the IRA." The IRA provides enhanced or new tax credits for heat pumps and electrification make-ready investment (i.e., electrical panel upgrades), which have become available this year. Geothermal heat pumps are now eligible for 30 percent tax credits (25D tax credit). Both heat pumps and heat pump waters are eligible for $2,000 federal tax credits (25C tax credit), and electrification make-ready investment are eligible for $600 tax credits (25C tax credit).

Did Pepco take into account the effects of these available federal tax credits on utility incentives that Pepco is planning to offer under its proposed building electrification program? (If so, please provide this analysis in MS Excel files with original formulas intact. If not, please explain why.)

RESPONSE:

Pepco did not take into account these federal tax credits because they would take up to a year to vest to customers and may not alleviate the upfront financial burden of major electrification upgrades.

SPONSOR: Pearl Donohoo-Vallett

POTOMAC ELECTRIC POWER COMPANY
MARYLAND CASE NO. 9702
RESPONSE TO OPC DATA REQUEST NO. 34

QUESTION NO. 9
Refer to Pepco's response to OPC DR 17-14 part b.

(a) Please explain how Pepco determined the 50% cost threshold.

(b) Do any of the existing commercial EmPOWER programs provide incentives up to 50% of total eligible costs? If so, please state the names of such programs and describe the incentive structures for the programs.

RESPONSE:

(a) Given the limited history of commercial electrification in Maryland and elsewhere nationally, cost and incentive thresholds were developed through conversations with trade allies and the Company's understanding of the Maryland small-to-medium commercial business market. As stated in OPC DR 17-14(a), the Company will continue to assess the market through this program to further refine program offerings for this segment in the future.

(b) Yes, the following EmPOWER programs may provide up to 50% or more of eligible costs for certain measures.
- Existing Buildings – Prescriptive
- Existing Buildings – Custom
- Building Tune-up

The program technical sheets below provide the incentive structure for the programs.

- Existing Buildings/Prescriptive
  - High Efficiency Equipment
  - HVAC
  - Retrofit Lighting

- Custom
  - Custom

- Building Tune-up
  - Small and Full BT
  - HVAC Tune-up

SPONSOR: Pearl Donohoo-Vallett

POTOMAC ELECTRIC POWER COMPANY
MARYLAND CASE NO. 9702
RESPONSE TO OPC DATA REQUEST NO. 34

QUESTION NO. 12
Refer to Pepco's response to OPC DR 17-19 part b. Please provide summary descriptions, budget estimates and any publicly available documentations (including URLs) for the HVAC and building maintenance programs at Prince George's Community College, Montgomery College, North American Trade Schools, and Lincoln College of Technology.

RESPONSE:

Please refer to MD 9702 OPC DR 34-12 Attachment Electronic Only for the requested summary.

SPONSOR: Pearl Donohoo-Vallett

School	Program	Program Cost per Student	Program URL
Montgomery College	HVAC Area of Concentration, Building Trades Technology AAS: 308C	$10,788.00	https://catalog.montgomerycollege.edu/preview_program.php?catoid=18&poid=4200
	HVAC Certificate: 244	$4,315.00	https://catalog.montgomerycollege.edu/preview_program.php?catoid=18&poid=4231
	Building Trades Technology Certificate: 263	$3,775.00	https://catalog.montgomerycollege.edu/preview_program.php?catoid=18&poid=4412
Prince George's Community College	Building Trades AAS	$9,760.00	https://www.pgcc.edu/programs-courses/program-finder/building-trades-aas/
	PGCC Certificate HVAC/R	$5,980.00	https://www.pgcc.edu/programs-courses/continuing-education/construction-and-skilled-trades/hvacr-nccer/
North American Trade Schools	HVAC/R	$9,525.00	https://natradeschools.edu/programs/hrvac/
Lincoln Tech	AC, Refrig & Heating Technology	$25,705.00	https://www.lincolntech.edu/careers/skilled-trades/hvac

Tuition Rate Information	Program Summary
https://www.montgomerycollege.edu/paying-for-college/tuition/current-rates.html	This program is intended to prepare students for careers in the building and construction trades. The General Education courses, in conjunction with specialized courses, provide a broad foundation and sharpen students' skills in preparation for entry into or advancement in today's workplace. This curriculum, following the HVAC area of concentration, provides training, skills, and knowledge that prepares students for employment as HVAC technicians or provides current building and construction professionals with essential HVAC technician skills. In order to receive the AAS, HVAC area of concentration students must pass the E.P.A. 608 Certification Exam and at least one Industry Competency Exam (ICE).
	This certificate curriculum prepares individuals for employment or advancement in the HVAC trade of the building and construction industry. A combination of academic and practical instruction will provide individuals with knowledge and skills that are necessary for success in the HVAC profession. Credits may also be applied to the building trades technology AAS degree.
	This certificate curriculum prepares students for employment or advancement in the building and construction industry. A combination of academic and practical instruction provides knowledge and skills that are necessary for success in these professions. Credits may also be applied to the Building Trades Technology AAS degree.
https://www.pgcc.edu/paying-for-college/tuition-and-costs/	The Building Trades, A.A.S degree prepares students for careers in the building and construction trades. Students choose one of four tracks of courses in the building trades, which provides the skills, knowledge and hands-on training to gain employment as carpenters, electricians, HVAC/R technicians, or plumbers. Upon successful completion of the program, graduates earn NCCER Levels 1-4 certification in the trade of their choice, as well as OSHA 10 certification.
	The curriculum, provided by the National Center for Construction Education and Research (NCCER), is designed to prepare HVAC/R students for entry into and advancement in this growing industry. Students who successfully complete the following courses will be eligible to receive the HVAC/R System 1 certificate.
n/a	The HRVAC training program is designed to provide students with the necessary skills to install and repair heating, air conditioning, and residential refrigeration equipment. Students of the HRVAC program will be trained to assume positions as entry-level HRVAC and HVAC technicians in a variety of industries and earn their EPA 608 Certificate.
https://www.lincolntech.edu/admissions/tuition-and-fees-program-campus	Lincoln's HVAC program introduces students to Green Technology - green alternatives to comfort heating and cooling systems, as well as Solar Thermal and Geothermal Green Technologies. Upon completion of Lincoln's Heating, Ventilation and Air Conditioning program, graduates can pursue several other certifications, including Environmental Protection Agency (EPA) certification testing to leverage opportunities working as independent contractors in one or more specific areas of the HVAC market.

POTOMAC ELECTRIC POWER COMPANY
MARYLAND CASE NO. 9702
RESPONSE TO OPC DATA REQUEST NO. 35

QUESTION NO. 1
Refer to Pepco's response to OPC DR 17-10, part c and the OPC DR 17-5 attachment electronic only workbook.

(a) Please explain why the heat pump costs with fuel backup are higher than the heat pump costs with electric backup.

(b) If Pepco assumes any costs associated with an integrated control technology that seamlessly switch between a heat pump and a fuel backup heater, please provide the cost of the integrated control technology included in the total cost of the heat pump measure.

RESPONSE:

(a) Measure cost estimations were informed using ICF proprietary data which considered multiple replacement scenarios. Some replace-on-burnout scenarios included a portion of the costs related to replacement of fossil fuel equipment, which raised the estimated costs of heat pumps with fuel backups.

(b) Program costs assume use of all necessary technologies for proper functionality of the systems. Pepco does not have itemized cost breakouts for each invoiced part of equipment upgrades.

SPONSOR: Pearl Donohoo-Vallett

Electrification Study Working Group November Update

PRESENTED BY

THE BRATTLE GROUP

APPLIED ENERGY GROUP

MONDRE ENERGY

PRESENTED TO

ELECTRIFICATION STUDY WORKING GROUP

NOVEMBER 13, 2023

Brattle

Agenda

1. Progress Update and Timeline
2. Recap of Scenarios
3. Overview of Updates to Results
4. Conclusion Next Steps

1 – Progress Update and Timeline

Progress Update

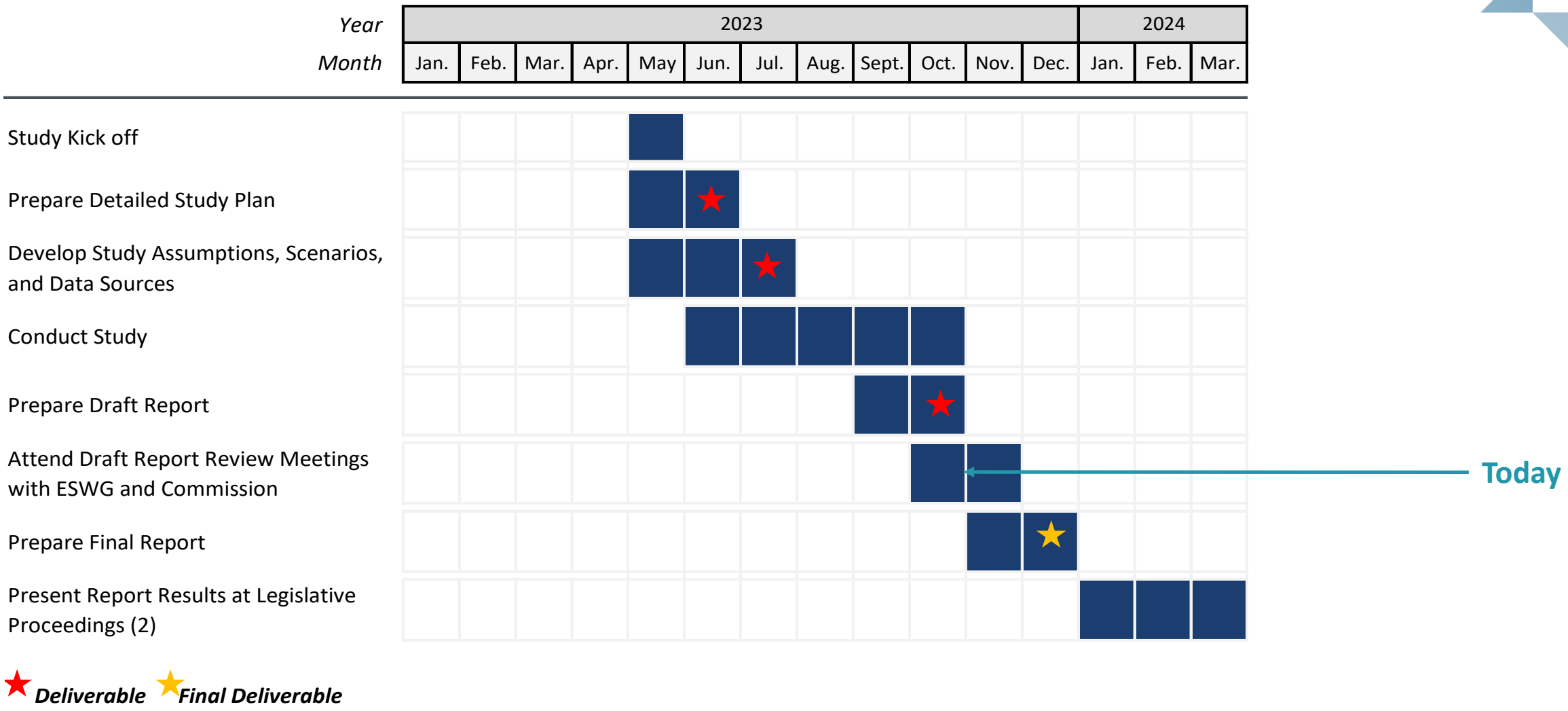
Since the last ESWG meeting in October, where we presented results, we implemented a few changes based on stakeholder feedback:

- Refined load flexibility assumptions in the High EE and Load Flex Case based on stakeholder feedback:
  - Removed modeling of Vehicle-to-Grid programs
  - Refined smart thermostat cooling impacts based on utility existing programs and EmPOWER filings
  - Updated maximum Time-of-Use (TOU) participation rate to 15% (previously was 20%)
- Updated Pepco temperature dataset, which mainly impacts Pepco S.2B peak load results. No other BAU EE and Load Flex Case results changed since the October ESWG meeting.
- Refined the language in the scenario matrix to make scenario definitions clearer
- Compared this study's scenario growth rates to historical utility peak growth

The overall impact of all the changes was a small increase of the High EE and Load Flex Case growth rates. For example, S.3B Maryland level growth rate changed from 1.17% in the October presentation to 1.24%. More detailed results are in subsequent slides.

We have also compiled the Draft Report Appendix, which is the other PowerPoint file sent to the ESWG.

Study Timeline and Milestones



2 - Recap of Scenarios

Purpose of the Electrification Study

Senate Bill 528 ("SB528" or "The Climate Solutions Now Act of 2022" or CSNA) requires Maryland to reduce GHG emissions by 60% from 2006 levels by 2031 and achieve net-zero GHG emissions by 2045.

SB528 directed the PSC to conduct this study "*assessing the capacity of each company's gas and electric distribution systems to successfully serve customers under a managed transition to a highly electrified building sector.*"

In addition, SB528 set the following requirements for this study:

- *use a projection of average growth in system peak demand between 2021 and 2031 to assess the overall impact on each gas and electric distribution system*
- *compare future electric distribution system peak and energy demand load growth to historic rates*
- *consider the impacts of energy efficiency and conservation and electric load flexibility*
- *consider the capacity of the existing distribution systems and projected electric distribution system improvements and expansions to serve existing electric loads and projected electric load growth*
- *assess the effects of shifts in seasonal system gas and electric loads"*

Our scenario design is focused on meeting the requirements for this study as stated in the CSNA

2022 Regular Session - Senate Bill 528 Enrolled (maryland.gov)

Scenario Matrix

	Decarbonization Policy Goals not Pursued		Pursuit of Policy Goals through Hybrid Solutions		Pursuit of Policy Goals through Zero Direct Emissions Solutions	
	S.0	**S.1**	**S.2A**	**S.2B**	**S.3A**	**S.3B**
	Reference	Low Electrification	Mid Electrification	High Electrification with Fuel Backup	High Electrification with Best-in-Class Technologies	High Electrification with Legacy Technologies
Description	"Reference" for load impacts of other scenarios. Defined as the state of the world as implied by each utility's load forecast.	Limited incremental electrification. Assumes policy goals are not met.	Mix of electrification and continued use of fuels.	High electrification with retention of existing fossil fuel equipment for backup.	Fossil fuel equipment is phased out through policy. Customers quickly adopt more advanced, efficient electric technologies.	Fossil fuel equipment is phased out through policy. Customers are slower to adopt more advanced, efficient electric technologies.
Buildings	**Fuel mix held flat** from 2022.	**Limited incremental electrification** (majority of existing gas and fossil customers do not adopt heat pumps by 2045).	**Fossil fuel equipment sales continue beyond 2030;** some customers switch to 100% heat HP.	By 2030, all new equipment sales are HPs. **Almost all existing fossil fueled customers retain their equipment as backup.**	By 2030, all new equipment sales are HPs[1]. **Most HPs are highly efficient ccASHPs.**	By 2030, all new equipment sales are HPs[1]. **Most HPs are less efficient ASHP+resistance backup.**
DERs	Distributed Energy Resources (DER) growth in line with RPS mandate.					
Transportation	Based on EIA projections.	3-year delay relative to ACC II and ACT.	Achievement of Advanced Clean Cars II (ACC II) and Advanced Clean Trucks (ACT) regulations.			
Energy Efficiency and Load Flexibility	For each scenario, we run two Energy Efficiency (EE) and Load Flexibility cases: **1) Business as Usual Case (i.e., existing programs only)** **2) High Case (i.e., new programs and growth of existing programs)**					

1 With some exceptions for the hardest-to-electrify cases (we assume at least 5% of sales will be exempt from the policy and remain as fossil fuel equipment sales)
ccASHP = cold climate air-source heat pump, ASHP = air-source heat pump, HP = heat pump

3 – Overview of Updated Results

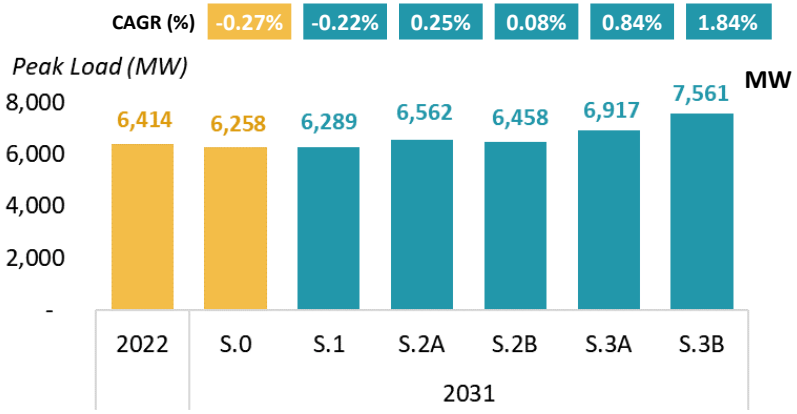
S.0 – Reference
S.1 – Low electrification
S.2A – Mid electrification
S.2B – High electrification w/ fossil backup
S.3A – High electrification w/ best-in-class tech
S.3B – High electrification w/ legacy tech

Summary of Updated BAU Results

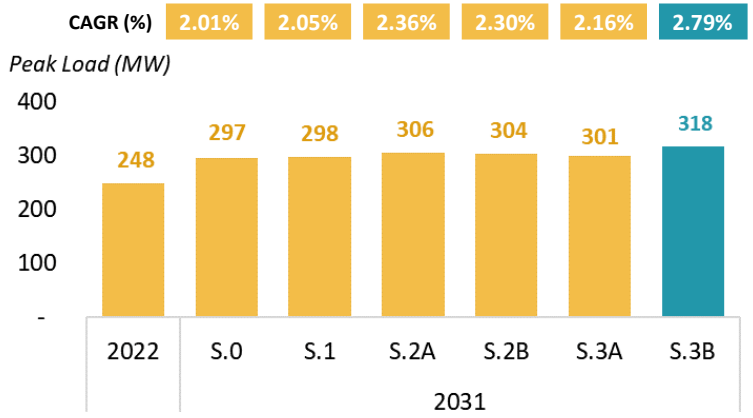
2022-2031 Peak Load Growth by Scenario

*Utilities that are currently **summer peaking** become **winter peaking** in some scenarios, with **BAU EE and load flexibility***

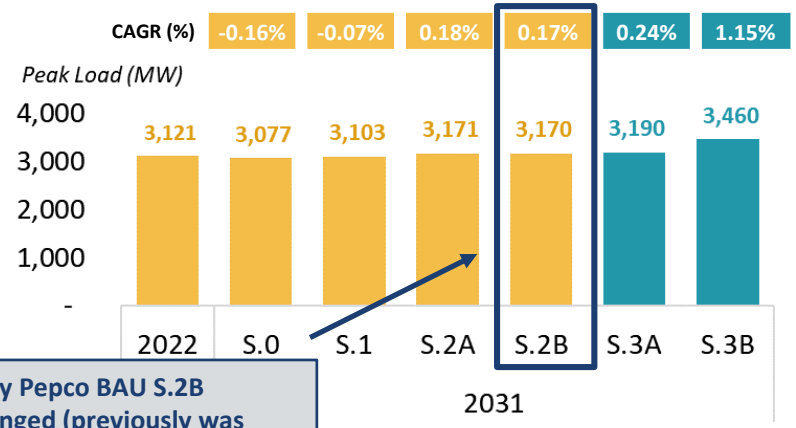
BGE



Choptank

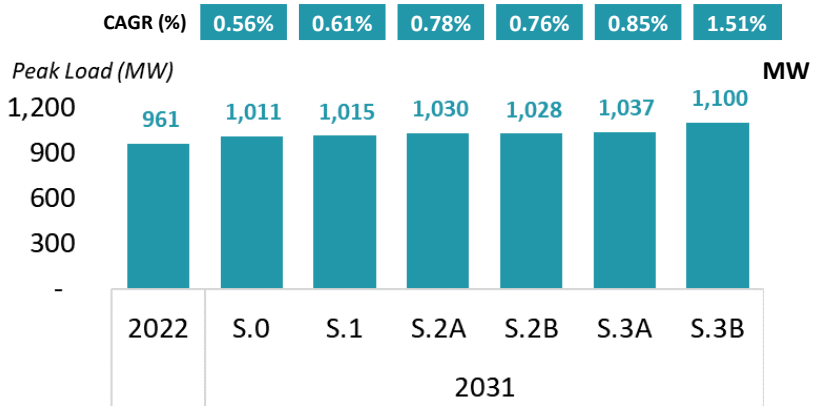


Pepco

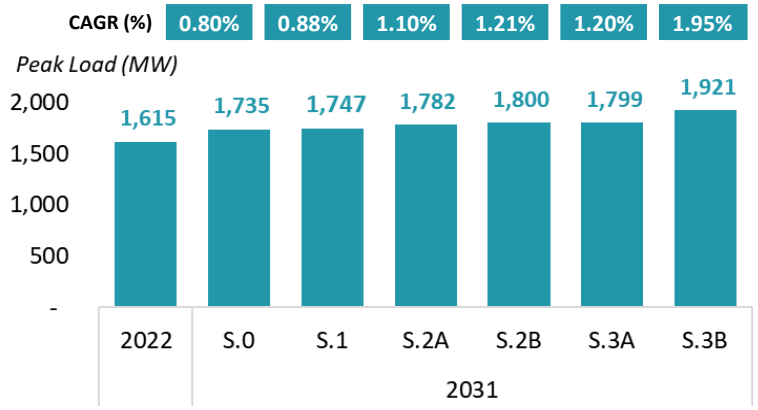


Only Pepco BAU S.2B changed (previously was 3,198 MW with 0.27% CAGR)

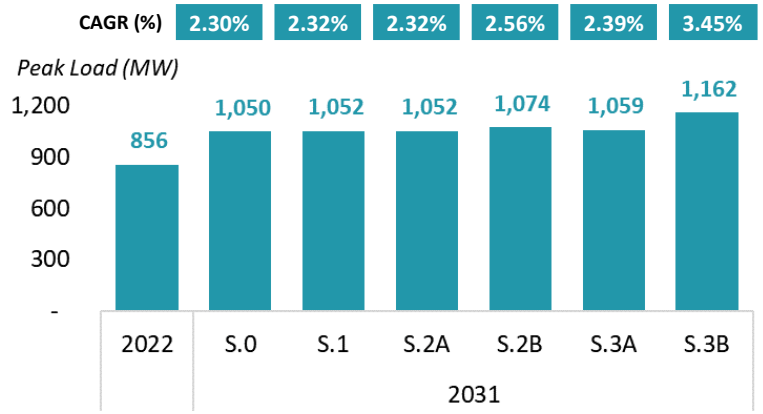
DPL



Potomac Edison



SMECO



Notes: Y-axis scales differ across charts. 2022 peak load is sourced from 2022 Ten Year Plan or utilities directly.

Load Flexibility Participation Assumptions

High case participation ramps up from current levels (low for most utility programs) to end state participation by 2031, following S-curve adoption

Program	Description	BAU Existing Participation	High 2031 Participation	
Residential				
Time-of-use (TOU)	Time varying pricing signals, consistent with proposed utility rates	0%	15%	**Previously: 20%**
Peak time rebate (PTR)	Residential customers reduce load during called event hours	BGE, Pepco, DPL: 90% (assume limited use of the program and that impacts are not reflected in utility forecasts) SMECO, Choptank, Potomac Edison: 0%	90%	
Smart thermostat	Customers reduce cooling or heating load by adjusting thermostats during utility called events (<20/yr)	Summer: BGE (28%, 342,000 customers); Pepco (38%, 206,012 customers); DPL (20%, 33,844 customers); SMECO, Choptank, Potomac Edison (0%) Winter: 0% for all utilities	Summer (~+25%pt from existing): BGE (55%); Pepco (65%); DPL (45%); SMECO, Choptank, Potomac Edison (25%) Winter: 25% for all utilities	**Refined BAU based on PHI data, no impact**
Smart water heating	Customers shift heat water during off peak hours on a frequent (daily) basis	0%	30%	
Commercial				
Smart thermostat	Small commercial customers reduce cooling or heating load by adjusting thermostats during utility called events (<20/yr)	0% (Note, PHI utilities have commercial smart thermostat programs but participation impact is small)	25% (Assume PHI utilities can only achieve up to 25%, including existing participation)	
Automated demand response (DR) – HVAC	Automated control of customer heating and cooling demand. Only applicable to large (Covered) customers	0%	10%	
Interruptible tariff	Large customers (Covered) reduce load during called events. Events are infrequent (<10/yr)	0%	15%	
Additional Programs				
Managed electric vehicle charging	Customers are incentivized to charge in off peak hours and shift EV load out of daily peak periods	0%	30% (all vehicle classes)	**No longer model V2G**
Behind-the-meter battery storage	Utilities can call on batteries to charge and discharge during event hours (70 events/yr). Assume only a portion of BTM storage capacity from the PPRP study enrolls in utility programs	0%	30% of BTM storage capacity	

Load Flexibility Program Impact Assumptions

Program impacts are modeled on a per-participant basis. See following slides for assumption justifications

Program	% of Load Shifted	# of Hrs Shifted from	# of Hrs Shifted to
Residential			
Time-of-use (TOU)	10% (summer); 5% (winter)	5 (summer); 3 (winter)	7 (summer); 8 (winter)
Peak time rebate (PTR)	5%	3	5
Smart thermostat	60% (cooling); 20% (heat pump space heating); 40% (electric resistance space heating)	3	6
Smart water heating	Modeled by shifting water heating load out of system peak windows. Maximum impact is 50% of hourly water heating load shifted out of peak hours	8	16
Commercial			
Smart thermostat	20% (cooling); 5% (heat pump space heating); 10% (electric resistance space heating)	3	6
Automated demand response (DR) – HVAC	60% (cooling); 15% (heat pump space heating); 30% (electric resistance space heating)	3	6
Interruptible tariff	20%	3	0
Additional Programs			
Managed electric vehicle charging	Modeled by shifting charging load out of system peak windows. Maximum impact is 50% of hourly vehicle charging load (on average, across all vehicles) shifted out of peak hours	6	18
Behind-the-meter battery storage	Impacts modeled at aggregate level. Maximum per customer impact is per customer battery storage capacity	4	7

Previously: 80%

Notes: '% of Load Shifted' refers to the percent of applicable end use load that is curtailed during each load flexibility event.

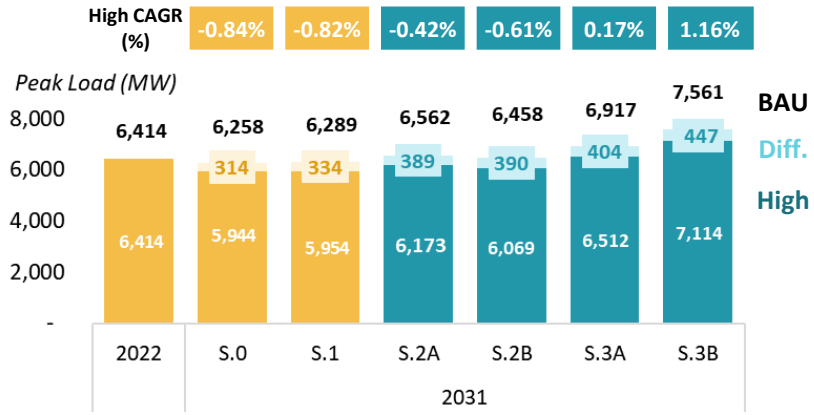
S.0 – Reference
S.1 – Low electrification
S.2A – Mid electrification
S.2B – High electrification w/ fossil backup
S.3A – High electrification w/ best-in-class tech
S.3B – High electrification w/ legacy tech

Summary of Updated High EE/Load Flex Results (all changed)

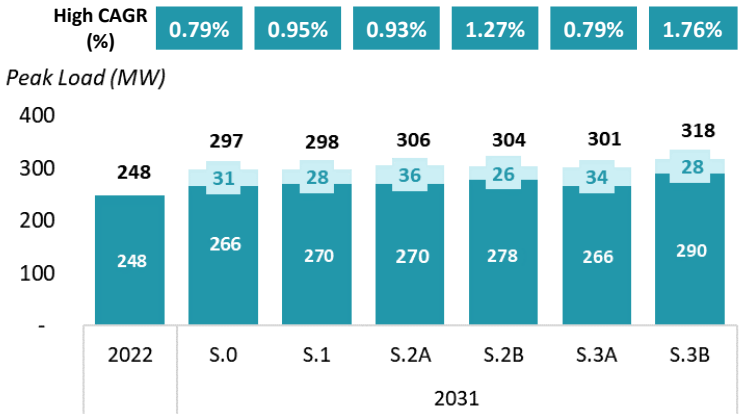
2022-2031 Peak Load Growth by Scenario

*Utilities see less **summer** and **winter** peak load growth with **High EE and load flexibility** than in the BAU cases*

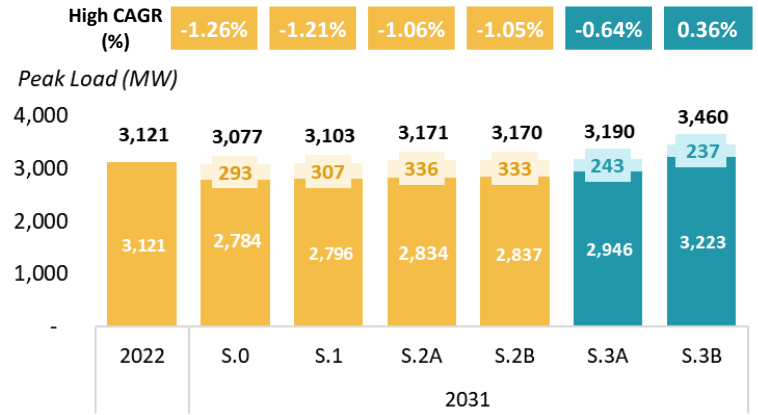
BGE



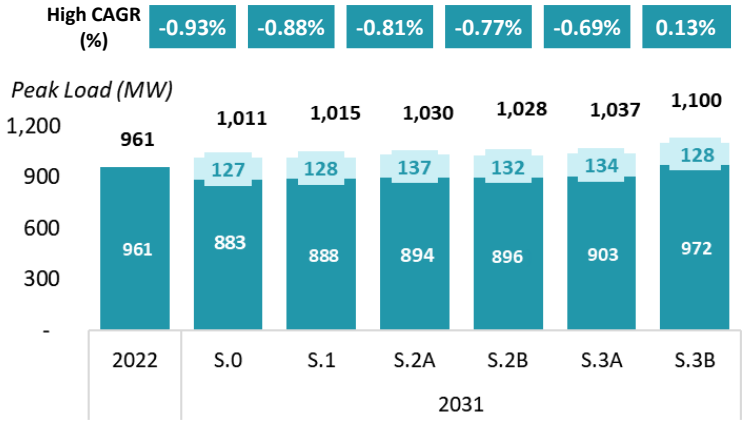
Choptank



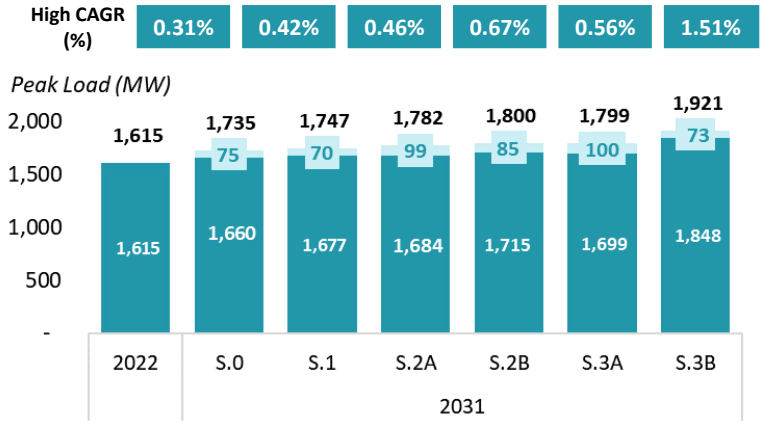
Pepco



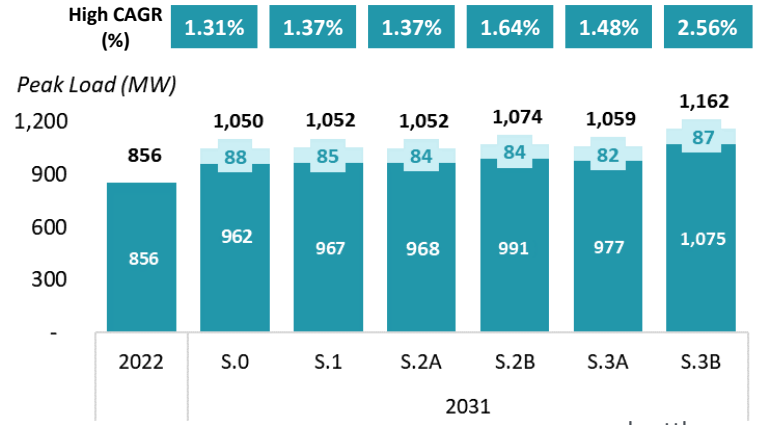
DPL



Potomac Edison



SMECO



Notes: Y-axis scales differ across charts. 2022 peak load is sourced from 2022 Ten Year Plan or utilities directly. Light bars (Diff.) represent difference between BAU peak load and High case peak.

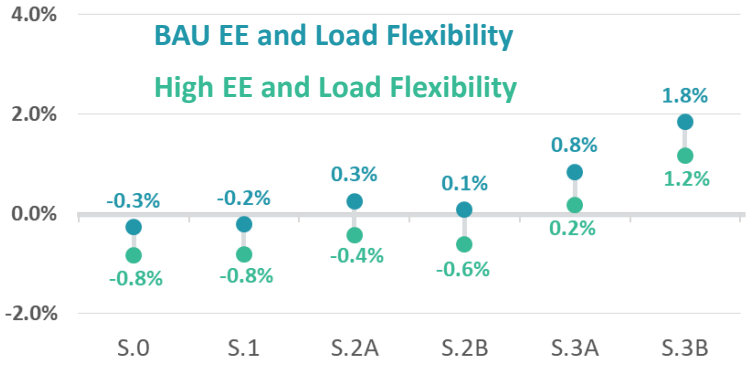
S.0 – Reference
S.1 – Low electrification
S.2A – Mid electrification
S.2B – High electrification w/ fossil backup
S.3A – High electrification w/ best-in-class tech
S.3B – High electrification w/ legacy tech

Updated Load Growth Results – BAU vs. High EE and LF Case

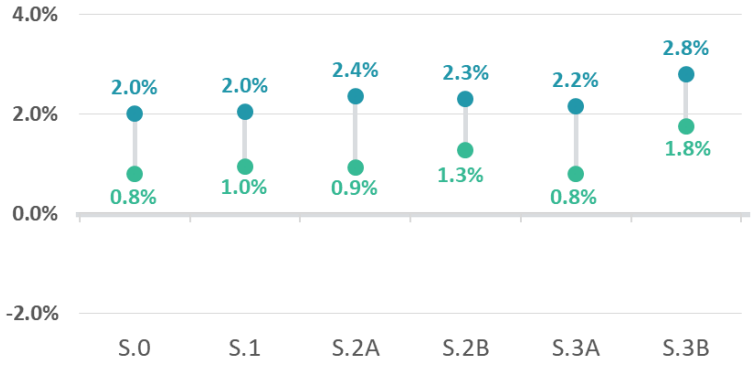
2022-2031 Compound Annual Peak Load Growth Rate (CAGR) by Scenario and Utility

*With **BAU** and **High** Energy Efficiency and Load Flexibility; Update has Higher High Load Growth*

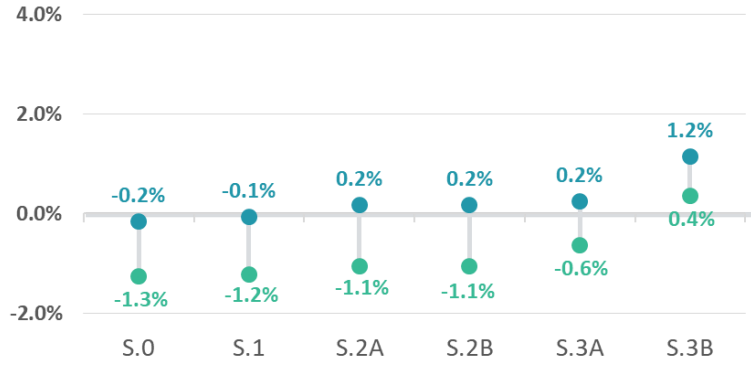
BGE



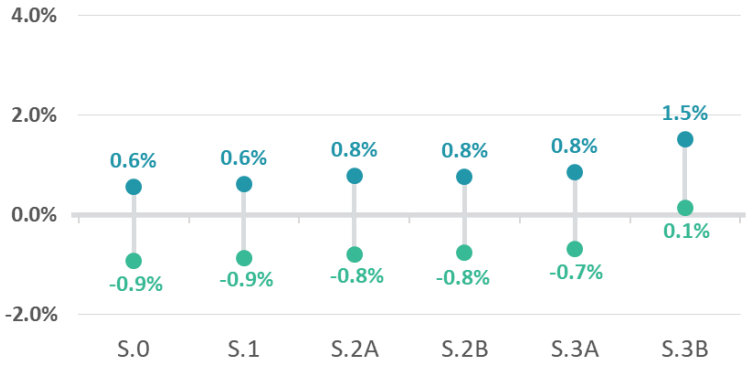
Choptank



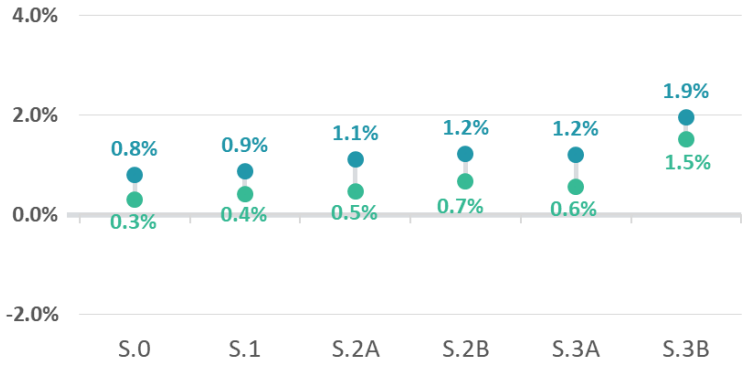
Pepco



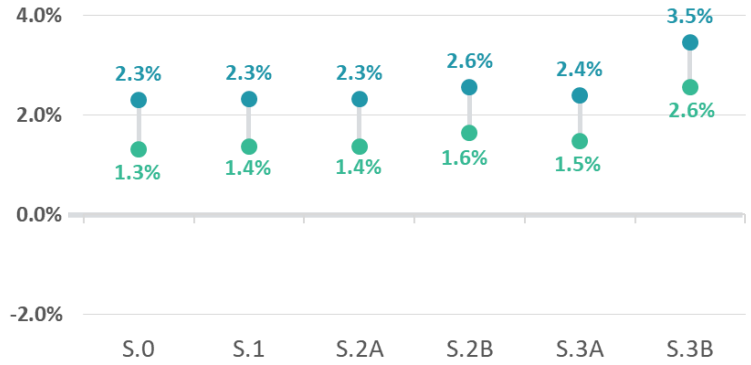
DPL



Potomac Edison



SMECO



4 – Conclusion and Next Steps

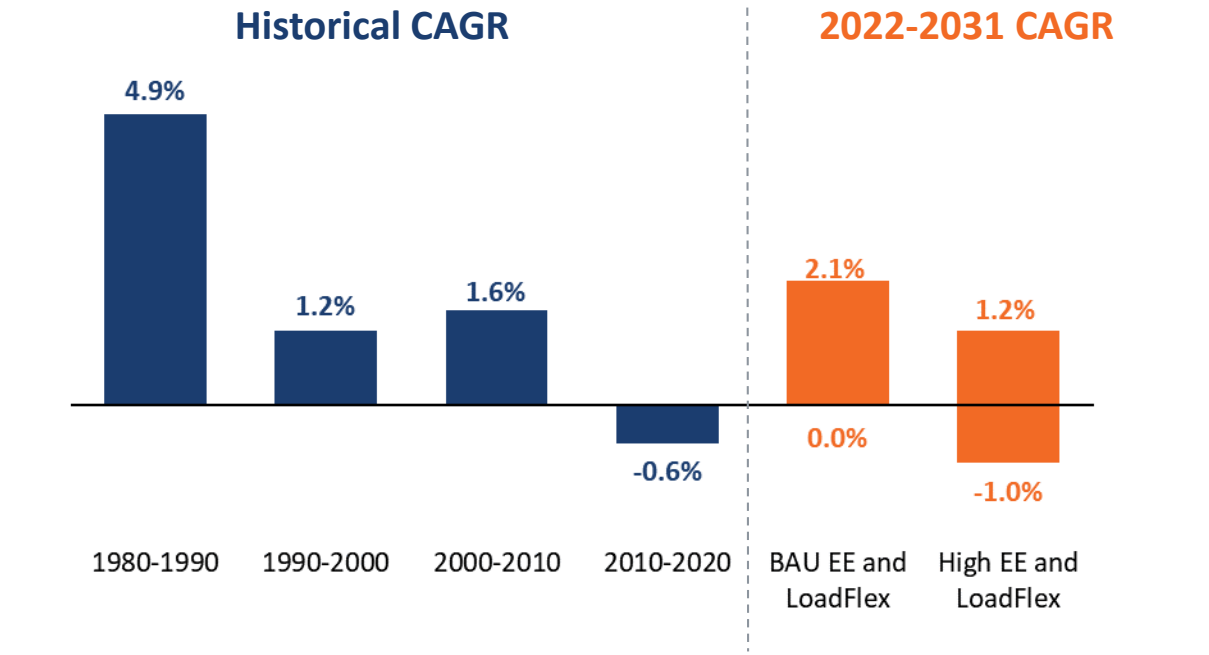
S.0 – Reference
S.1 – Low electrification
S.2A – Mid electrification
S.2B – High electrification w/ fossil backup
S.3A – High electrification w/ best-in-class tech
S.3B – High electrification w/ legacy tech

Maryland-Wide Historical Peak Growth Rates

Results show that peak load growth through 2031 with high electrification of the building sector will be comparable to or less than the Maryland system has seen over the past 40 years.

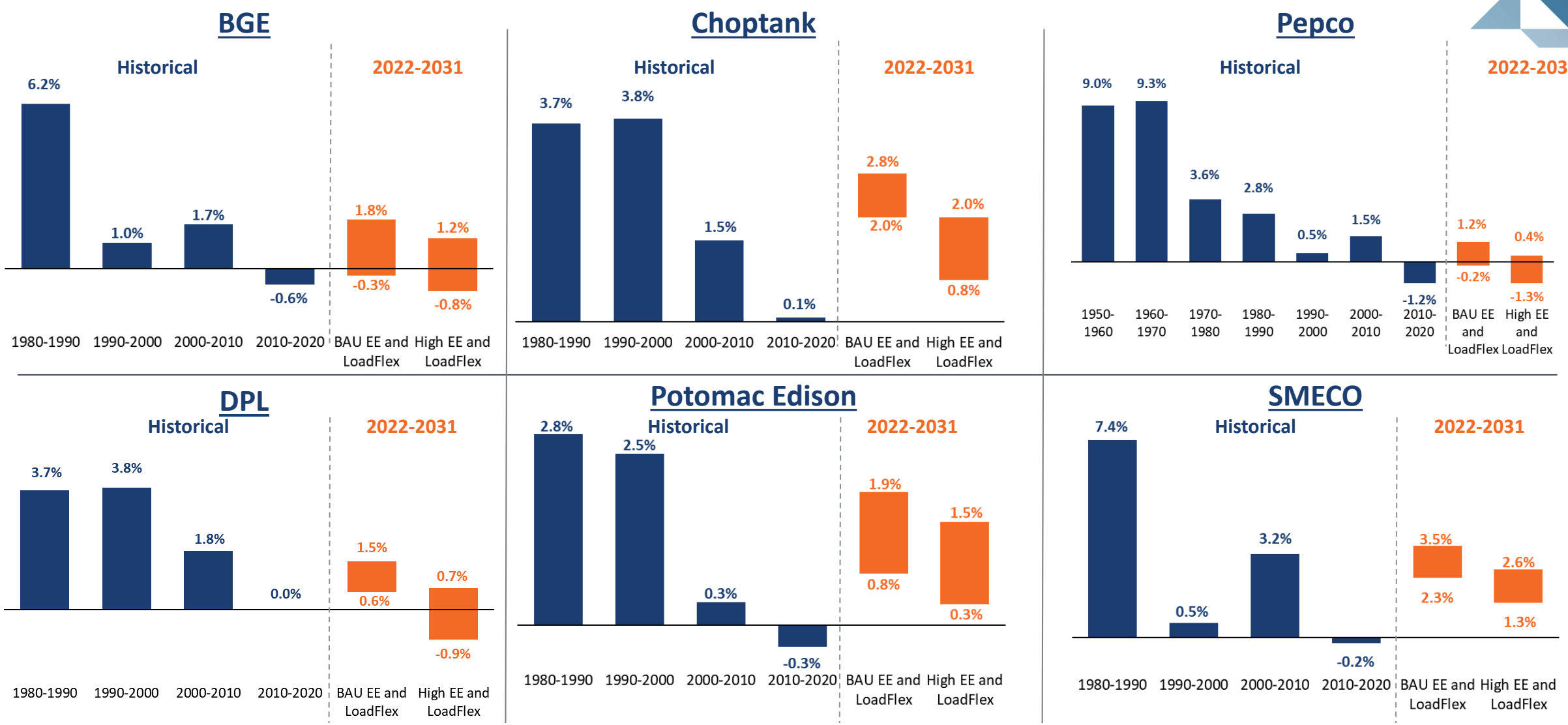
- Historically, there was significant load growth in the 1980s of 4.9% per year and more moderate growth of 1.2-1.5% from 1990-2010. Load declined between 2010-2020.
- High Electrification with Legacy Tech (S.3B) with BAU EE and Load Flex would have the highest growth rate of 2.1% per year
  - High EE and Load Flex would reduce this to 1.2% per year
- High Electrification with Best-in-Class tech (S.3A) with BAU EE and Load Flex would have a growth rate of 1.1% per year
  - High EE and Load Flex would reduce this to 0.3% per year
- The lower ends of the ranges are the Reference, Low Electrification, and Mid Electrification Scenarios, which do not include a highly electrified building sector

Maryland Historical and Forecasted Growth Rates



Notes: Historical load growth calculated based on load weighted average for Maryland utility historical peak load. Historical peak load provided by utilities where applicable, otherwise CAGRs from respective PJM LDA historical peaks. Only accounts for in-scope Maryland utilities. Forecasted load growth rates show range of CAGRs for all scenarios modeled.

Historical Growth Rates by Utility



Notes: Vertical axis scale differs across charts. Historical peak load provided by utilities where applicable. Otherwise, CAGRs sourced from respective PJM LDAs. Forecasted load growth rates show range of CAGRs for all scenarios.

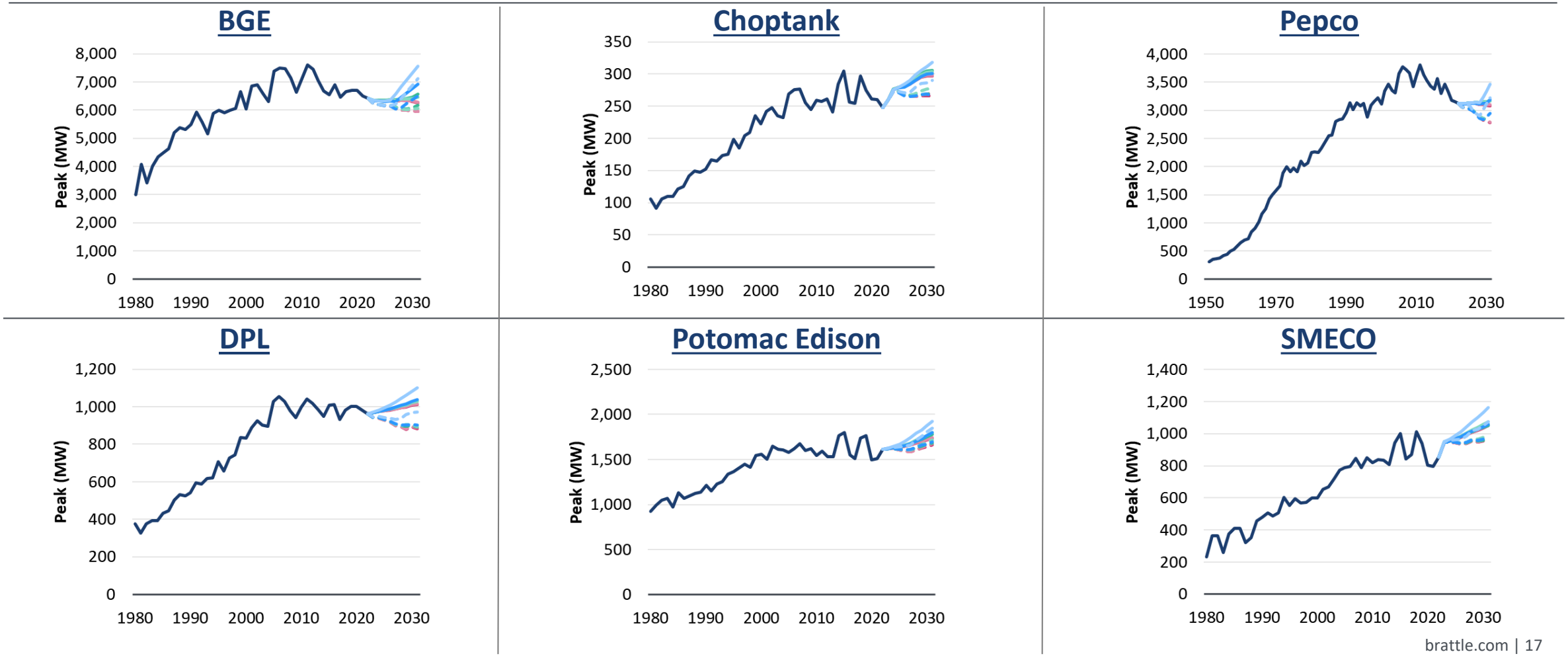
S.0 – Reference
S.1 – Low electrification
S.2A – Mid electrification
S.2B – High electrification w/ fossil backup
S.3A – High electrification w/ best-in-class tech
S.3B – High electrification w/ legacy tech

Solid = BAU
Dashed = High EE

Historical Growth by Utility

Historical and Projected Peak Loads by Utility

Historical loads are from utility data and/or from PJM load growth data for the utility's load zone



Sources for historical load: 1) BGE: PJM load zone data 2) Choptank: Utility data 2010-2022, PJM growth rate for load zone 1980-2010 3) Pepco: Utility growth rate data 1950 – 2022 4) DPL: Utility growth rate data 1999-2022, PJM growth rate for load zone 1980-1999 5) Potomac Edison: Utility data 2009-2022, PJM growth rate for load zone 1980-2009 6) SMECO: Utility data 1993-2022, PJM growth rate for load zone 1980-1993.

S.0 – Reference
S.1 – Low electrification
S.2A – Mid electrification
S.2B – High electrification w/ fossil backup
S.3A – High electrification w/ best-in-class tech
S.3B – High electrification w/ legacy tech

Recap of Results for Maryland System

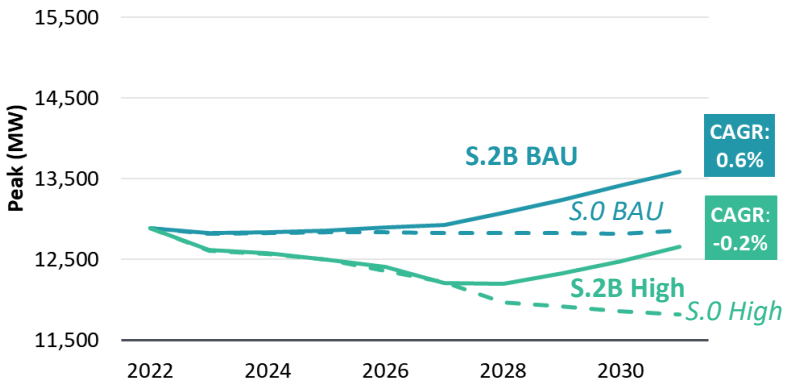
Results show that in the High Electrification Scenarios, the aggregate Maryland system would see 0.6%-2.1% annual growth with BAU EE and DR.

- The Maryland system, which is currently summer peaking, would switch to winter peaking around 2026-2027
- BGE and Pepco, the largest utilities, see limited load growth because they have significant headroom between the winter and summer peaks and because they forecast limited growth from non-electrification drivers like economic growth
- Pursuing policies to incentivize efficient electrification over legacy technologies (S.3A vs. S.3B) could result in significant mitigation of load growth
- A hybrid approach with fossil backup would also result in electric load mitigation, but would require continued direct emissions from buildings
- Additional energy efficiency and load flexibility could result in significant further mitigation of load growth in every scenario

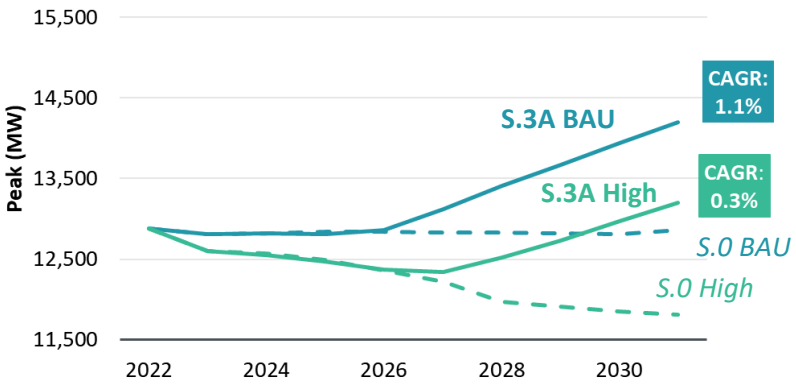
Maryland[1] System Peak Load

*With **BAU** and **High** Energy Efficiency and Load Flexibility*

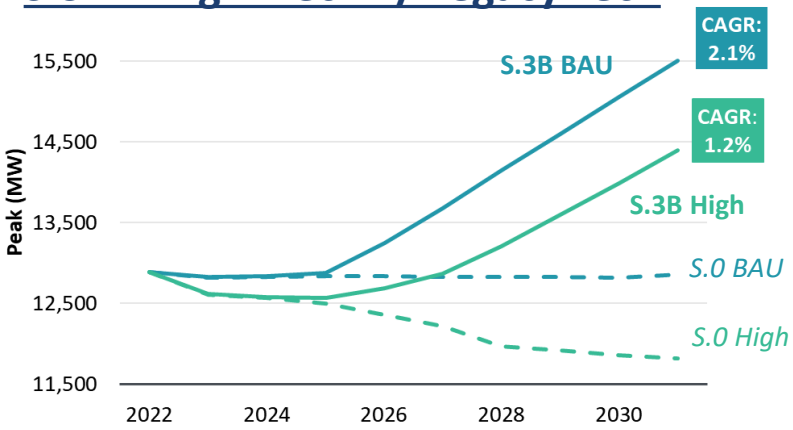
S.2B – Hybrid with Fuel Backup



S.3A – High Elec. w/ Best-in-Class Tech



S.3B – High Elec. w/ Legacy Tech



1 Does not include out-of-scope utilities

Next Steps

Over the next two weeks, while stakeholders review the draft appendix, we plan to:

- Draft the study executive summary report
- Refine the appendix and data results based on any stakeholder feedback – please submit any feedback by the end of the week (11/17)