BEFORE THE
MARYLAND PUBLIC SERVICE COMMISSION

IN THE MATTER OF THE APPLICATION OF BALTIMORE GAS AND ELECTRIC COMPANY FOR AN ELECTRIC AND GAS MULTI-YEAR PLAN	* * *	CASE NO. 9692

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PUBLIC DIRECT TESTIMONY

OF

Kenji Takahashi

ON BEHALF OF THE OFFICE OF PEOPLE'S COUNSEL

June 20, 2023

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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 Appendix A.

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 resources 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 has been technological, resource, economic, and policy assessments of building decarbonization and its impact on gas system planning. I have assessed the potential for building decarbonization in several states including Massachusetts, Rhode Island, Vermont, New York,

Maryland, Oregon, and California, as well as in several U.S. regions, including the northeast and the southwest. For example, I led a Synapse team to analyze net zero emissions scenarios for the building sector for Oregon. This project estimated the potential impacts on electric system investments due to electrification, as well as energy bill impacts for residential customers. In 2022, I 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. Finally, 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 the relationship between building electrification and the operations of natural gas companies?

A. In 2017, 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, and I testified before the Massachusetts Department of Public Utilities on the matter. More recently, I examined the gas energy efficiency program proposal by New Mexico Gas on behalf of New Mexico's Office of the Attorney General and recommended the discontinuation of rebates for gas equipment efficiency measures and the implementation of building electrification programs.

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

A. Yes. 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.

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 Baltimore Gas and Electric Company's ("BGE" or the "Company") building electrification and non-road electrification programs presented by Witness Mark D. Case on behalf of the Company. BGE describes these two programs, along with an electrification workforce development proposal, as its customer electrification plan.

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

A. The sources for my testimony are BGE's Application, in particular filings by Witness Case, and responses to discovery requests, public documents, and my personal knowledge and experience.

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.

II. SUMMARY AND RECOMMENDATIONS

Q. Please summarize your primary conclusions concerning BGE's proposed building and non-road electrification programs.

A. My primary conclusions are as follows:

- BGE's electrification program proposal raises various policy and program implementation questions, and any decision by the Commission to approve or modify the proposal would have to address those questions. However, the current Multi-Year Plan ("MYP") base rate case process is not designed for and cannot accommodate adequate discussion and informed resolution of such policy and program questions.

- BGE's electrification program proposal is untimely and premature because the Maryland Building Codes Administration, Maryland Department of Environment ("MDE"), and the Commission, through the EmPOWER Maryland program, are currently investigating and addressing various policy and program questions concerning the promotion of electrification in the building and other sectors.

- BGE's proposal to require program participants to retain their gas furnace as a backup heating system when installing air-source heat pumps (ASHP) (a) is contrary to the state's overarching policy direction as established through the *Climate Solutions Now Act of 2022* ("CSNA") and the major findings in a 2021 report by the Maryland Commission on Climate Change ("MCCC"), (b) ignores the current state and continuing advancement of cold climate heat pump technology, and (c) is not supported or justified by reliable, rigorous studies.

- A study conducted by Energy and Environmental Economics, Inc., or E3 ("E3 study") which BGE commissioned and references to support its electrification program proposal, does not justify BGE's proposal to require the retention of existing heating systems as backup for ASHPs. The E3 study's Limited Gas scenario assumes more extensive building electrification than the other scenarios but is overly biased toward maintaining the existing gas systems in that it assumes no or very little amounts of gas system retirements through 2045. The E3 study also assumes overly high costs for the electric transmission and distribution system and ASHPs. Correcting these errors would likely make the Limited Gas scenario a lower-cost scenario than the other scenarios and would undercut the E3 study's

support for BGE's proposal to require the retention of existing heating systems as backup for ASHPs.

- Another study commissioned by BGE and used to support its electrification proposal, an analysis by 1898 & Co. of potential electrification impacts on the electric system, does not support the conclusions that Witness Case draws from it. The analysis contains multiple errors, and a corrected analysis would not show that peak load would "more than triple," and, accordingly, would indicate substantially less need for new electric infrastructure and infrastructure investment.

- Program designs, incentives, and budgets for some of the proposed electrification programs would need to be modified, if the Commission should approve the electrification program. In particular:

    - Per-customer incentive amounts BGE assumed for ASHPs, geothermal heat pumps (GSHP), heat pump water heaters (HPWH), and electrification make-ready measures (e.g., electrical panel upgrades) are too high because they do not take into account available federal tax credits.

- BGE developed per-customer incentive estimates based on cost estimates BGE obtained from California and New York, and from feedback from trade allies in the Baltimore area. However, BGE does not have any Maryland-specific heat pump costs, let alone Baltimore-specific heat pump costs, and as a result it is possible that BGE has overestimated the total cost of ASHPs. If it has, per-customer incentive for ASHPs could be reduced further.

- The proposed program budget for program administration is too high.

- BGE's downstream incentive approach for its building electrification program proposal is inconsistent with EmPOWER's new approach to use midstream incentives for HVAC and HPWH, and also with ongoing efforts to streamline EmPOWER's HVAC and HPWH offerings.

- BGE has not provided sufficient evidence to support and justify its proposed non-road electrification programs.

Q. Please summarize your recommendations.

A. My recommendations on BGE's proposed building and non-road electrification programs include the following:

- The Commission should reject BGE's proposed electrification programs. If BGE then wishes to pursue its electrification programs, the Commission should direct BGE to propose its building and non-road electrification programs within the EmPOWER program.

- The Commission should investigate key policy and program implementation issues concerning electrification in the EmPOWER docket or another policy docket. Among other things, the Commission should investigate program designs, the role of the utilities and other entities, performance incentives, cost-effectiveness analysis framework, goal setting, cost recovery, customer equity and bill impacts, federal incentives, and gas planning.

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

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

- Remove the requirement to retain gas backup in the Company's building electrification programs;

- Increase the number of participants for residential ASHP, GSHP, HPWH, and make-ready investments (e.g., panel upgrades) using the

additional funding that would be freed up by reducing measure incentive levels;

- Conduct a state-specific survey on the costs of building electrification measures—either individually or jointly with other utilities—in order to set appropriate amounts for electrification incentives;
- Offer electrification incentives through a midstream incentive approach instead of a conventional downstream incentive approach;
- Remove the non-road electrification program proposal entirely (approximately $6.6 million); and
- Conduct a market characterization study on commercial and industrial (C&I) non-road measures.

Further, I recommend that the Commission establish guidance on incentive-setting for electrification measures and require BGE to use the guidance to set incentives and develop the total budget for customer incentives. Ideally, such guidance should be developed through a stakeholder process, but I offer the following minimum recommendations: for low-income and moderate-income customers, the total customer incentives that comprise federal rebates, federal tax credits, and utility incentives should not exceed 100 percent of the total installed costs of measures. For the rest of the

customers, the total incentives should not exceed 100 percent of the total incremental costs of electrification measures (e.g., the cost difference between an electric heat pump and a gas furnace).

III. OVERVIEW OF BGE'S CUSTOMER ELECTRIFICATION PROGRAMS

Q. Please summarize BGE's proposed customer-side electrification programs.

A. BGE proposes and seeks cost recovery for three new customer-side beneficial electrification programs: a building electrification program ("BE program"), a C&I non-road electrification program ("Non-Road program"), and a workforce development program.[1] BGE estimates the total required funding for these three programs over the current MYP to be $271,517,443.[2] The annual budgets for each program are summarized in Table 1 below. The BE program is the largest component of the programs, with a combined three-year cycle budget of $261,803,512. For context, BGE's EmPOWER Energy Efficiency and Conservation program budget was $120 million in 2022.[3] BGE proposes to defer these expenditures to a regulatory asset to be recovered in base rates over a 12.5-year amortization period.[4]

[1] Direct Testimony of Mark Case at 51.
[2] Company Exhibit MDC-5 11-12 and 20.
[3] BGE Annual EmPOWER MD Report YTD Q4 2022 https://synapseenergyeconomics.box.com/s/012n4j04filccmw4ebh2sci7p8ru71mg.
[4] Direct Testimony of Mark Case at 63.

Table 1: Summary of BGE Proposed Customer Electrification Program Budgets, Excluding Amortization Costs

Total Program Costs	2024	2025	2026	Cycle Total
BE Program: Residential Segment	$26,621,343	$83,786,084	$140,952,865	$251,360,293
BE Program: Commercial Segment	$1,839,299	$3,378,339	$5,225,582	$10,443,219
Non-Road Program	$1,740,006	$2,242,769	$2,637,147	$6,619,921
Workforce Development Program	$1,250,000	$922,500	$922,500	$3,095,000
Total All Programs	$31,450,648	$90,329,692	$149,738,094	$271,518,433

Source: Exhibit MDC-5.

For the proposed BE program, BGE plans to provide a variety of cash and non-cash incentives for both commercial and residential customers. The BE program has three areas:

- **Residential Space Heating and Water Heating**, which includes significant rebates for ASHPs, GSHPs, and HPWHs.
- **Residential Products,** which includes rebates for replacing existing fossil fuel equipment with electric appliances, including cooktops and clothes dryers.[5]
- **Commercial Buildings,** which includes electrification incentives for rooftop ASHP, commercial HPWH, and commercial cooking equipment.[6]

[5] Case Direct Testimony at 53.
[6] Id. at 54.

The BE Program includes fuel-switching rebates ranging from $500 to $7,500 for residential measures and $1,500 to $25,000 for commercial measures.[7] BGE proposes to include a requirement that customers with gas furnaces retain them as a backup heating system in order to be eligible for BGE's heat pump rebates. BGE claims requiring gas furnace backup systems "will prevent higher winter electric peak events than all electric ASHP systems."[8]

For the Non-Road program, BGE plans to provide financial incentives for various electrification measures, targeting several C&I market segments. These include construction equipment, airport group support equipment, port and intermodal equipment, forklifts, and industrial process equipment. The proposed equipment incentives range from as low as $100 per product for golf carts to $80,000 per product for pressing, cutting, and folding machinery.

IV. STUDIES THAT BGE COMMISSIONED TO SUPPORT ITS ELECTRIFICATION PROGRAMS

Q. What studies did BGE commission to support its electrification programs?

A. BGE commissioned two studies that it relies on to support its electrification program proposal: one study by Energy and Environmental Economics

[7] Id. at 52.
[8] Id. at 53.

("E3") and another study by 1898 & Company, a division of Burns & McDonnell Engineering Company, Inc.

Q. Please summarize the study conducted by E3.

A. BGE engaged E3 to analyze decarbonization pathways to achieve Maryland's greenhouse gas ("GHG") emissions reduction targets and identify potential implications for BGE's customers and service territory ("E3 Pathways Study"). The E3 Pathways Study evaluated three potential pathways to achieving the state's decarbonization goals: a "Limited Gas" scenario and two "Integrated Energy System" ("IES") scenarios. (BGE calls one IES scenario a "Hybrid" scenario, the other a "Diverse" scenario). The Limited Gas scenario includes high electrification and a shift away from natural gas used in buildings, while the IES scenarios rely on a combination of electric and gas infrastructure to meet energy demand. The Hybrid scenario includes a significant role for alternative fuels and gas-electric hybrid heating, where 28 percent of homes retain gas heating systems as backup to electric heat pumps.[9] The Diverse scenario includes lower-level electrification as well as gas-powered heat pumps, networked geothermal systems, and a role for alternative fuels. All scenarios include "at least a 60

[9] 2022 E3 Pathways Study at 17, 21.

percent reduction in annual natural gas throughput on BGE's system" by 2045.[10]

The E3 Pathways Study concluded that the two IES scenarios (Hybrid and Diverse) would "achieve Maryland's goals at a significantly lower cost and with less risk for customers and the State's economy" than the Limited Gas scenario by leveraging both existing electric infrastructure and existing natural gas infrastructure.[11]

Q. Please summarize the 1898 & Co study.

A. On page 47 of his direct testimony, BGE Witness Case states that "[p]reliminary analysis conducted in parallel with the E3 work indicates that, under the Limited Gas pathway, demand on the BGE electric system could more than triple with the necessary electrification, requiring significant build out of substations and feeders to provide the required electric grid capacity. This infrastructure would require an enormous financial investment, threatening affordability for customers, and poses an extremely difficult if not impossible siting and permitting challenge in central Maryland's heavily developed regions." As revealed in OPCDR01-01, this "preliminary analysis" that informed BGE's rejection of pathways comparable to the Limited Gas pathway was conducted by 1898 & Co. BGE

[10] Case Direct Testimony at 46.
[11] Id. at 47.

relies upon the 1898 & Co. report to justify its choice to support only hybrid electrification as an approach to decarbonization, rather than full electrification.

V. BGE'S ELECTRIFICATION PROGRAM PROPOSAL DOES NOT BELONG IN THE CURRENT MYP

Q. What is your concern about BGE's proposal to include electrification programs in the MYP?

A. While I agree that building electrification is one of the most important strategies to reduce GHG emissions from buildings in Maryland and recognize that state policies such as the CSNA position electrification as such (see details of the state GHG policies in Section IV of my testimony below), BGE's electrification program proposal should not have been proposed and should not be approved in the MYP for three reasons:

- The electrification programs that BGE proposes are novel and present various policy and program implementation questions, including questions concerning the way existing EmPOWER programs are implemented and evaluated. Base rate cases, including MYP cases, are not an appropriate or adequate setting for the discussion and resolution of such policy questions.

- The state of Maryland, through various administrative agencies including the Commission itself through EmPOWER, is currently

working to address program implementation issues to promote building electrification as a key strategy toward the state's climate mandates under the CSNA. Thus, BGE's proposal is untimely and premature.

- The likely outcome of these initiatives by the state agencies is a decarbonization strategy that, consistent with earlier State efforts, features high levels of electrification and very limited usage of gas. BGE's proposal to condition financial incentives for heat pumps on customers' retention of existing gas back-up heating systems is at odds with this strategy. Thus, I am concerned that it would conflict with the implementation of the CSNA.

A. BGE's electrification programs present various policy and program implementation questions. The MYP is not the place to address such questions.

Q. What policy and program questions need to be addressed as part of designing and implementing electrification programs.

A. There are numerous questions concerning electrification programs that need to be vetted by stakeholders and ultimately decided by the Commission. Such questions include, but are not limited to the following:

- **Program designs**: Should backup heating be required? Should whole-home heat pumps be encouraged?

- **The role of the utilities and other entities:** Is the public utility the appropriate provider of broad-based electrification programs? Or are there more suitable non-utility entities that are implementing or could implement electrification programs?

  Funding sources: Is it appropriate to fund electrification programs through electric utility rates, gas utility rates, or both? If so, at what level of funding?

- **Performance incentives:** Should a utility or a third-party administrator receive performance incentives in connection with electrification programs, and if so, how should performance incentives be estimated?

- **Cost-effectiveness analysis framework:** Should any modifications be made to the Maryland Jurisdiction-Specific Test developed in the Commission's EmPOWER docket before it is applied to electrification programs? Are the current avoided costs of capacity, transmission, and distribution appropriate for electrification? What avoided natural gas infrastructure costs are appropriate? What grid emissions rates need to be used?

- **Goal setting**: To the extent that electrification is pursued in EmPOWER, how should the current electricity and gas savings goals be modified? Should fuel-neutral goals (e.g., energy usage in MMBtu or emissions savings) be established?

- **Cost recovery mechanism**: Should the costs of electrification programs be expensed and recovered from ratepayers on a current basis every year in accordance with the direction the Commission recently established for the recovery of EmPOWER program costs?

- **Customer incentive-setting**: How should a program administrator incorporate federal incentives and develop utility customer incentives for electrification measures?

- **Customer equity and bill impacts**: How would building electrification affect customer energy bills? Would the impact differ by customer class or certain customer segments (e.g., low-income customers, disadvantaged communities)? How can we address and mitigate any potential customer equity issues that could arise from building electrification?

- **Gas planning**: How should a gas utility incorporate the impacts of building electrification in its long-term planning?

These are complex questions that cannot be adequately addressed within a base rate case (whether an MYP or a conventional base rate case) due to such cases' constrained statutory timeframes and the resulting lack of opportunities for Commission hearings, working group meetings, and public comments. They need to be addressed in a policy docket that does afford such opportunities and that is statewide in scope, given the statewide need for electrification. Developing electrification policy on a piecemeal, rate-case-by-rate-case basis would require rushed and underinformed decision-making and could create chaos among consumers, contractors, and the market in general.

Q. Is there any example of a regulatory proceeding that discussed policy issues in Maryland before implementing a novel program?

A. Yes. A case in point is Maryland's statewide EV program.

Q. Please explain how the statewide EV program was established.

A. In September 2016, the Commission initiated a public conference (PC44), to begin a "targeted review to ensure that electric distribution systems in Maryland are customer-centered, affordable, reliable and environmentally sustainable."[12] The Commission held public hearings and received numerous comments from over 46 groups on topics including electric vehicles ("EV"), rate design, energy storage, interconnection rules, among others. Through

[12] Maillog # 199669, Notice of Public Conference, at 1 (Sept. 26, 2016) ("PC44 Initiation Notice")

PC44 the Commission established an EV working group which coordinated between utilities, MDE, the Electric Vehicle Infrastructure Council, and addressed actions including EV tariffs and EV supply equipment investment.[13] In January 2018, after a year of EV working group meetings, the leader of the working group filed a petition for a proceeding to consider the implementation of a coordinated statewide EV portfolio, which included BGE's EV program.[14] In February 2018 Commission filed notice of proceeding (Case No. 9478) and request for comments.[15] Over the course of a year the Commission held multiple hearings and opportunities for stakeholder comments.

Q. How do BGE's electrification proposals in the current MYP differ from the process for establishing EV programs in Maryland?

A. BGE is only requesting cost recovery in the MYP for Phase I of its EV pilot program, not Commission approval, because the program was already approved in Case 9478 as described above. The Commission's approval of BGE's EV pilot program came after extensive investigation and public stakeholder input concerning utility engagement in EV charging and market development. This is because utility-administered EV programs posed novel policy questions that required extensive fact-finding, public input, and

[13] Commission. Notice. PC 44. January 31, 2017. Available at: https://webpsc.psc.state.md.us/DMS/pc/PC44
[14] Maillog #218613, Leader of PC44 Electric Vehicle Work Group, Petition for Implementation of a Statewide Electric Vehicle Portfolio (Jan. 22, 2018).
[15] Maillog #218878.

debate. Utility engagement in electrification efforts poses similar novel policy issues that should be addressed through a comparatively robust public stakeholder process. Thus, it is premature for BGE to propose and implement its electrification programs in the current MYP without proper fact-finding and deliberation.

Q. Are there any examples of a regulatory proceeding in other jurisdictions where stakeholders discussed and addressed policy questions concerning building electrification?

A. Yes. I am aware that Colorado and California both opened regulatory proceedings and stakeholder processes to examine how utilities can support building electrification.

Q. Please provide a brief summary of Colorado's regulatory proceedings.

A. Colorado SB 21-246 requires investor-owned electric utilities to develop and implement beneficial electrification (BE) plans every three years. Furthermore, SB 21-264 requires gas distribution utilities to file clean heat plans (CHPs) that must include plans to meet certain GHG emission reduction targets for 2025 and 2030.[16] The bill recognizes the importance of

[16] SB21-264. (1)(a)(II). Available at: https://leg.colorado.gov/bills/sb21-264; the codified bill is found at: https://casetext.com/statute/colorado-revised-statutes/title-40-utilities/public-utilities/general-and-administrative/article-32-air-quality-improvement-costs/part-1-general-provisions/section-40-32-108-clean-heat-targets-legislative-declaration-definitions-plans-rules-reports.

improving energy efficiency of buildings in the state as well as switching from gas space and water heating to high-efficiency electric heating.

The Public Utilities Commission ("PUC") filed a Notice of Proposed Rulemaking on October 1, 2021 to meet the statutory CHP requirements in SB 21-264.[17] However, the PUC went beyond these requirements by incorporating short-term and long-term gas infrastructure planning issues and demand-side management (DSM) rules in the same proceeding,[18] recognizing that CHPs "will not address all of the issues that the gas utilities and its customers will face through the transitions required to meet Colorado's goals."[19] As part of the rulemaking proceeding, the PUC received over 300 public comment filings from stakeholders, held two rounds of oral public comment hearings spanning seven days total, and convened six community meetings in disadvantaged communities around the state. In addition, the PUC held various workshops on topics and issues that arose during the comment process, including GHG emissions accounting methodologies, disadvantaged community definitions, and line extensions. The PUC issued its final decision in December 2022, adopting many of the recommendations and feedback from stakeholders.[20] The first

[17] Colorado PUC. 2021. *Notice of Proposed Rulemaking*. Proceeding No. 21R-0449G. Available at: https://www.dora.state.co.us/pls/efi/EFI_Search_UI.search.
[18] Some of the gas planning issues were already under review in Proceeding No. 21R-0314G.
[19] Colorado PUC. 2021. p. 27.
[20] Colorado PUC. 2022. *Commission Decision Adopting Rules.* Proceeding No. 21R-0449G.

utility CHP plan will be filed in August 2023, after the utility files its BE and DSM plans.

Q. Please provide a brief summary of California's proceeding.

A. In 2017, Sierra Club, Natural Resources Defense Council (NRDC), and others filed a joint motion to reevaluate the "Three-Prong-Test," a test that had impeded fuel switching for many years.[21] The Three Prong Test required that the fuel substitution measures had to pass cost-effectiveness testing at the measure level from the perspectives of both the implementing utility (excluding benefits of other fuel savings) and the total resource (including other fuel savings). [22] That requirement created a barrier for measures that would replace gas fuel with electric fuel because they are not cost-effective as electric efficiency measures from the electric utility's perspective (because they increase electric consumption).

Interested parties were invited to comment on the design and implementation of the test in June 2018.[23] The main opponent of the update to the Three-Prong Test was Southern California Gas (SoCalGas), the

[21] Borgenson et al. 2017. *Motion of The Natural Resources Defense Council (NRDC), Sierra Club, and The California Energy Efficiency Industry Council (The Council) Seeking Review and Modification of The Three-Prong Fuel Substitution Test*. Rulemaking 13-11-005. Available at: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M191/K912/191912103.PDF
[22] CPUC. 2019. *Decision Modifying the Energy Efficiency Three-Prong Test Related to Fuel Substitution*. Rulemaking 13-11-005. Available at: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M310/K159/310159146.PDF
[23] CPUC. 2018. *Administrative Law Judge's Ruling Seeking Comments on Three-Prong Test*. June 25, 2018. Rulemaking 13-11-005. Available at: https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M216/K775/216775944.PDF

largest gas utility in the state. SoCalGas argued that the amendment removes the cost-effectiveness protections put in place for ratepayers, encourages fuel wars, and impacts energy costs and reliability.[24] In contrast, environmental advocates, including the Sierra Club and NRDC, commented that the unamended test was antiquated and unrepresentative of today's needs.[25,26] The PUC released a proposed decision in June 2018 for comment, and in August, 2019 issued a final decision that replaced the Three-Prong Test with a new Fuel Substitution test and required that the overall energy efficiency portfolio must remain cost-effective.[27]

Q. Are you aware of any jurisdictions that allowed for and approved a fuel switching/electrification program in a rate case?

A. No.

Q. What is your conclusion about key policy and program implementation questions regarding BGE's electrification program proposal?

A. As I discussed above, novel programs like BGE's electrification program would require addressing various policy and program implementation questions as part of designing and implementing a program. Maryland

[24] Southern California Gas Company. 2019. *Opening Comments Of Southern California Gas Company (U 904 G) To Proposed Decision Modifying The Energy Efficiency Three-Prong Test Related To Fuel Substitution*, Rulemaking 13-11-005. Available at: http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M309/K726/309726334.PDF
[25] Seel, A. 2018. "Three Prongs Don't Make a Right." Sierra Club. Available at: https://www.sierraclub.org/planet/2018/04/three-prongs-dont-make-right
[26] UtilityDive. 2019. "California opens $1B in efficiency funding to electrification." Available at: https://www.utilitydive.com/news/california-opens-1b-in-efficiency-funding-to-electrification/560096/
[27] CPUC. 2019.

recently went through a long stakeholder process to discuss and resolve various EV-related topics before implementing an EV pilot program. Other jurisdictions also have spent a fair amount of time sorting out and resolving key policy and program questions before launching building electrification programs. The current MYP, and base rate cases generally, are not designed to discuss and resolve novel and complex policy and program issues. Thus, BGE's electrification program proposal should not be included in the current MYP.

B. BGE's proposal is untimely and premature because BGE's electrification programs presuppose answers to key building electrification policy and program questions that the State is in the process of addressing.

Q. Is EmPOWER Maryland considering incorporating building electrification?

A. Yes.

Q. Please summarize EmPOWER Maryland's recent and ongoing activities to incorporate electrification.

EmPOWER Maryland's initiative concerning building electrification started with the Public Service Commission Order No. 89679, issued December 18, 2020. Order No. 89679 established the Future Programming Work Group (Work Group) and directed the Work Group to consider various topics for EmPOWER's 2021–2023 Plan, including promoting electrification and state climate action plan coordination. The Work Group held 28 meetings over

the course of 13 months and stakeholders submitted numerous written comments on various issues.[28] In one of the Work Group meetings, the MDE made a presentation on the recommendations by the MCCC and the State's *2030 Greenhouse Gas Emissions Reduction Act Plan*. Among others, the MCCC recommended that "the General Assembly amend PUA § 7-211 to permit electrification of existing fossil fuel systems through EmPOWER and to direct the Commission to require electric utilities to proactively encourage customers with either natural gas, propane or oil space heating and water heating to replace those systems with electric heat pump technology, especially for LI households."[29] The Work Group discussed a few key issues concerning electrification including whether to discontinue gas appliance rebates, but they did not reach any consensus.

To help the state meet its GHG reduction goals through EmPOWER Maryland's programs, the Work Group commissioned a GHG abatement potential study by AEG ("AEG potential study") in 2022. This study included building electrification measures in a Maximum Achievable scenario in addition to energy efficiency and demand response.[30] On February 2, 2023, the Commission held a hearing regarding goal setting for

[28] Future Programming Work Group Report. April 15, 2022. Case No. 9648. At 2.
[29] Ibid.
[30] AEG. 2023. *EmPOWER Maryland 2024-2029 Greenhouse Gas Abatement Potential Study – Final Report*.

EmPOWER Maryland's 2024–2026 program cycle to review several EmPOWER Maryland-related reports, including the AEG potential study and the Work Group's recommendation report. The Commission then issued an order on March 23, 2023, directing each utility to file three separate program plans that follow three achievable potential scenarios analyzed by the AEG potential study by August 1, 2023.[31] One of the scenarios must follow the Maximum Achievable potential scenario, which includes electrification programs.

Q. Please describe the State's ongoing efforts to address policy questions concerning building or other electrification.

A. In compliance with the CSNA, the MDE is currently developing a state plan that reduces statewide GHG emissions by 60 percent by 2030 and "sets the state on a path" toward achieving net-zero statewide GHG emissions by 2045. The MDE is directed to develop a draft state climate plan by June 30, 2023, convene a series of public workshops, and adopt a final plan by December 31, 2023. This plan will include a set of recommendations for policies to help Maryland meet the CSNA's emission reduction targets.[32]

The CSNA also requires the Building Codes Administration to assess various issues concerning electrification and make recommendations to

[31] Order No. 90546
[32] For more information about MDE's plan, see: https://mde.maryland.gov/programs/Air/ClimateChange/Pages/index.aspx.

satisfy the General Assembly's stated intent "that the State move toward broader electrification of both existing buildings and new construction on completion of the study…"[33] Further, the CSNA requires the Building Codes Administration to develop recommendations "for the fastest and most cost–efficient methods for decarbonizing buildings and other sectors in the State" and "regarding efficient cost–effectiveness measures for the electrification of new and existing buildings"[34]

Q. What is your conclusion about the status of the ongoing policy and program activities concerning electrification in Maryland?

A. In Maryland, the Building Codes Administration, MDE, and the Commission, through EmPOWER Maryland, have been investigating and addressing various policy and program questions related to the promotion of electrification in the building and other sectors, and these efforts are ongoing. Consequently, BGE's electrification program proposal is untimely and premature and thus should not be implemented at this time.

C. BGE's building electrification proposal contradicts the state's climate policy.

Q. What aspects of BGE's building electrification program proposal conflict with the state's climate policy direction?

[33] CSNA. Section 10. Available at: https://mgaleg.maryland.gov/2022RS/Chapters_noln/CH_38_sb0528e.pdf.
[34] Ibid.

A. BGE's proposed electrification program would require residential customers to keep their existing gas heating systems when they install new electric heat pumps. This requirement does not align with the state's climate policy direction because customers would keep using pipeline gas, whereas the state has established a policy to aggressively promote building electrification to reduce GHG emissions and has found, through the MCCC, that a scenario that pursues aggressive electrification costs less for the society than a scenario that relies on hybrid heating systems.

Q. What are 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. This plan included two major components: (a) major findings from a study conducted by E3 ("the Statewide E3 study") analyzing 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, as I mentioned in the summary section of my testimony, and found that the MWG Policy 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,
- Construct new buildings to meet space and water heating demand without fossil fuels,
- Replace almost all fossil fuel heaters with heat pumps in existing homes by 2045, 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. It is also important to note that the second core recommendation, the Clean Heat Retrofit Program, includes (a) encouraging fuel-switching and beneficial electrification through EmPOWER beginning in 2024 and (b) targeting 50 percent of residential heating system, cooling system, and water heater sales to be heat pumps by 2025 and 95 percent by 2030.

Q. What does the Climate Solutions Now Act of 2022 require?

A. The CSNA mandates a 60 percent reduction in the state's GHG emissions by 2031, relative to 2006 levels, and net zero GHG emissions by 2045.

Q. Please characterize the policy direction set by the CSNA.

A. Consistent with the recommendations by the Commission on Climate Change, the CSNA has 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."[35] The Act also requires the Building Codes Administration to "develop recommendations for an all–electric building code and building energy performance standards for the State" as well as to "develop recommendations regarding efficient cost–effectiveness measures for the electrification of new and existing buildings."[36] These mandates from the CSNA are clear indications that the state intends to aggressively promote electrification while transitioning away from gas infrastructure. BGE's proposal to promote hybrid heating is in conflict with the state's policy direction.

Q. What is your recommendation?

[35] CSNA. Section 10.
[36] Ibid.

A. If BGE wishes to pursue its electrification programs, the Commission should direct BGE to propose its building and non-road electrification programs within the EmPOWER program instead of in this proceeding. The Commission should also investigate key policy and program implementation issues concerning electrification programs in a policy docket. Among other things, the Commission should investigate program designs, the role of the utilities and other entities, funding sources, performance incentives, cost-effectiveness analysis framework, goal setting, cost recovery, customer equity and bill impacts, federal incentives, and gas planning.

VI. BGE'S PROPOSED ELECTRIFICATION PROGRAM DESIGNS ARE FLAWED

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

A. As discussed above in the summary section in my testimony, there are numerous issues with BGE's proposed building electrification programs.

- BGE's proposal on gas equipment retention does not align with the state's climate policy direction and ignores technology and market realities. It is also not supported by any rigorous studies, including the studies that BGE commissioned and Mr. Case discussed in his direct testimony.

- Program designs, incentives, and budgets for some of the proposed electrification programs should be modified, if the Commission decides to approve the electrification program. In particular:
    - Per-customer incentive amounts BGE assumed for ASHPs, GSHPs, HPWHs, and electrification make-ready measures (e.g., electrical panel upgrades) are too high because they do not adequately take into account available federal financial incentives. Per customer incentive for ASHPs could be reduced further as BGE's estimates for the total cost of ASHPs could be overstated.
    - The proposed program budget for program administration is too high.
    - BGE's downstream incentive approach for its BE Program proposal is inconsistent with EmPOWER's new approach to use midstream incentives for HVAC and HPWH and with ongoing efforts to streamline EmPOWER's HVAC and HPWH offerings; it creates customer and contractor confusion.

- BGE has not provided sufficient evidence to support and justify the proposed non-road electrification programs.

A. BGE's building electrification program proposal does not align with policy, technology, and market realities.

Q. What aspects of BGE's building electrification program proposal do you think fail to reflect policy, technology, and market realities?

A. BGE's proposed electrification program would require customers to keep their existing gas heating systems when they install new electric heat pumps. However, as I initially discussed above, this requirement does not align with the state's climate policy direction, ignores the advancement of cold climate ASHPs, and would impose unnecessary costs on ratepayers. Further, this requirement is not supported or justified by reliable, rigorous studies.

Q. What are your concerns about BGE's proposal to require customers to retain existing gas space heating as backup?

A. BGE should not require the retention of existing gas space heating as backup for the following reasons:

- BGE's proposal on gas equipment retention does not align with the state's climate policy direction.
- Backup heaters are not required for cold-climate heat pumps in Maryland's climate, which are widely available in the market.

Q. Please explain why BGE's gas equipment retention proposal does not align with the state's climate policy directions.

A. This hybrid heating approach clearly contradicts (a) the major findings in a 2021 report by the Maryland Commission on Climate Change (MCCC) and (b) the state's overarching policy direction as established through the CSNA, which provides further support for the MCCC findings. Please see my discussions on this topic under Section III above.

Q. How would cold-climate heat pumps perform in Maryland's climate?

A. Cold-climate heat pumps are now widely available in the market. In mild climates like Maryland's, such advanced heat pumps do not require backup heating if sized properly to meet the full heating load. Cold climate heat pumps can provide comfortable heating very efficiently even in frigid temperature conditions. The Northeast Energy Efficiency Partnerships (NEEP) developed and has been maintaining a Cold Climate Air Source Heat Pump (ccASHP) List over the past several years.[37] NEEP establishes minimum requirements for manufacturers to list their heat pumps as ccASHP.[38] 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.[39] Space heating systems are typically sized based on

[37] NEEP's Cold Climate Air Source Heat Pump List. Available at: https://ashp.neep.org/#!/product_list/
[38] Currently the NEEP ccASHP list has over 80,000 models of ccASHPs from over 200 HVAC brands.
[39] 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.

design temperatures, which represents weather conditions that meet space heating loads for 99 percent of the hours in a year.[40] The design day temperature in Baltimore, Maryland is 17°F.[41] This means that cold climate heat pumps 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?

A. Yes.

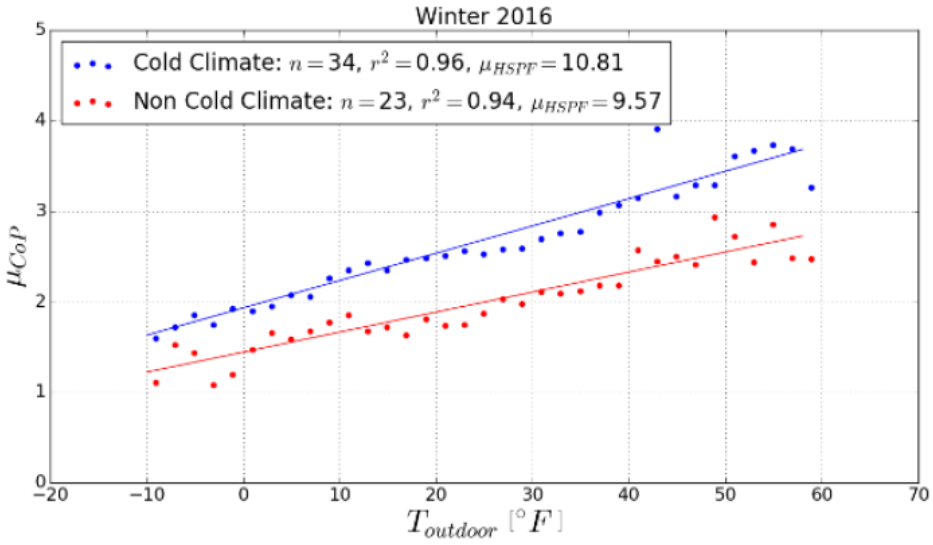
Q. What have those studies found about the actual performance of ccASHPs?

A. Many in-field studies demonstrated the superior performance of cold climate heat pumps over the past several years. For example, a 2016 study conducted by Cadmus Group evaluated the performance of mini-split heat pumps in numerous homes in Massachusetts and Rhode Island.[42] 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

[40] Green Building Advisor. 2021. "Design Temperature vs. Degree Days," Available at: https://www.greenbuildingadvisor.com/article/design-temperature-vs-degree-days; Air Conditioning Contractors of America. 2014. *ACCA Manual J® Residential Load Calculation Eighth Edition*. Available at: https://higherlogicdownload.s3.amazonaws.com/ACCA/8e4cf5b4-e984-4971-bb79-7889082c7cf2/UploadedImages/MJ8-Adden-E-Updated-Weather-Data-11Aug2014.pdf.
[41] U.S. EPA. 2015. *ENERGY STAR Certified Homes County-Level Design Temperature Reference Guide*. Available at: https://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/County%20Level%20Design%20Temperature%20Reference%20Guide%20-%202015-06-24.pdf.
[42] Cadmus 2016. *Ductless Mini-Split Heat Pump Impact Evaluation*. Available at: https://ripuc.ri.gov/sites/g/files/xkgbur841/files/eventsactions/docket/4755-TRM-DMSHP-Evaluation-Report-12-30-2016.pdf.

during the winter of 2016. As shown in this figure, the average COP values for cold climate heat pumps 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. But regular heat pumps are also very energy efficient at Baltimore's design temperature, especially when compared to gas boilers and furnaces, which tend to be 70 percent to 90 percent efficient (representing a COP of 0.7 to 0.9).

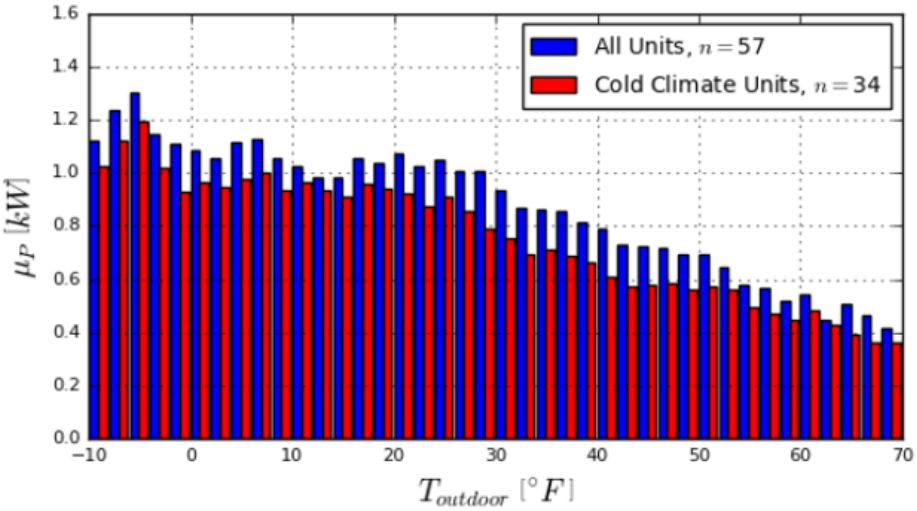
Figure 1. Average Heating COP vs. Outdoor Air Temperature for Cold-Climate and Non-Cold-Climate Systems – Winter 2016



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

The same Cadmus 2016 study also examined electricity demand at varying temperatures and found that little changes in kW usage between 17°F (Baltimore's design temperature) and 0°F, as shown in Figure 2 below.

Figure 2. Winter 2016 Average Power Consumption – Heating kW usage vs. Outdoor Temperature

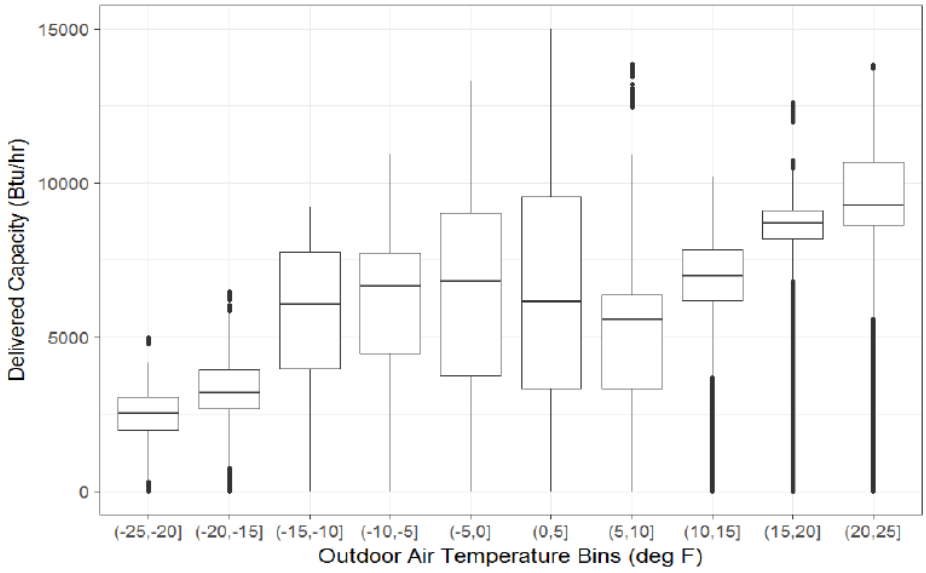


Source: Cadmus 2016. Ductless Mini-Split Heat Pump Impact Evaluation.
Note: μP [kW] represents the mean power consumption of the population studied.

While the energy input could be stable in this temperature range, heating capacities could decline as the temperature goes down. However, 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 3 below.[43]

[43] Shoenbauer, B. et al. 2018. "Field Assessment of Ducted and Ductless Cold Climate Air Source Heat Pumps." Available at: https://www.mncee.org/field-assessment-ducted-and-ductless-cold-climate-air-source-heat-pumps.

Figure 3. Capacity of a Mini-Split Heat Pumps vs. Outdoor Temperature



Source: Shoenbauer, B. et al. 2018. "Field Assessment of Ducted and Ductless Cold Climate Air Source Heat Pumps."

Q. What do these in-field studies imply about the usage and grid impacts of ccASHPs in Maryland?

A. I draw two main conclusions from these studies: (a) ccASHPs in Maryland do not require fossil fuel back-up heating; and (b) the potential grid impact from ccASHPs is much lower than what BGE and its consultants E3 and 1898 & Co claim.

Q. Do you expect that heat pump technologies will be further improved in the future?

A. Yes. While the efficiencies of fossil-fuel-based heating technologies, such as gas furnaces, haven't seen much technology advancement in the past decade and are not expected to see notable improvement in the future, it is expected

that heat pump technologies are going to improve further over the next decade or so. For example, the National Renewable Energy Laboratory ("NREL") conducted a series of Electrification Futures studies; and in one of the studies, NREL projected a range of efficiency advancements for heat pumps and heat pump water heaters through 2050 under three different scenarios.[44] In the most aggressive scenario, the study projects that a COP will increase by 30 to 50 percent in the most aggressive scenario and by 12 to 25 percent in the most conservative scenario by 2030.

Q. How do the costs of ccASHPs compare with the costs of regular ASHPs?

A. A 2018 evaluation study by Navigant Consulting (now Guidehouse) examined the costs of 305 ASHP units, more specifically ductless minisplit heat pump ("DMSHP"), that were part of the Massachusetts Residential Heating and Cooling Program.[45] Figure 4 below shows a summary of this survey. As shown in this figure, the study found that total installed costs of regular and cold-climate (DMSHP) are comparable. At the lower rebate threshold of 18 SEER and 10 HSPF, the total installed cost of cold-climate systems was slightly (3 to 6 percent) higher, except the two largest unit categories, which were 13 to 18 percent more expensive. On the other hand,

[44] NREL. 2017. *Electrification Futures Study: End-Use Electric Technology Cost and Performance Projections through 2050*. Available at: https://www.nrel.gov/analysis/electrification-futures.html.
[45] Navigant. 2018. *Ductless Mini-Split Heat Pump Cost Study (RES 28): Final Report*. Prepared for the Electric Program Administrators of Massachusetts Part of the Residential Evaluation Program Area. Available at: https://ma-eeac.org/wp-content/uploads/RES28_Assembled_Report_2018-10-05.pdf.

at the upper rebate threshold of 20 SEER and 12 HSPF, the study found the total cost of cold-climate systems was consistently lower than the installed cost of regular non-cold-climate systems.

Figure 4. Total Installed Cost of DMSHP Systems at Common SEER-HSPF Combinations

Capacity, kBtu/h	Number of Zones	Base Case 15 SEER, 8.2 HSPF	Lower Rebate Threshold 18 SEER, 10 HSPF		Upper Rebate Threshold 20 SEER, 12 HSPF		Above Current Rebate Levels 28 SEER, 14 HSPF	
		Regular	Regular	Cold Climate	Regular	Cold Climate	Regular	Cold Climate
9 ± 1.5	1	$3,643	$3,860	$3,993	$4,212	$4,035	-*	$4,419
12 ± 1.5	1	$3,717	$3,957	$4,058	$4,407	$4,199	$4,407	$4,515
18†	1	$4,276	$4,475	$4,646	$4,956	$4,812	-‡	-‡
24 ± 3	1	$4,586	$4,811	$5,016	$5,256	$5,176	-*	-*
24 ± 3	2	$6,263	$6,679	$7,060	-*	-*	-*	-*
24 ± 3	3	$7,434	$7,852	$8,202	-*	-*	-*	-*
30 ± 3	3	$7,962	$8,024	$9,049	-*	-*	-*	-*
36 ± 3	4	$8,857	$8,857	$10,438	-*	-*	-*	-*

* The evaluation team could not identify any systems available on the market with this combination of capacity, zones, and efficiency levels.
† The evaluation team estimated the equipment costs for 18 kBtu/h using linear interpolation between the equipment costs at 12 kBtu/h and 24 kBtu/h. Based on contractor survey data, the team assumed that installation costs for 18 kBtu/h systems are the same as for 24 kBtu/h systems.
‡ Since the 18 kBtu/h data was estimated based on data for 12 and 24 kBtu/h systems, it could only be calculated for system configurations that are available at both the 12 and 24 kBtu/h capacities.

Source: Navigant. 2018. Ductless Mini-Split Heat Pump Cost Study (RES 28)

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 base level incentives provided to all efficient heat pumps—in order 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.[46] 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.[47] To be eligible for these rebates, customers must fill out 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.

- **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.[48] The program offers rebates for cold-climate air source heat pumps, with higher incentives for full-load heating heat pumps sized to meet at least 90 percent of the building heat load.[49] In addition, NYS Clean Heat offers specific, higher incentives for

[46] Mass Save. 2023. "Air Source Heat Pump Rebates." Available at: https://www.masssave.com/en/residential/rebates-and-incentives/air-source-heat-pumps.
[47] Mass Save. March 2023. *Heat Pump Program Offers.* Available at: http://ceere.org/MassSave2023HeatPumpProgramOverview.pdf.
[48] Cohn, Charlotte and Nora Wang Esram. February 2022. *Building Electrification: Programs and Best Practices.* Available at: https://www.aceee.org/research-report/b2201.
[49] The Joint Energy Efficiency Providers. September 2022. *NYS Clean Heat: Statewide Heat Pump Program Manual*. Available at: https://cleanheat.ny.gov/assets/pdf/NYS-Clean-Heat-Program-Manual.pdf.

optimizing use of the full-load heat pump system by adding integrated controls or for decommissioning the pre-existing fossil-fuel heating system.[50]

Q. What are the cost implications of the gas heating backup requirement for BGE's customers?

A. I expect that BGE's backup heating requirement could result in unnecessary costs for BGE customers for two reasons: (a) BGE would need to continuously upgrade and maintain many parts of its gas distribution system for use during just a small portion of the year, forcing the Company to raise gas rates significantly in the future; and (b) the customers who were required to maintain their gas heating system as a condition of participating in BGE's heat pump program would also need to replace their old heating system with a new gas heating system in the future once the existing system fails.

B. BGE's studies are flawed and do not support its proposal to require customers to retain existing gas heating systems as backup heating.

Q. Do you have concerns with the studies that BGE commissioned to inform its electrification strategy?

[50] The Joint Energy Efficiency Providers. 2022. *NYS Clean Heat: Statewide Heat Pump Program Manual*. Available at: https://cleanheat.ny.gov/assets/pdf/NYS-Clean-Heat-Program-Manual.pdf.

A. Yes. I have major concerns about both the E3 study and the 1898 & Co study. I found that these studies have many flaws and do not justify BGE's proposal to require the retention of existing gas space heating as backup.

Q. What are the major issues with the E3 Study?

A. As mentioned near the beginning of my testimony, the E3 study analyzed three scenarios: the Limited Gas pathway, the Hybrid pathway, and the Diverse pathway. E3 describes the latter two scenarios as Integrated Energy System ("IES") scenarios. E3 concluded that the IES scenarios "achieve Maryland's goals at a significantly lower cost and with less risk for customers and the State's economy" and that the Limited Gas pathway "would result in a significantly higher cost, more economic and energy system disruption, and a less diverse/resilient system compared to IES scenarios."[51]

Q. Are E3's conclusions justified?

A. No. The E3 study has several major flaws that call into question the study's conclusions. The flaws include the following:

1) The E3 study's analysis of gas asset operation and retirements for the scenario with the highest levels of electrification, the Limited Gas scenario, is overly biased toward maintaining the existing gas

[51] Case direct testimony, at 47.

systems in that it assumes no or very small amounts of gas system retirements through 2045.

2) The E3 study's estimates for electric system transmission and distribution costs are overly high; and

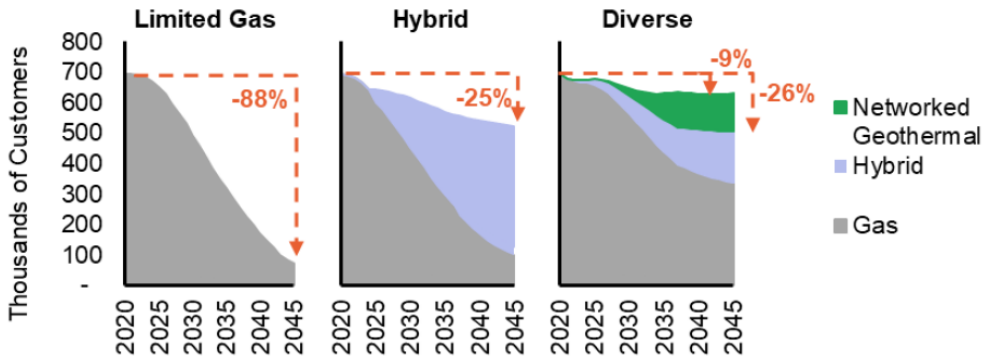
3) The E3 study's assumptions about the cost of heat pumps are overstated.

Q. Please elaborate on how the E3 study is overly biased toward maintaining BGE's existing gas system.

A. The first flaw is substantially inflating the cost of operating and maintaining the gas system for the Limited Gas pathway. The Limited Gas pathway assumes that the total number of customers declines by 88 percent by 2045; this is substantially more than projected for the other pathways, as shown in the figure below. This steep decline would presumably allow for the retirement of parts of BGE's gas distribution network, but the extent to which the E3 study report assumed and modeled such retirements is not clear. E3 appears to have assumed minimal asset retirements, stating that "opportunities for avoided reinvestments will only be a fraction of the total value of the system between 2022 and 2050" and that "not all gas infrastructure that is up for replacement can be replaced, and ongoing investments will be needed for reasons ranging from safety and reliability to

the feasibility challenges inherent in implementing electrification projects at neighborhood scale."[52]

Figure 5. BGE's residential and commercial customer counts by scenario in the E3 study for BGE

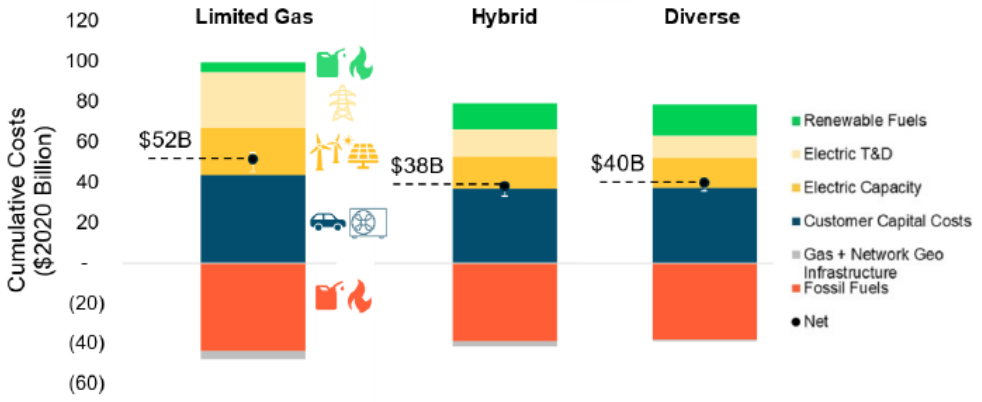


Source: 2022 E3 Pathway Study. Figure 12.

The only apparent quantification of gas system retirements in the E3 study is shown in Figure 6 below. This figure shows that the gas system cost reduction under the Limited Gas pathway (shown as "Gas + Network Geo Infrastructure" in the figure) is extremely small relative to the additional costs for electric capacity and transmission and distribution ("T&D"). This result is surprising given that the E3 study is projecting a nearly 90 percent reduction in customer counts by 2045 under the Limited Gas pathway (see Figure 5).

[52] E3 study at 33.

Figure 6. 2045 Incremental costs by component by scenario relative to Reference Scenario in the E3 study for BGE



Source: 2022 E3 Pathway Study. Figure 17.

BGE provided the actual estimates of gas system costs in its response to OPCDR22-05 CONFIDENTIAL Attachment 1. ****BEGIN CONFIDENTIAL**** [redacted] ****END CONFIDENTIAL****

Q. Besides E3's arguments for keeping the existing gas system mentioned above, is there any other reason why E3 made such a false assumption?

A. It is possible that this decision was based on the intention and objective of the study itself, stated on page 11 of the study where the study mentioned: "BGE specifically asked E3 to build on its prior efforts in the State by

evaluating the implications of decarbonization strategies that achieve the state's newly legislated net-zero targets ***with an intent to understand how BGE's electric and gas businesses and infrastructure could play a supporting role*** [emphasis added]."[53]

Q. Please explain why you find the E3 study's estimates for transmission and distribution costs are overly high.

A. The E3 study used overly high T&D costs of $203/kW-year to $258/kW-year, which were provided by BGE.[54] These values are nearly *eight times higher* than the avoided T&D values of $25.1 to $34.09 per kW-year that BGE's other consultant, Brattle Group, is using to evaluate the cost-effectiveness of its EV fleet programs.[55] Further, BGE stated that Brattle's T&D avoided cost value is consistent with the methodology used for avoided T&D costs in BGE's EmPOWER plan.[56]

Q. Would the results of the E3 study be different if E3 had used the same T&D values used bythe Brattle Group?

A. The E3 study estimated that the total incremental cost of T&D for the Limited Gas pathway is approximately $29 billion in 2045, as is shown in Figure 6 above. If we adjust this value based on the T&D value used by Brattle Group, the total incremental T&D cost would be reduced to just $4

[53] E3 study, at 11.
[54] E3 study, at 79.
[55] A supporting workpaper "Fleet Electrification BCA_Final" filed with Direct Testimony of Witness Case.
[56] BGE response to OPCDR22-14.

billion, representing a reduction of $25 billion relative to E3's estimate. As the net total cost for the Limited Gas pathway is $52 million (see Figure 6), this reduction in T&D costs would reduce the net total cost for the scenario by roughly 50 percent to approximately $27 billion. Applying a similar adjustment to the T&D costs to the other two scenarios, I estimate that the net total cost for the Limited Pathway would be similar to the net costs for the Hybrid and Diverse Pathway scenarios, even taking into account the study's bias towards maintaining the existing gas system. If that bias were eliminated, the Limited Gas pathway would likely be the lowest cost of all the scenarios due to cost savings from retirements of the gas network systems made possible by the projected 88 percent reduction in customer counts.

Q. Please explain why you find that the E3 study's assumptions for the costs of heat pumps are overstated.

[redacted]The E3 study assumes costs (in 2020 dollars) of $12,500 in year 2020 and $13,200 in year 2030 for a hybrid ASHP using a gas heating system as backup heating. For an ASHP using electric resistance as backup heating, the study assumes costs of $14,300 in 2020 and 11,500 in 2030. I converted these values for year 2020 into 2022 dollars based on the recent inflation rates to make them comparable to the cost estimates provided by BGE in the MYP filing (which I assume BGE obtained in 2022). I then estimated the

heat pump costs for year 2022 by assuming a linear cost trajectory from 2020 to 2030 based on E3's cost estimates for those two years. The resulting cost estimates for year 2022, in 2022 dollars, are: $15,744 for an ASHP with electric backup and $13,754 for an ASHP with fuel backup, as shown in Table 2 below. ****BEGIN CONFIDENTIAL**** [redacted]

[redacted]

[57] OPCDR14-08 CONFIDENTIAL Attachment 1.
[58] OPCDR01-01_Attachment1, at 19.

[redacted]. **END CONFIDENTIAL**

Q. Is the E3 study a reliable basis for drawing conclusions about the impact of electrification on BGE's system?

A. The E3 study is overly biased toward maintaining the existing gas systems under the Limited Gas scenario and assumes overly high costs for both electric transmission and distribution systems and ASHPs. Correcting these errors would likely make the Limited Gas scenario a lower-cost scenario than BGE's IES scenarios. If the Limited Gas scenario is in fact the lowest-cost scenario, as this analysis suggests, there is no basis for BGE's proposal to require the retention of existing gas furnaces as back-up heating for ASHPs.

Q. Do you have concerns with the 1898 & Co. study that BGE used to support the gas equipment retention proposal?

[59] OPCDR34-02.
[60] The cost of building systems in Baltimore is 94 percent of the national average, according to RS Means. See PDF page 60 of this online document: https://www.rsmeans.com/media/wysiwyg/quarterly_updates/2021-CCI-LocationFactors-V2.pdf.

A. Yes. I found that this study has flaws in some of the assumptions and methodologies it used to estimate peak load and grid impacts of electrification.

Q. Please describe 1898 & Co.'s methods to estimate peak load and the infrastructure impacts of electrification.

A. BGE asked 1898 & Co. to produce an estimate of the peak load—and the distribution system cost to meet that peak load—associated with electrification of the residential and transportation sectors. 1898 & Co.'s approach was to:

- Estimate new electrified loads in each county, based on demographic data and historical growth rates, along with an electrification trajectory toward full electrification in 2045;
- Assume new construction reflects the average of existing buildings, which shifts towards all-electric over time. Assume no change in space or water heating technology in homes heated using electricity today;
- Estimate the peak load impact of each newly electrified space heating, water heating, and EV load;
- Assign those new loads proportionally across the feeders in that county;

- Evaluate whether the new load leads to a peak load in excess of a given feeder's rated capacity;
- If the load exceeds the rated capacity, add the cost to build a new feeder alongside the existing feeder; and
- If the overall load on a substation exceeds that substation's rated load, add the cost to build a new substation.

Q. What are your major concerns with 1898 & Co.'s methods and assumptions?

A. Specifically, 1898 & Co. made unreasonable assumptions and used inaccurate methods in the following areas:

- Peak coincidence
- EV loads
- Heat pump performance
- Efficiency improvements and existing electrically heated buildings
- Cost model

Q. What are your concerns regarding peak coincidence?

A. 1898 & Co. used only the summer peak load for each feeder as the starting point for its calculations. This peak load generally occurs in the afternoon or

early evening of a hot summer day. 1898 & Co. adjusted this peak load to account for growth and energy efficiency, then added the assumed peak electric loads from each technology to this starting point. This is nonsensical for multiple reasons. First, it adds the peak new electric *heating* load, which would generally occur on the coldest winter morning, to the summer peak load. For feeders that peak in the summer, this overstates the peak load because the space heating load should be added to the coincident winter load. For feeders that peak in the winter, 1898 & Co. and BGE acknowledged the error of using the summer peak.[61] Because BGE has more summer-peaking feeders than winter-peaking ones, and higher overall load in summer than in winter, the net effect of this error is to overstate the need to add distribution capacity.

Second, 1898 & Co. assumes that the peaks for several different end uses—including space heating, water heating, and vehicle electrification loads—are coincident with the peaks on each feeder. In reality, the respective peaks for those end uses are driven by a wide range of factors and occur at different times of day.

Q. What are your concerns regarding assumed EV loads?

[61] BGE's response to OPCDR10-03(A).

A. 1898 & Co. assumes an unreasonable amount of EV charging load. The 1898 & Co. analysis assumes that 84 percent of EVs charge for two hours at 19.2 kW every night (resulting in a total average nightly energy draw of 38.4 kWh for each EV), and that 20 percent of cars that charge at night are charging at any given time. That is, 1898 & Co. assume five segments of the fleet, each charging for 2 hours, distributed over 10 hours of nighttime. For purposes of grid impacts, this is effectively assuming that each EV charges at 3.84 kW for 10 hours. 1898 & Co. assumes that the remaining 16 percent of EVs charge during the day and that their charging is not peak-coincident.

EVs generally have a fuel economy of about 3 miles per kWh of energy. This means that charging 38.4 kWh every night is enough energy to drive 115 miles per day, or almost 42,000 miles per year. In fact, vehicles in Maryland drive just over 11,000 miles per year.[62] As a result, 1898 & Co. overstates the potential EV load by a factor of about 3.75.[63] This extreme overestimate results in nonsensically high peak loads and resulting infrastructure needs.

Q. What are your concerns regarding assumed heat pump performance?

[62] In 2021, Maryland roads experienced 56.616 billion miles of driving. The state had 5.07 million registered vehicles. The ratio is 11,169 miles per vehicle.
[63] 115 miles per day * 365 days divided by the average per vehicle mile of 11,169 miles in 2021.

A. 1898 & Co. assumes that all ASHPs would be operating at the efficiency of electric resistance heat during peak conditions, which it describes as "polar vortex" conditions. During "polar vortex" conditions in Maryland, temperatures reach as low as 1 degree F according to BGE and E3 (BGE response to OPCDR-22-07). To the extent that cold climate ASHPs are used, this assumption is unreasonable because such heat pumps are designed to maintain adequate capacity and operate very efficiently during such conditions, as I explained in detail in the early part of this section above. Thus, 1898 & Co. is effectively anticipating that no cold climate heat pumps are used in Maryland. However, this assumption is counterbalanced by an assumption that during peak conditions, heat pumps would only be running about half the time (that is, a diversity factor of 50 percent). In practice, during the coldest period for which a heating system is designed, such as a polar vortex, it would be expected to run 100 percent of the time.

The net effect of 1898 & Co.'s underestimating both the efficiency and/or use of cold climate heat pumps and the frequency of heat pump use during peak conditions is that 1898 & Co. assumed the use of ASHPs with an effective efficiency of about 200 percent. While this may be a reasonable assumption at winter peak given improvements in cold climate performance, the errors on which it is based point to a worrisome lack of understanding of

heat pump technology and use, which demonstrates how unreliable and inappropriate the study is as a basis for decision-making.

Q. What are your concerns regarding efficiency improvements and electrically heated buildings?

A. 1898 & Co. assumed an annual reduction in peak electric consumption of 0.2 percent as a result of increasing efficiency and a 0.1 percent impact from reducing line losses during peak times. These levels of efficiency improvement are not grounded in any evaluation of Maryland's building stock or the potential for cost-effective efficiency being pursued by the EmPOWER program. 1898 & Co. assumes new construction loads to be equivalent to today's buildings, without accounting for building code improvements. As a result, the starting point load for 1898 & Co.'s analysis is too high. 1898 & Co. also neglected to include the potential impact of market transition (with or without programmatic encouragement) on homes with electric resistance-based water heating and space heating. Homes which upgrade from resistance-based space and water heating to heat-pump-based options will see a reduction in their winter peak load. For water heating, the impact is clear and not weather dependent: a new HPWH reduces electric consumption by a factor of 3 or more relative to a resistance-based starting point. For space heating, peak loads decline after

accounting for the real-world cold-climate performance of these technologies, as I discussed above.

Q. What are your concerns regarding 1898 & Co.'s cost model?

A. 1898 & Co. assumed that a new feeder needs to be constructed the moment the peak load on a given feeder passes the maximum load. Most of BGE's feeders have a capacity of 9.9 MVA. This approach builds a new feeder identical to the existing feeder if the load reaches 10.0 MVA. This is true even if the other feeders on the same substation have excess capacity. 1898 & Co's report itself states that the resulting model is "very non-optimized" and not based on reality of engineering, design, or construction.[64] This method ignores the real-world steps that a utility would take, such as shifting load to nearby feeders.

Q. What are your conclusions regarding the suitability of the 1898 & Co. study as a basis for conclusions regarding the impact of electrification on BGE's system?

A. The 1898 & Co. analysis should not be relied upon to draw the conclusions that Witness Case draws from it. A corrected analysis would not show that peak load would "more than triple." Such analysis would likely produce results closer to a forecast recently developed by the New York Independent

[64] Page 10: "Further, the model creates an idealized grid design on one hand and a very non-optimized design on another. Substation design is simplified. If a feeder is overloaded, the model mechanically adds another feeder following the existing right of way. Both are not based in the reality of engineering, design, and construction, but are simplifications for the purposes of 'what-if' modeling."

System Operator (NYISO), which shows a winter peak load increase of just about 60 percent by 2045 due to building and transportation electrification.[65]

C. If the Commission does not remove BGE's Electrification Programs from consideration in the MYP, program designs and incentives for some of the programs would need to be modifed.

Q. Please summarize key issues you identified in BGE's proposal on building and non-road electrification programs.

A. I found the following major issues with BGE's proposal on building and non-road electrification programs.

- Per-customer incentive amounts BGE assumed for heat pumps, HPWHs, and make-ready measures are too high.
- The proposed program administration costs are too high.
- BGE's building electrification proposal relies on a downstream incentive approach instead of a midstream incentive approach.
- BGE has not provided sufficient evidence to support and justify the proposed non-road electrification programs.

Q. Please elaborate on why the per-customer incentive amounts assumed by BGE for certain measures are too high.

[65] NYISO. 2022. *2022 Load & Capacity Data Gold Book*. Page 22. Available at https://www.nyiso.com/documents/20142/2226333/2022-Gold-Book-Final-Public.pdf.

A. BGE calculated utility incentive levels and the total budget for the incentives in a confidential Excel file OPCDR14-08 CONFIDENTIAL Attachment 1. This file shows that BGE properly incorporated the federal IRA rebates for heat pumps, HPWHs, and electrical panel upgrades. However, BGE confirmed that it did not incorporate the available federal tax credits for these measures and for geothermal heat pumps in its response to OPC's data request.[66] Geothermal heat pumps are now eligible for 30 percent tax credits.[67] Both heat pumps and heat pump waters are eligible for $2,000 federal tax credits, and electrification make-ready investment (i.e., electrical panel upgrades) are eligible for $600 tax credits.[68]

Q. What is your recommendation about how BGE should adjust the utility incentive levels?

A. I recommend that BGE's incentive levels be adjusted downward by the amount of available federal tax credits: the total combined incentives should be no more than the total installed measure costs for low-income households with incomes below 80 percent of the Area Median Income (AMI) and moderate-income households whose incomes are between 80 and 150 percent of the AMI. These households are eligible for the IRA rebates. For

[66] BGE's response to OPCDR34-01, part C.
[67] U.S. EPA. 2022. "Geothermal Heat Pumps Tax Credit." Available at: https://www.energystar.gov/about/federal_tax_credits/geothermal_heat_pumps.
[68] Rewiring America. "25C Residential Energy Efficiency Tax Credit and 25D Residential Clean Energy Tax Credit." Available at: https://www.rewiringamerica.org/ira-fact-sheets.

the rest of the households with income above 150 percent of the AMI, I recommend that BGE's incentives should still be adjusted downward by the amount of federal tax credits; but the total combined incentives should not exceed the total incremental measure costs, which represent the cost premium of electrification measures relative to the cost of standard fossil-based measures (e.g., gas furnace, gas water heater).

Q. How do your recommended incentive adjustments change per-customer utility incentives and the overall incentive budget?

A. Applying the incentive adjustments I mentioned above, I estimated the incentive levels for each of the three income groups that are included in the Excel file OPCDR14-08 CONFIDENTIAL Attachment 1. BGE has its own estimates of the share of customers in these income groups who would participate in BGE's electrification program. Column (2) of the table below presents the weighted average of BGE's proposed incentive levels across the three income groups by measure type. Column (3) shows measure incentives that were revised to take into account federal tax credits. As shown in column (5), incentives were reduced by 20 percent for GSHPs, 53 percent for ASHPs, 44 percent for mini-split ASHPs, 100 percent for HPWHs, and 44 percent for make-ready investments.

Table 3. BGE Per-Customer Incentives for Residential Electrification with Federal Tax Credits

(1) Measure type	(2) BGE average ($)	(3) Revised - average ($)	(4) Difference ($)	(5) Difference (%)
GSHP	$7,500	$5,993	$1,507	20%
ASHP	$4,039	$1,881	$2,159	53%
Mini-Split ASHP	$4,596	$2,590	$2,005	44%
HPWH	$1,367	$0	$1,367	100%
Make Ready	$1,350	$750	$600	44%

Based on these per-customer incentives and BGE's projected participants, I estimated the total incentive budget for each measure type in the table below. I estimate that that the federal tax credits could reduce BGE's estimated incentive budget by approximately $74 million, or 50 percent. Note that these estimates assume no caps on federal IRA rebates.

Table 4. BGE Total Incentive Budget Estimates for Residential Electrification with Federal Tax Credits

	Original - ($)	Revised - ($)	Difference ($)	Difference (%)
GSHP	$733,690	$586,285	-$147,405	-20%
ASHP	$106,091,852	$57,431,208	-$48,660,644	-46%
Mini-Split ASHP	$6,363,229	$4,105,621	-$2,257,608	-35%
HPWH	$15,021,336	$0	-$15,021,336	-100%
Make Ready	$18,534,044	$10,296,691	-$8,237,353	-44%
Total	$146,744,152	$72,419,806	-$74,324,346	-51%

BGE's final incentive budget estimate assumes substantial reductions in federal IRA rebates as each state has its own allocated budget for the IRA rebates. The table below presents BGE's final incentive budget estimate and

my revised incentive budget estimate. Overall, I estimate that federal tax credits could reduce the incentive budget by approximately $74 million or by 30 percent, assuming that every homeowner is eligible to receive federal tax credits. However, not every homeowner is eligible for federal tax credits because homeowners can only use it to decrease or eliminate their tax liability.[69] According to the Tax Policy Center, approximately 40 percent of households did not owe federal income taxes.[70] This means that these households would not have been eligible for federal tax credits. Based on this data and to be more conservative, if I assume 50 percent of program participants would not be eligible for federal tax credits, I estimate that BGE could reduce the incentive budget by approximately $37 million (half of $74 million that I estimated above).

[69] IRA. "Q&A on Tax Credits for Sections 25C and 25D." Available at: https://www.irs.gov/pub/irs-drop/n-13-70.pdf.
[70] Tax Policy Center. 2022. "T22-0132 - Distribution of Tax Units with Zero or Negative Individual Income Tax, By Expanded Cash Income Percentile, 2022." Available at: https://www.taxpolicycenter.org/model-estimates/tax-units-with-zero-or-negative-federal-individual-income-tax-oct-2022/t22-0132.

Table 5. BGE Total Incentive Budget Estimates for Residential Electrification with Federal Tax Credits before Adjusting for Tax credit eligibility

	Original - ($)	Revised - ($)	Difference ($)	Difference (%)
GSHP	$733,690	$586,285	-$147,405	-20%
ASHP	$173,046,874	$124,386,007	-$48,660,867	-28%
Mini-Split ASHP	$10,111,635	$7,854,027	-$2,257,608	-22%
HPWH	$22,902,032	$7,880,696	-$15,021,336	-66%
Make Ready	$37,074,753	$28,837,399	-$8,237,353	-22%
Total	$243,868,983	$169,544,414	-$74,324,570	-30%

Q. Are there any other potential issues with BGE's incentive amounts?

A. Yes. Per-customer incentives for ASHPs could be reduced further as BGE's estimates for the total cost of ASHPs could be potentially overstated. According to OPCDR14-08 CONFIDENTIAL Attachment 1, ****BEGIN CONFIDENTIAL**** [redacted] ****END CONFIDENTIAL**** BGE stated these costs were estimated using several sources, including SoCalEdison's proposed electrification projects and NY Clean Heat Program performance data and feedback from trade allies in the Baltimore area. However, the 1898 & Co study mentioned national average costs of $7,700 for high efficiency heat pumps and $5,700 for regular heat pumps for single-family residential units.[71] In response to OPCDR34-02, BGE stated that "1898 & Co. also validated these costs through a personal

[71] OPCDR01-01_Attachment1, at 19.

communication with a representative of a national distributor of heat pump systems for the mid-Atlantic zone, which covers the BGE service territory."[72] I expect that the HVAC costs in Baltimore are slightly lower than the national average costs, based on RS Means' location cost factor for Baltimore.[73] This means that BGE's heat pump costs are potentially overstated substantially.

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

A. If the Commission decides to allow the electrification plan (which, as explained above, I recommend against), I recommend that BGE should reduce the incentive levels by the federal tax credits as I described above. However, instead of reducing the total incentive budget, I recommend that BGE should support more program participants with the freed-up budget of approximately $37 million (or potentially more if the total costs of heat pumps are less than what BGE is assuming currently) and further promote building electrification. I also recommend that, if the Commission decides to approve BGE's electrification proposal, the Commission direct BGE to conduct a state-specific survey on the costs of building electrification measures. BGE can use the results to develop the right amount of

[72] OPCDR34-02.
[73] The cost of building systems in Baltimore is 94 percent of the national average, according to RS Means. See PDF page 60 of this online document: https://www.rsmeans.com/media/wysiwyg/quarterly_updates/2021-CCI-LocationFactors-V2.pdf.

electrification incentives per customer since it does not currently possess any Maryland-specific data on heat pump costs, let alone Baltimore-specific data. Furthermore, I recommend the Commission establish guidance on customer incentive setting for electrification measures and require BGE to use the guidance to set incentives and develop the total budget for customer incentives. Ideally, such a guidance should be developed through a stakeholder process, but I offer the following minimum recommendations: for low-income and moderate-income customers, the total incentives that comprise federal rebates, federal tax credits, and utility incentives should not exceed 100 percent of the total measure costs. For the rest of the customers, the total incentives should not exceed 100 percent of the total incremental costs of electrification measures. For example, if a heat pump costs $7,700 and a gas furnace costs $5,700, the total incremental cost for the heat pump is $2,000.

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

A. One reasonable approach to assess whether a budget estimate is reasonable is to look at the average budget per program participant. This approach indicates how much money BGE is planning to spend to reach and acquire each program participant and deliver/install measures on average. I compared BGE's residential BE Program non-incentive budget to BGE's reported 2022 residential HVAC EmPOWER budget. I found that on a per-

customer basis BGE assumes a much higher program budget for program administration, marketing, and evaluation, measurement, and verification (EM&V), as shown in Table 6 below.

Table 6. Comparison of cost per participant for BGE's residential BE program and EmPOWER residential HVAC program

Budget Category	BE Residential Program 3-year Cycle Total	EmPOWER HVAC 2022 Reported Budget
Utility Admin	$29.92	$16.28
Outside Services	$198.94	$131.38
Marketing and Median Buys	$175.88	$119.31
EM&V	$23.43	$28.28
Total (excluding incentives)	$428.18	$295.25

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

A. Table 7 below shows an estimated budget for BGE's residential BE Program based on the EmPOWER HVAC per-customer budget in Table 6 above. If I assume EmPOWER's cost-per-participant estimate, the total cost of BGE's proposed residential BE Program would be about $7.7 million lower. However, I expect that BGE could reduce the non-incentive budget further if the Company offers its electrification programs within EmPOWER. Thus, I recommend the PSC should direct BGE to combine forces with EmPOWER and develop a revised budget.

Table 7. Adjusted non-incentive budget for BGE residential BE program

Budget Category	Adjusted Non-incentive Budget
Utility Admin	$940,558
Outside Services	$7,589,493
Marketing and Media Buys	$6,892,135
EM&V	$1,633,604
Total Excluding Incentives	**$17,055,790**
Reduction from original non-incentive budget	$7,679,159

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

A. BGE proposes to provide prescriptive "downstream" incentives offered through the utility to customers, downstream, using EmPOWER delivery channels. The term "downstream" refers to incentives that are targeted towards end-use customers. In contrast, "midstream" incentives are delivered in the middle of the supply chain to vendors or contractors.

Q. What is your concern about BGE's incentive approach?

A. Downstream incentives can be cumbersome for the customer as well as the rebate provider, potentially leading to lower participation and higher overhead costs. Furthermore, the HVAC programs offered through EmPOWER have largely transitioned to a midstream model where incentives are targeted at equipment distributors and installation

contractors.[74] If BGE offers other rebates for heat pumps and HPWHs downstream through its BE Program, BGE will be duplicating efforts with the EmPOWER programs and potentially creating confusion for customers and contractors. OPC has previously expressed concerns with the lack of a streamlined approach for EmPOWER HVAC and Appliance Rebates programs.[75] I agree with this concern. Offering incentives outside of EmPOWER is not streamlined and creates greater confusion.

Q. Why do you recommend a midstream incentive approach?

Midstream incentive models provide several benefits. Rather than requiring the customer to claim a rebate, which can take time and effort and may have delayed reimbursement periods, midstream models apply incentives before they reach the customer. Midstream incentives thus require no effort from the customer; rebates are applied "behind the scenes." Distributors pass price discounts directly to contractors, who in turn pass the discounts to customers. Midstream models can also help with market transformation because direct incentives to distributors and retailers will encourage them to keep these newer and more efficient products in stock, rather than having them as special-order items.

[74] VEIC. 2022. *Comments to the Maryland Public Service Commission on EmPOWER Semi-Annual Reports for Q3-Q4 2022*. Prepared for the Office of the People's Counsel. ML#302522.
[75] Ibid.

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 via wholesale distributors, rather than an end-use customer rebate.[76] 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.[77]

Q. What is your concern about BGE's non-road electrification program proposal?

A. BGE's non-road electrification program is a very novel program that provides financial incentives to various types of industrial equipment and machines. These include forklifts; golf carts; welders; belt loaders; machinery for pressing, cutting, and folding; injection molding machines; refrigerated rail cars; robots; and ovens.[78] BGE stated that to develop incentives, it relied on incentive benchmarks from utility programs offered by JEA, Salt River Project, Entergy, and CenterPoint Energy and by comparing cost estimates from a few different sources such as manufacturer and dealer interviews. I reviewed these utility incentive programs but was

[76] Nadel, Steven. *Programs to Electrify Space Heating in Homes and Buildings.* ACEEE Topic Brief. June 2020. Available at: https://www.aceee.org/sites/default/files/pdfs/programs_to_electrify_space_heating_brief_final_6-23-20.pdf
[77] Levin, E. 2018. Driving the Heat Pump Market: Lessons Learned from the Northeast. Winooski: VEIC (Vermont Energy Investment Corporation). www.veic.org/clientsresults/reports/driving-the-heat-pump-market-lessons-learned-from-the-northeast.
[78] Exhibit MDC-5, page 10.

not able to find any additional measure information such as market evaluation studies or cost-effectiveness results about the programs offered by the four utilities. I am also not aware of any other utilities that offer electrification incentives for C&I machines. More importantly, I found that BGE has not conducted any market study and does not have any data about the current share of the measures BGE would be promoting under the proposed program.[79] Without such data, I cannot assess how much these measures should be promoted and the level of incentives that should be provided. There may be some measures that may not need any incentives because customers may be already choosing electric machines over fossil-fuel-based machines. Such measures would have a very high number of free riders under BGE's program.

Q. What is your recommendation for the non-road electrification program?

A. I recommend that that the Commission not allow BGE to implement the non-road electrification program proposal entirely (about $6.6 million) because BGE has not provided sufficient evidence to justify the proposed spending.

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?

[79] BGE's response to OPCDR14-06.

A. Yes. BGE has conducted a detailed cost-effectiveness analysis on its proposed building and non-road electrification programs. This is a good start, but we should not take the results of the cost-effectiveness analysis at face value for electrification programs at this point, for a number of reasons. First, electrification programs should be implemented in EmPOWER Maryland and I expect that program designs for such programs will be different from what BGE is proposing in this filing. This means that cost-effectiveness results could be very different for those future programs. Second, there are many issues that need to be addressed before implementing the programs, including how to conduct cost-effectiveness tests on electrification programs; what benefits and costs should be used; and what the appropriate level of benefits and costs are.

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

A. My recommendations on BGE's proposed building and non-road electrification programs include the following:

- The Commission should deny approval of BGE's proposed electrification programs in the MYP.

- If BGE wishes to pursue its electrification programs, the Commission should direct BGE to propose its building and non-road electrification

programs within the EmPOWER program instead of in this proceeding.

- The Commission should investigate key policy and program implementation issues concerning electrification programs in in the EmPOWER docket or another policy docket. Among other things, the Commission should investigate program designs, the role of the utilities and other entities, performance incentives, cost-effectiveness analysis framework, goal setting, cost recovery, customer equity and bill impacts, federal incentives, and gas planning.

If the Commission decides to approve BGE's electrification program proposal, or if BGE seeks approval for its electrification programs within EmPOWER later, I recommend that the Commission direct BGE to modify some aspects of the proposed programs as follows:

- Remove the requirement to retain gas backup in the Company's building electrification programs;

- Increase the number of participants for residential ASHP, GSHP, HPWH, and make-ready investments (e.g., panel upgrades) using the additional funding that would be freed up by reducing measure incentive levels;

- Conduct a state-specific survey on the costs of building electrification measures—either individually or jointly with other utilities—in order to set appropriate amounts for electrification incentives;
- Offer electrification incentives through a midstream incentive approach instead of a conventional downstream incentive approach;
- Remove the non-road electrification program proposal entirely (approximately $6.6 million); and
- Conduct a market characterization study on C&I non-road measures.

Finally, I recommend that the Commission establish guidance on customer incentive-setting for electrification measures and require BGE to use the guidance to set incentives and develop the total budget for customer incentives. Ideally, such guidance should be developed through a stakeholder process, but I offer the following minimum recommendations: for low-income and moderate-income customers, the total customer incentives that comprise federal rebates, federal tax credits and utility incentives should not exceed 100 percent of the total installed costs of measures. For the rest of the customers, the total incentives should not exceed 100 percent of the total incremental costs of electrification measures (e.g., the cost difference between a heat pump and a gas furnace).

Q. Does this conclude your testimony?

A. Yes.