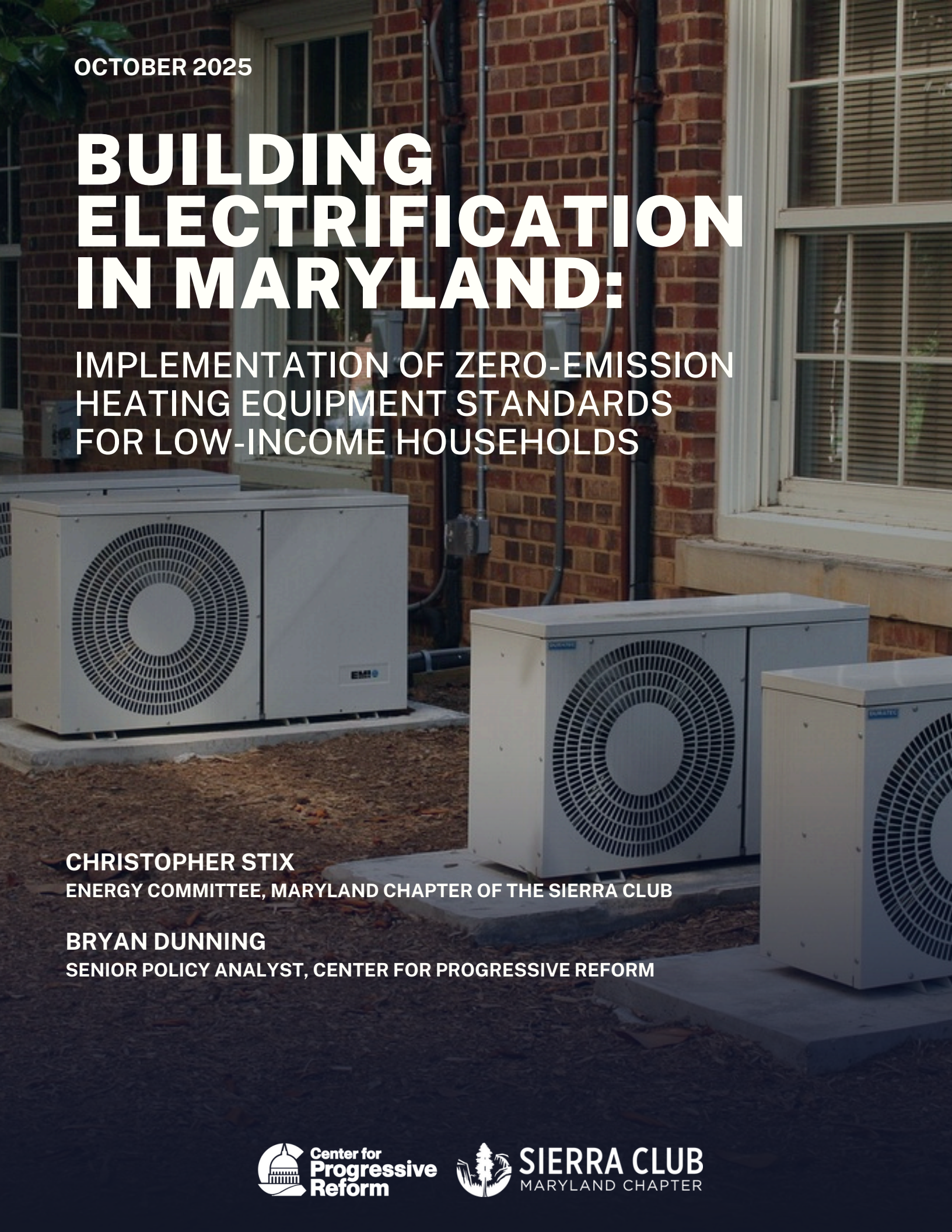

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BUILDING ELECTRIFICATION IN MARYLAND:

IMPLEMENTATION OF ZERO-EMISSION HEATING EQUIPMENT STANDARDS FOR LOW-INCOME HOUSEHOLDS

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Building Electrification in Maryland:
Implementation of Zero-Emission Heating Equipment Standards for Low-Income Households

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About the Sierra Club Maryland Chapter

The Sierra Club Maryland Chapter is a grassroots environmental organization working for the protection of Maryland's land, air, and water, as well as a just and equitable transition from dirty fossil fuels to a clean energy future for all. Guided by the Sierra Club's motto "explore, enjoy, protect," the chapter staff and volunteers focus on connecting people to nature through

outings and educational offerings and actively work with partners across the state to advocate for clean transportation, clean energy, waste and plastic pollution reduction, and nature conservation. The Maryland Chapter has over 70,000 members and supporters.

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The Center for Progressive Reform is a nonprofit research and advocacy organization that conducts independent scholarly research and policy analysis and advocates for effective, collective solutions to our most pressing societal challenges. Guided by a national network of scholars and professional staff with expertise in governance and regulation, we convene policymakers and advocates to shape legislative and agency policy at the state and federal levels and advance the broad interests of today's social movements for the environment, democracy, and racial justice and equity.

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Executive Summary

Executive Summary

Maryland has committed to an equitable approach to achieving its ambitious climate goals while minimizing harms or costs placed on historically disadvantaged communities. One of the programs critical to achieving the state's climate and energy goals as mandated under the Climate Solutions Now Act of 2022 is zero-emission heating equipment standards (ZEHES). Equitable implementation of ZEHES requires low-income households to be able to fully benefit from clean, efficient heating under the program.

As fossil fuel-burning heating equipment nears the end of its life and needs replacement, ZEHES will require property owners to replace this equipment with non-emitting equipment (with some exceptions for large boilers and furnaces). For low-income (LI) Marylanders, this will require 14,000 space heating units and up to 22,000 water heaters to be replaced with heat pumps each year.[i] LI households will need significant support to cover the cost of these replacements, which are significantly higher than the cost of fossil fuel equipment. This report addresses the costs and the benefits of installing heat pumps and how to successfully and equitably deliver ZEHES to LI households in Maryland.

ZEHES is projected to require replacements starting in 2029 and will require yearly replacements until all eligible building and water heating systems have been replaced. Based on the expected lifespan of legacy fossil fuel systems, water heating replacement should be achieved (in whole or substantial part) by 2039, and building heating replacement by 2059 for a ZEHES policy with the effective year of 2029. In the context of replacements for LI households, modeling projects a yearly total cost of close to $300 million, with an additional cost, depending on implementation policy, of an additional $80 million for building weatherization.[ii]

In the absence of ZEHES, building owners would still be required to pay the costs of replacing their equipment at the end of its life. As such, costs of a ZEHES program are best evaluated by the incremental cost of replacement — that is, the price difference between a heat pump system and the legacy system replaced. For LI households, the model projects this to be an annual cost of approximately $185 million.

[i] RMI Model based on ResStock 2024.2.

[ii] This $80 million for weatherization does not include projected home repair costs that are necessary to prepare the home for weatherization.

The ZEHES program will drive substantial cost savings for Marylanders. These savings expand per household and compound over time, reaching approximately $350 million in energy cost savings per year (in 2024 dollars) by 2050 for LI households. If weatherization is included in ZEHES implementation, it would add $45 million per year in energy cost savings. The estimated health benefits from cleaner air represent an additional $145 million per year across the state to LI households.[iii] The investment in heat pumps for LI families will also reduce statewide greenhouse gas emissions by over 1 million tons per year by 2050. This is a good investment for Maryland.

The benefits from ZEHES will start with the installation of heat pumps, starting in 2029, and at the household level will increase over time as utility and gas prices increase. Although in the vast majority of cases heat pumps will represent good investments, for LI residents to get the benefits of ZEHES, it will be necessary for the state to help address the upfront costs.

Today, we can no longer count on material federal support, and the State of Maryland faces significant fiscal challenges. In planning for ZEHES implementation, it is therefore necessary to ensure funds to support LI households are available. These should be dedicated funds and will likely have to come from sources outside of the general Maryland budget. We see four sources that could provide the funds:

1. The Strategic Energy Investment Fund (SEIF) receives payments from the Regional Greenhouse Gas Initiative (RGGI) and alternative compliance payments (ACPs) from utilities that fail to procure sufficient clean energy. In fiscal 2024, the fund reached $561 million, a record[1]. While much of the SEIF is dedicated to LI utility bill support and clean energy development, significant funds in the 2025 legislative session were diverted to the general budget and to rebates on electric bills for each Maryland resident, regardless of income. While we appreciate the challenging budget situation, the SEIF funds are essential for achieving Maryland's energy and climate goals, and diverting those funds from the purpose of the SEIF statute is a dangerous precedent. These funds would be best invested in projects such as electrification that would lead to lower long-term costs and a healthier environment for Marylanders.

[iii] Health savings are based on models for outside air quality improvements resulting from ZEHES implementation. Additional research is necessary to estimate health benefits and attendant savings for individuals. However, it is extremely likely that total health savings from ZEHES are underestimated by the $145 million figure provided here.

2. Maryland's EmPOWER program uses ratepayer funds to support energy efficiency and greenhouse gas reduction. Currently, the program achieves its goals, but its allocation of expenditures is not equitable. Only 22 percent of residential funding goes to low-income customers. To be equitable, the LI allocation should be 40 percent. This could provide significant funding for LI electrification. By allocating these funds to LI ratepayers, EmPOWER can deliver lower electric bills through electrification without raising the EmPOWER surcharge.

3. A clean heat standard (CHS), currently being developed by MDE, would require gas and delivered fuel providers to buildings to invest in actions that reduce greenhouse gases from fuels burned in buildings. This would result in lower emissions and provide funding for investments in electrification. This could be a significant source of funds and drive market transformation when implemented later this decade.

4. Low- to zero-interest financing through green banks and other programs also could be a measurable source of funds. Issuing bonds backed by the state could also provide funding for ZEHES without impacting the general budget.

This report makes a number of policy recommendations aimed at lowering the upfront costs of ZEHES implementation for low-income families, maximizing energy cost savings, and driving community trust and engagement with state ZEHES programs. These recommendations include:

- Supporting the evaluation of novel technologies, such as low-cost window heat pumps and pathways to implement adoption of effective new technologies into existing programs.

- Increasing the number of skilled HVAC and water heater contractors to reduce costs through competition and increase program satisfaction.

- Evaluating heat pump rate design to increase savings.

- Running a pilot project focused on installing heat pumps first. Modelling suggests that most of the energy savings comes from installing heat pumps, with a much smaller portion from weatherization. If confirmed through a pilot project, this would be a pathway to ensure that sufficient resources are available for equitable ZEHES implementation.

- Building capacity for ZEHES implementation. As we approach the 2029 implementation date of ZEHES, the state needs to work to build implementation capacity. During this period, investing in heat pumps to replace electric resistance heating, electric tanked hot water heating, and delivered fuel heating will be particularly attractive to build agency capacity and drive market transformation. SEIF funds and unused EmPOWER funds can finance these efforts.

- Expanding community engagement and developing protections for renters will serve to greatly enhance the equity, quality, and success of ZEHES implementation in 2029.

Introduction

Introduction

As part of Maryland's carbon reduction goals enshrined in the Climate Solutions Now Act (CSNA) of 2022, the state must reduce greenhouse gas (GHG) emissions by 60 percent of 2006 levels by 2031 and achieve net-zero emissions by 2045. Although CSNA does not specify precisely where these emission reductions must come from, it does direct agencies in Maryland to consider implementation of CSNA in their planning and directs the Maryland Department of the Environment (MDE) to create a climate pollution reduction plan.[2] The plan, released the following year and entitled *Maryland's Climate Pollution Reduction Plan*,[3] recommends investment in clean energy generation, energy efficiency, and transitioning new and existing buildings in the state from using methane gas, propane, or fuel oil to 100 percent electric air and water heating.[4]

Modernizing buildings with clean, energy efficient heating is critical to the success of achieving CSNA's reduction targets. The buildings sector accounted for approximately 16 percent[5] of state emissions.[iv] [6] MDE indicated in its climate pollution reduction plan that implementation of zero-emission heating equipment standards (ZEHES) in 2029 would achieve substantial GHG reductions.[7] ZEHES is a critical policy to reduce GHG reductions in buildings; beyond the ecological, benefits at the point of use include lower bills and reduced exposure to toxins and particulate matter.[8]

Maryland Governor Wes Moore further directed MDE, through an executive order in June 2024, to propose rules for both ZEHES and a clean heat standard (CHS).[9] MDE has solicited public comment related to ZEHES, as well as established working groups on both subjects, though promulgation of a proposed rule and the administrative requirements of rulemaking have yet to commence.

Successful equitable implementation of ZEHES will require addressing numerous issues in program design and funding. Equitable implementation of ZEHES requires low-income (LI)[v] households to be able to fully benefit from clean, efficient heating under the program.

One threshold issue is the cost of electrification in Maryland for single-family and multifamily homes subject to ZEHES. Evaluation of costs is crucial to highlighting where dedicated funding (either direct incentives or financing) will be necessary, and such funding will be particularly important for LI households to achieve ZEHES

[iv] This does not include the upstream emissions associated with producing and transporting fossil fuels used for heating in the buildings sector.
[v] 80% Area Median Income or lower.

equitably. In addition to the costs, a successful ZEHES program and funding design will need to evaluate potential savings over the life of installed equipment to assess the overall financial impact on residents and building owners.

To estimate costs and savings, the authors of this paper have worked with RMI. RMI created a model that estimates total and incremental costs, as well as modeled energy and GHG savings for buildings subject to ZEHES through 2050. Based on the outputs of the model, and following consultation with Maryland stakeholders, this report presents an initial evaluation of the costs and savings from ZEHES, as well as highlighting potential challenges to implementation. In assessing these challenges, the report presents pathways to secure the necessary financing and actions for reducing costs and improving stakeholder satisfaction with replacements under ZEHES.

Considerations and Limitations of the Model

The model is constructed in-line with the model rule promulgated by Northeast States for Coordinated Air Use Management (NESCAUM).[vi] [10] As this analysis is based on the NESCAUM model rule, it is possible that the total cost of the ZEHES program in Maryland could shift depending on how Maryland modifies and implements the model rule. All data points discussed in this report, unless specifically indicated as otherwise, are derived from the modeling.

Introduction to ZEHES

ZEHES contemplates the replacement of fossil fuel heating equipment — furnaces, boilers, and water heating equipment — as they approach the end of their useful life with non-emitting alternatives. The replacements are expected to be heat pumps (ASHP) and heat pump water heaters (HPWH). Currently, replacement is expected to begin in 2029 and continue through the 2050s.

Not all buildings will be covered by ZEHES. Large buildings (defined in the model as containing five or more units in the building) where individual units in the building do not have their own heating system are exempt, and as such, not considered in the model.[vii] This represents approximately 14 percent of LI residential households in the state that burn fossil fuels for heating.[11] ZEHES also does not impact housing that is

[vi] MDE has used the NESCAUM model rule as the starting point for the state's ZEHES program. Maryland is one of nine states that signed an MOU for the NESCAUM approach.

[vii] Five-unit buildings are a proxy for the model rule's exemption for furnaces that consume more than 225,000-300,000 BTUs of fossil fuels per hour.

currently utilizing electricity for heating. In practice, this means approximately 50 percent of LI residential households are not covered for space heating and 61 percent are not covered for water heating. When these electric-heated buildings replace their space and water heating, they will need to install zero-emissions equipment.[viii] Maryland buildings covered by Building Energy Performance Standards (BEPS),[ix] which represent about 4 percent of LI households, will also need to comply with ZEHES.

Primary outputs of the model

The design of the model is based on the scope of ZEHES implementation as described in the paragraphs above. As such, the data outputs discussed in this report are reflective of the costs and savings of ZEHES as currently contemplated under the model rule and based on current Maryland law and regulations. However, there are a number of actions that the state of Maryland can take that would result in lower upfront costs for electric replacements, maximized energy savings to residents, or both. Such policies are discussed in this report, but it is important to keep in mind that adoption of such policies will change the cost and saving estimates generated by the model.

[viii] Although beyond the scope of this report, ZEHES will impact other decarbonization policies currently active or contemplated in Maryland.

[ix] Covered buildings over 35,000 square feet (25,000 square feet in Montgomery County), which will be required to meet successively more stringent energy standards over time.

Model Outputs and Findings

Model Outputs and Findings

Replacements

Projected numbers of replacements for existing emitting heating systems are evaluated year over year between 2029 and 2050. The timing for when a replacement must occur is based on the life expectancy of water heaters (10 years), furnaces (25 years), air conditioners (15 years),[x] and boilers (30 years). The number of yearly replacements in the state of Maryland is drawn from the ResStock database created by the National Renewable Energy Laboratory. In these projections, the number of necessary replacements is broken out by:

- *fuel source* — either methane gas, propane, or fuel oil[xi]
- *housing type* — single-family or multifamily (subject to the five-unit limitation)
- *ownership* — owned or rented
- *income* — LI or non-LI
- *design* — furnace or boiler, tank or tankless

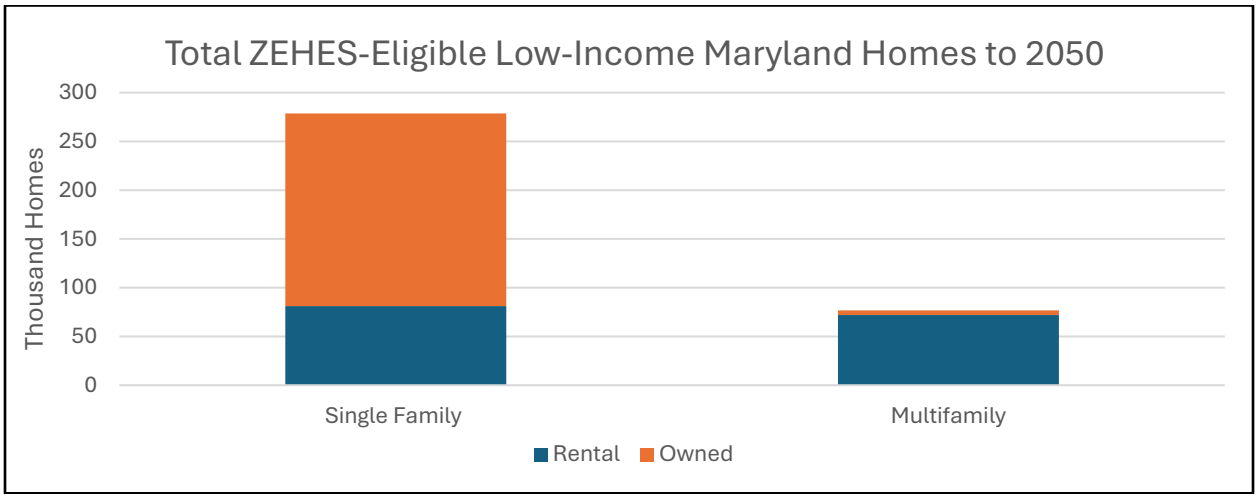
Starting in 2029, the total number of all ZEHES mandated replacements is 45,481 ASHPs and 73,655 HPWHs per year. Comparatively, for LI homes, only 13,967 ASHPs and 21,605 HPWHs will require replacement per year starting in 2029.[xii] A breakdown of yearly replacements within this LI subgroup is included as Table 1, and total replacements required over the life of the ZEHES program for LI is included as Chart 1.

[x] Although air conditioners are not covered by ZEHES, this report has included both life expectancy and costs as they represent replacement costs that are avoided by installing heat pumps.
[xi] The analysis of propane was performed on the ResStock 2024 versions separately from the work by RMI. This analysis excludes shared propane heating, manufactured homes, and multifamily propane due to lack of data on heating equipment or small sample sizes.
[xii] Households that did not report income (approximately 10% of households) were excluded from the analysis. While the number of multifamily units covered by ZEHES appears to be low for Maryland, multifamily units with shared heating, units with electric heat, and units with existing heat pumps are not covered by ZEHES.

Table 1. Required Yearly Installations Under ZEHES

Required Yearly Installations Under ZEHES		
Building and Equipment Types	**ASHP**	**HPHW**
ALL	45,481	73,655
LI Only	13,967	21,605
LI Single Family	10,946	16,593
LI Single Family (owned)	7,753	11,909
LI Single Family (rental)	3,193	4,684
LI Multifamily	3,021	5,012
LI Multifamily (owned)	190	328
LI Multifamily (rental)	2,831	4,684

Chart 1. Total ZEHES-Eligible Low-Income Maryland Homes to 2050



Upfront costs

The costs for ASHP, HPWH, and traditional fossil fuel home and water heating equipment used in the model are assessed based on national quotes from contractors and validated for Maryland by a select set of interviews and review of other published sources. Upfront costs vary depending on the factors established in the building and

fuel types, as well as the age of the house. The costs presented in this report reflect the mean cost based on the data points utilized in the model. All figures in this document are reported in 2024 dollars.

Cost analysis is conducted to assess the total costs for electrification, as well as incremental costs comparing the incremental difference in cost between heat pumps and traditional fossil fuel systems.[xiii] The costs are broken out based on the following metrics:

- Equipment costs,[xiv] installation costs, and panel upgrade costs for ASHPs, HPWHs, and legacy fossil fuel systems
- Weatherization costs to be incurred while conducting upgrades during space heating replacement
- Avoided air conditioning costs during space heating replacement[xv]

The average upfront costs for ASHP in 2029 in Maryland are $22,808, with an incremental cost of $17,197 (including panel upgrades, weatherization, and first year's avoided AC costs). Comparatively, the same costs for ASHP in 2029 for LI homes in Maryland are $21,341, with an incremental cost of $15,970. Charts 2 and 3 below demonstrate the projected upfront costs for LI households by fuel source for building and water heating units. Weatherization is included with ASHPs, as it is broadly bundled with Maryland's existing energy efficiency and electrification programs and required by statute under Maryland's EmPOWER program.[12]

[xiii] Traditional fossil fuel heating equipment is modeled based on legacy furnaces, boilers, and hot water systems, not newer high-efficiency systems. Functionally, an incremental comparison between heat pump electric systems and high-efficiency fossil fuel systems would reflect a lower incremental cost as high-efficiency fossil fuel systems are more expensive.

[xiv] Modeled equipment costs are based on standard-efficiency heat pumps with electric resistance backup - 7.8 HSPF2, and 16 SEER2 models, and 3.7 EUF models for HPWHs. Further details are included in the assumptions section included in appendix to this report.

[xv] Because a heat pump provides both heating and air conditioning, installation of a heat pump will eventually lead to avoiding air conditioner replacement costs. In the absence of the heat pump installation, air conditioning would not be replaced at the same time as heating is replaced. Therefore, for air conditioners, which are modeled to last 15 years, avoided air conditioning costs are modeled at 1/15th of the avoided cost each year through the 15th year.

Chart 2. Low-Income Cost Per Home for Heat Pump

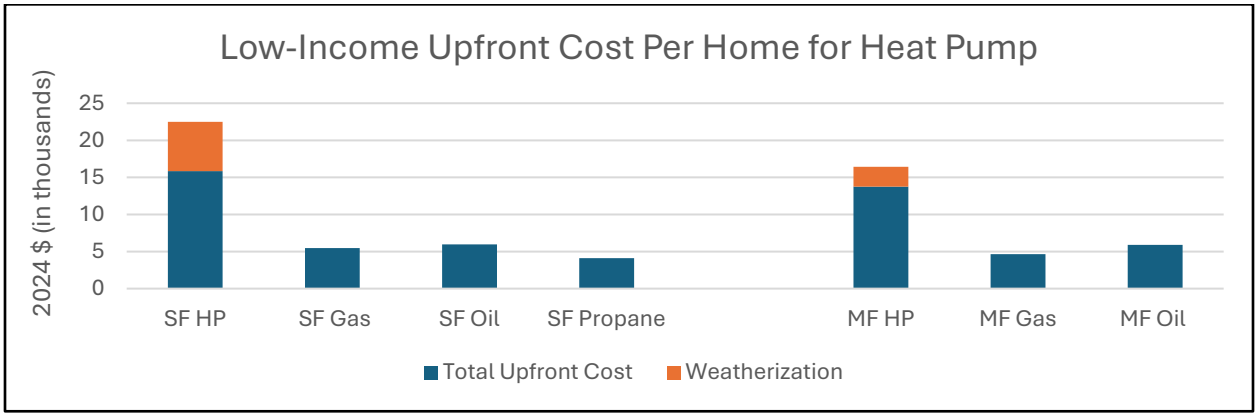
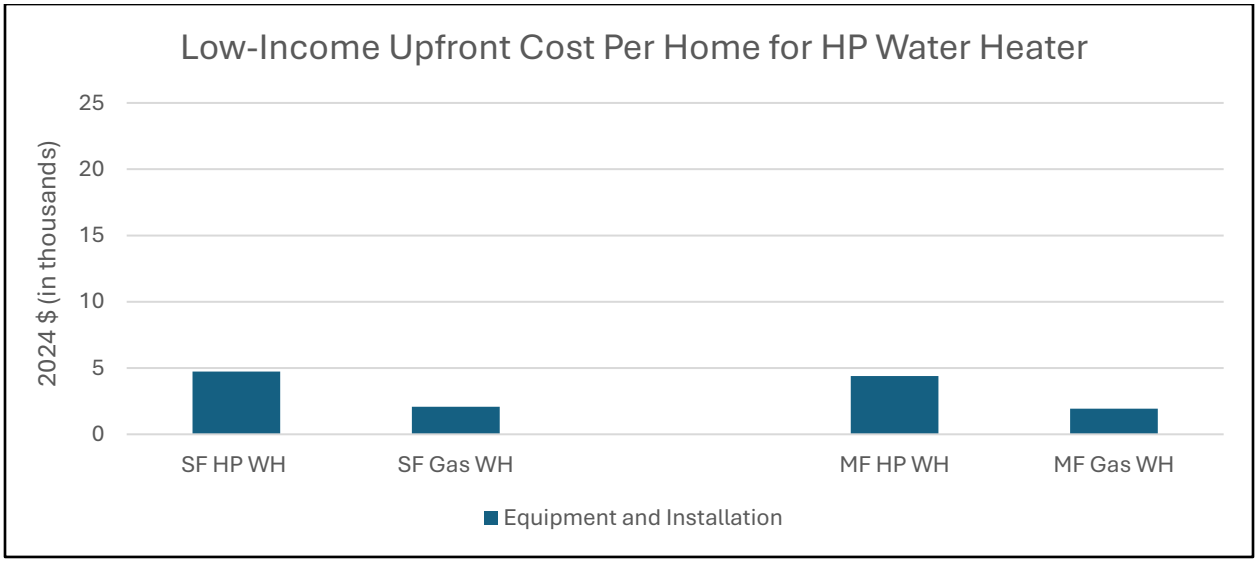


Chart 3. Low-Income Upfront Cost Per Home for HP Water Heater



The combination of costs for electric heat pump infrastructure is greater than that of legacy fossil fuel equipment.[xvi] In evaluating the cost to individuals who will be making replacements under ZEHES, it is important to evaluate these costs on an incremental basis — the difference between the cost of a like-kind replacement and a heat pump. In addition to the upfront costs, weatherization, often conducted in line with a system replacement under DHCD and other Maryland agency electrification and efficiency

[xvi] In this report, we focus on the comparative costs between heat pumps and "like kind" fossil fuel equipment, which represent legacy fossil fuel systems rather than newer efficiency models. As the structure of the ZEHES program is to achieve replacements without onsite combustion, the cost comparison focuses on what is reasonably expected to be replaced under the ZEHES program.

programs, are typically accrued at the time of space heating replacement. Although weatherization is *not* mandated by ZEHES, this report evaluates the costs of weatherization to account for the likely financial implications of replacements supported by Maryland agencies. Weatherization adds a significant upfront cost and increases total costs by roughly 27 percent. Table 2 contains data about the yearly costs (for year 2029) of ZEHES adoption.

Table 2. LI Upfront Costs and Incremental Costs in 2029[13] [xvii]

LI Upfront Costs and Incremental Costs in 2029 (in millions of 2024 dollars)			
	Heat Pump	**Fossil Fuel**	**Incremental**
Building Heating Equipment and Installation	$201	$74	$127
WH Equipment and Installation	$88	$39	$49
Panel Upgrade	$14		$14
AC Avoided (First Year)	$(6)		$(6)
Total	**$297**	**$113**	**$184**
Weatherization	$80	$ -	$80
Total with Weatherization	**$377**	**$113**	**$264**

Other estimates of the upfront costs of low-income electrification

The Green and Healthy Task Force estimated the cost of electrification and necessary home repairs in a December 2024 report to the governor and legislature. In order to complete energy efficiency and electrification work by 2032, they estimated that almost 88,319 homes would need efficiency and repairs per year starting in 2027 at a cost of $16,800 (multifamily) to $30,000 per home (single-family). The total cost including repairs would be nearly $7.9 billion in 2024 dollars ($4.6 billion excluding repairs). The

[xvii] 91% of households are estimated to require weatherization based on building codes, which only required R30 before 2012 and vintage of Maryland low-income housing stock from ResStock 2020.

per-home costs for electrification are not inconsistent with the estimate in this report, though the pace of investment would be much faster.[14]

Energy, health, and greenhouse gas savings

We evaluated modeled energy savings by comparing projected yearly energy costs for heat pump systems relative to energy costs for legacy emitting systems. Energy savings reflect the efficiency standards for standard-efficiency heat pumps and energy delivery (largely commodity and distribution/transmission) costs. Energy costs are analyzed based on Maryland forecasts for electricity, gas, propane, and oil prices.[xviii] Additional energy savings also are modeled based on projected disconnections from gas service delivery. Details of electricity and gas cost modeling are included as an appendix to this report.

Economy-wide savings

The model estimates social health savings based on a report conducted by Rewiring America.[15] The savings are based on reduction of excess morbidity and mortality from *outdoor* exposures to fossil fuel from residential use. Projected health savings begin at $10 million in 2029 and reflect $9 to 10 million of additional savings year over year until implementation is largely completed by 2043 — bringing the cumulative health savings for the state to $145 million from LI ZEHES implementation. This represents savings of close to $1,000 per year per home.

Savings from energy costs, weatherization, and health are included in Chart 4. As health savings, again, are socialized savings based on outdoor exposure, it is likely that additional individualized health savings will result from removing in-home emission sources, but additional research is required to assess these savings.

Projected savings for avoided GHG emissions are made with the assumption that electric replacements are powered by electric generation on track with Maryland's RPS and its current clean energy path. The projected GHG emissions savings of more than 800,000 tons per year from LI homes reflect $311 million in annual savings[xix] [16] from LI ZEHES implementation. Savings from GHG reductions are captured in Chart 5.

[xviii] Electricity (after 2029), propane, and oil prices are based on a 10-year average annual percentage increase in residential prices.

[xix] In 2024 dollars, based on EPA's December 2023 average of 2040 and 2050 social cost of carbon at a 2% discount rate.

Although both the health and GHG savings are *social* costs in the state of Maryland, ZEHES represents significant savings to the state's medical system, demonstrates clear alignment with state goals under CSNA, and will broadly improve the well-being of residents across the state. Further, the total annualized socialized savings from ZEHES from LI implementation will exceed the upfront costs of the program by the 2040s.

Chart 4. Annual Energy, Weatherization, & Health Savings

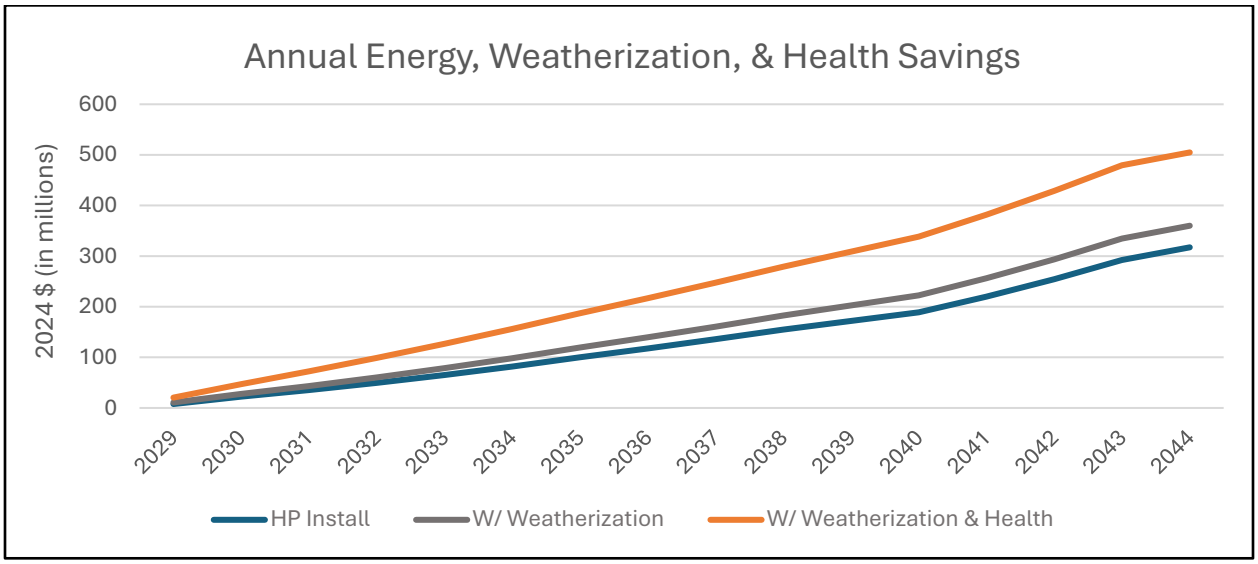
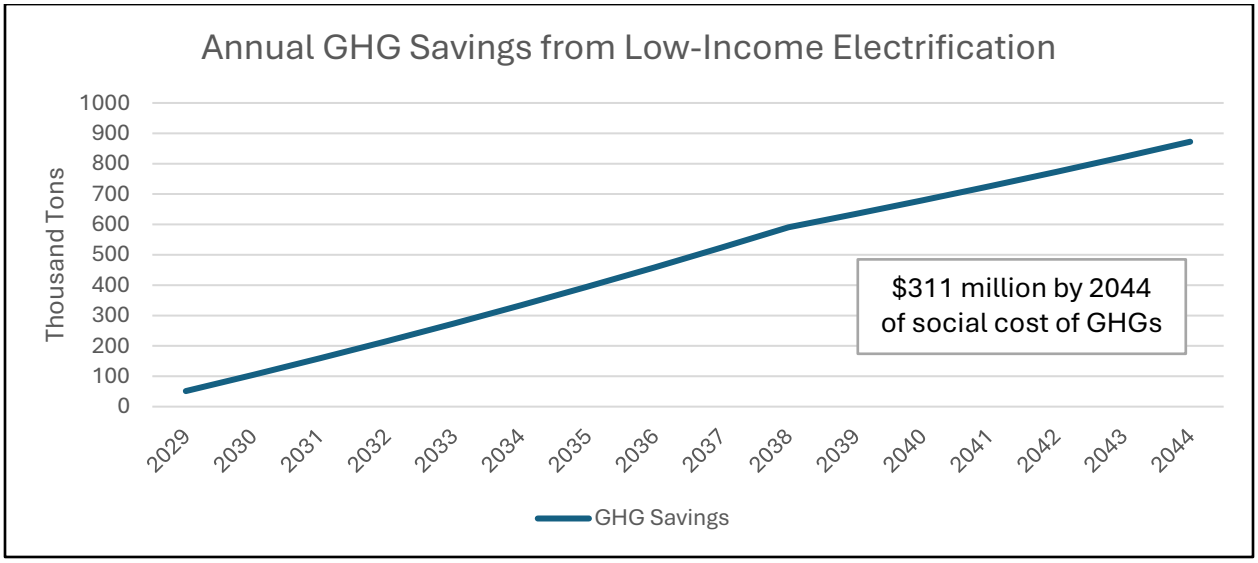


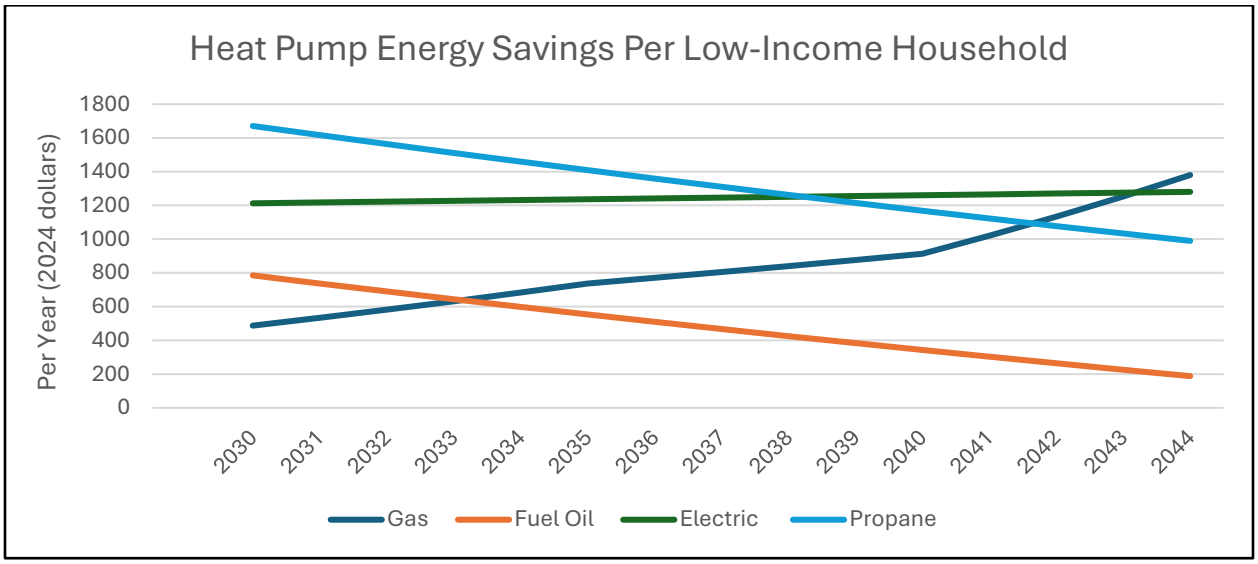
Chart 5. Annual GHG Savings from Low-Income Electrification



When switching to ASHP and HPWH, the source one switches *from* makes a difference in savings. Shifting to a heat pump from electric resistance, propane, and oil fuel sources, for example, results in significant initial energy savings. Comparatively, the savings from switching from gas systems are initially insignificant to modest until the mid-2030s, reflecting rough initial parity in gas and electric costs through the early 2030s. As gas utilities replace pipelines and services, distribution costs for gas will rise and switching to heat pumps generates greater energy savings. This is discussed, alongside projected electricity costs, in greater detail in the appendix.

Although ZEHES will not mandate replacement of electric resistance systems, the model includes analysis of the costs and savings for replacements of these systems. Switching to HPs from resistance has substantial energy savings for LI residents, which disproportionately use electric resistance heat and hot water heating. Shifting to HPs in these instances will have the equity benefit of reducing energy burden in the state, and will, if achieved in the lead up to 2029, facilitate the implementation of ZEHES. Energy savings from heat pumps by fuel source replaced are detailed in Chart 6.

Chart 6. Heat Pump Energy Savings Per Low-Income Household



Finally, when implementing ZEHES in a resource-constrained environment, evaluating the payback periods for heat pump investments has the potential to enable a more rapid transition. Table 3 shows the payback periods for transitioning from heating fuels for both space heating and water heating.

Table 3. Years to Pay Back Incremental Investment in Heat Pump from Life Cycle Energy Savings

Years to Pay Back Incremental Investment in Heat Pump from Lifecycle Energy Savings			
Prior Heating	**Start in 2025**	**Start in 2030**	**Start in 2035**
Methane Gas Space Heater	17	13	10
Fuel Oil Space Heater	17	nmf	nmf
Propane Space Heater	7	7	8
Electric Resistance	7	4	4
Electric Water Heater	3	3	4
Gas Water Heater	18	14	11

Modeled incentives

The model projects the cost of ZEHES for LI customers will amount to $297 million in total upfront costs, or $377 million total upfront per year (Table 2), including weatherization. Funding for ZEHES implementation will be required by the state, whether in the form of incentives or financing options. This will be especially necessary to support LI residents replacing their equipment under ZEHES. The model does not currently project incentives or financing within its cost estimates, a deliberate choice in report design given high levels of uncertainty regarding funding availability in 2029.

These uncertainties are extremely significant at the federal level, where funding from agencies has been cancelled or withheld. It is unclear what, if any, federal funding will be reliably available in 2029.[xx] [17] Further, although Maryland has state-driven funding sources — most notably the EmPOWER program and the SEIF — and is projected to

[xx] Currently, the state has been awarded ~$137 million for incentives from IRA Home Energy Rebates: the Home Electrification and Appliance Rebates (HEARA) program and the Home Efficiency Rebates Opportunity Program (HOMES), which focus on fuel switching from fossil fuels to electrification and whole-home efficiency upgrades that will reduce energy use by at least 20%. These programs will be IRA funded, *assuming* the state ultimately receives this funding from its 2024 application. As of this date, although the state has received conditional approval from the federal Department of Energy, it is unclear if, or how much, of the funding will be disbursed for the programs. In any case, this money will be exhausted by 2029 when ZEHES goes into effect, and it is not currently likely that such funds will be reestablished by 2029 under the current administration.

adopt a CHS prior to the start date of ZEHES implementation, it is difficult to project the exact amount of funding that will be available from these sources. The remainder of this report discusses potential sources of these needed funds, as well as ways to reduce the required resources needed for ZEHES implementation through either reducing upfront costs or improving energy savings.

Landscape of Funding and Financial Support

Landscape of Funding and Financial Support

Funding

In order to achieve an equitable transition to electrification in Maryland through ZEHES, the upfront costs must be addressed, and both incentives and financing will be required.

For homes where energy cost savings are sufficient to pay back the incremental cost of electrification over the lifespan of the replacement equipment, financing can meet the upfront cost of replacement. Financing will be particularly important for rental housing, where the owner of the property may be able to take on debt.

Comparatively, for replacements in LI homes, although financing may be beneficial in certain circumstances, direct incentive programs will be necessary to achieve an equitable rollout. Incentives should be at least the incremental cost of replacement and may need to reflect the full cost — either with or without weatherization.

Sources of funding

There are a number of existing and potential funding sources within the state of Maryland that currently flow, at least in part, toward building efficiency and electrification. These include the Maryland EmPOWER program, the SEIF, the proposed CHS program, and financing, mostly currently handled through the Montgomery County Green Bank, the Maryland Clean Energy Center (MCEC), and the DHCD BeSmart program. These funding mechanisms are distinct from the Maryland General Fund — although they are not all restricted funds — and monies from the SEIF have been used to address general fund shortfalls and to finance legislative programs outside of allocating general fund monies. There are other, albeit smaller, funding streams, as well, that support electrification and energy efficiency; the most recent Green and Healthy Task Force Report details these other sources in detail as of December 2024.[18]

Although it is beyond the scope of this report, the Maryland Commission on Climate Change has been recommending a number of potential funding options to meet its climate targets under CSNA, such as a cap-and-invest program or polluters pay programs. Although such initiatives would benefit ZEHES implementation, no legislation has moved on these initiatives as of writing.

SEIF

The SEIF could be a powerful tool to achieve ZEHES implementation. In its 2023 climate pollution reduction plan, MDE specifically highlighted SEIF funding as a necessity for achieving building decarbonization.[19] Currently, the SEIF is the largest of the four enumerated funding streams, receiving $561 million, largely from two sources: RGGI auctions[xxi] ($214 million), and ACPs[xxii] made by utilities ($318 million). Of the $318 million in ACPs, $262 million were Tier 1, non-solar, which tend to be more flexible than other sources of SEIF funding. Notably, the amount of SEIF funds generated by ACPs was substantially higher than in prior years, predominantly from non-solar ACP payments; historically, proceeds from the RGGI auction are the main source of SEIF funds.[20]

The SEIF received $265 million more in 2024 than it spent from those funds during fiscal year 2025. Funds within the SEIF are allocated to programs based on their funding source. The SEIF, under law,[21] mandates investments in specific programs, which often makes the SEIF inflexible in application.

Although the SEIF is designed to support clean energy build out, energy efficiency, and other climate-change related programs, its funds can be re-allocated by legislative action. For example, for the 2026 budget year, the legislature directed a significant portion of the excess funds to provide ratepayers with rebates and to lower the state's budget deficit. Absent protections, it is entirely plausible that this critical source of funding will not be used for its intended purpose. Although SEIF payments could provide significant funds for LI ZEHES implementation (potentially more than $100 million annually), it is important to keep in mind that the funds from this source will be volatile. For instance, the Tier 1 ACP price is due to drop 19 percent from 2024 to 2030, reiterating the need to allocate both ACP and RGGI SEIF funding sources for ZEHES.

Currently, although some funds from RGGI flow to electrification, this is limited to a maximum of 20 percent of the funds. It is also subject to justification by cost-benefit analysis[22] that limits the ability of the Maryland Energy Administration (MEA) to maximize its engagement in electrification. However, MEA has recommended that existing statutes be changed so that SEIF funding may be directed to electrification under CSNA.[23] Legislation was proposed to address this issue, though it did not make it out of committee, and it may be a legislative priority in FY 2026 to maximize the

[xxi] An interstate agreement in which generators bid on carbon allowances.

[xxii] Funds from utilities that were unable to procure sufficient clean generation as laid out by the Renewable Energy Portfolio Standard.

functionality of the SEIF.[24] Additionally, non-solar ACP funds in the SEIF can be used, subject to certain restrictions, and while the non-solar ACP funds are volatile, they are currently substantial. Directing these toward heat pump installation for delivered fuels and electric resistance homes will serve to build substantial capacity for implementation of ZEHES in 2029.

EmPOWER

EmPOWER is a program funded by ratepayers and operated by each of the large Maryland utilities and DHCD that provides incentives for energy efficiency and electrification. Maryland's program has been successfully delivering nation-leading results; the low-income program is now increasingly focused on delivering clean, efficient heating equipment. The ZEHES model in this report does not include current state EmPOWER incentives because there will be changes to the program in each three-year EmPOWER cycle.[xxiii] However, it will be critical that DHCD's LI EmPOWER program is available to robustly fund electrification and fuel switching — including a broad swath of funding options.[xxiv]

The program's goals shifted in 2025, in response to 2024 legislation, to target GHG reductions and to allow electrification and fuel switching, as well as energy efficiency. One facet of the legislation in question is that it ties DHCD programs under EmPOWER to require weatherization when conducting fuel switching.[25] The program could, and *should,* be focused on ZEHES implementation, a fuel switching program. Including weatherization, DHCD's multifamily Energy Efficiency and Housing Affordability (MEEHA) program is proposed to cover 70-90 percent of costs. In its 2025 budget, DHCD included $38 million in its operating budget for single-family homes from EmPOWER and $35.9 million in its capital budget for multifamily from EmPOWER.

EmPOWER may be a more significant source of LI funding. As a matter of equity, more EmPOWER funds should be deployed to support LI households under the principles of Justice 40 and to mitigate the regressive impact of EmPOWER charges on LI customers.

[xxiii] EmPOWER funding is determined across a three-year funding cycle, subject to application and approval by the MD PSC.

[xxiv] As this report focuses on LI ZEHES implementation, the DHCD program is discussed. However, for ZEHES implementation across all income levels in the state, funding options under EmPOWER will need to consider how utility programs contribute to electrification. Several utilities have thus far implemented electrification programs under EmPOWER, though this needs to be expanded across all utilities in the state.

In a 2023 analysis, Earthjustice, GHHI, RMI, Chesapeake Climate Action, and Sierra Club recommended that 40 percent of EmPOWER funds be allocated to LI families.[26] To achieve this, utility GHG savings targets would need legislation to allow for allocation to LI. In calendar year 2024, only 11 percent of EmPOWER funds were spent through the DHCD LI program, and only 22 percent of residential EmPOWER spending went to LI households.[27] If 40 percent of residential funds were equitably spent, then an additional almost $70 million would be available for LI incentives, covering a significant portion of the needed yearly incentives to electrify homes under ZEHES.

In the first half of 2025, DHCD installed 1,036 heat pumps, mostly in multifamily properties under its MEEHA program, for an annual rate of 2,072 installs, a significant step toward the goal of 14,000 per year.[28] More should be achievable; in 2024, the utilities and DHCD underspent their residential EmPOWER budgets by $69 million and the overall EmPOWER budget by $214 million, funds that could have been deployed without increasing utility rates.[29] This under-deployment by DHCD highlights the agency's capacity to deploy funding, and significant continued investment by the agency to build its capacity would allow it to fully deploy incentive funding by 2029. As will be discussed, pre-ZEHES focus on heat pump installations for homes using electric resistance and delivered fuels represents a pathway to capacity expansion.

CHS program

The CHS is in early stages of development by MDE, and the exact details of its impact will be subject to how the rules are ultimately promulgated. As currently contemplated, the CHS will establish a system for building fuels not dissimilar from the Renewable Energy Certificate (REC) market.[xxv] Under the CHS, utilities can either create their own CHS certificate through electrification or efficiency installations in buildings, or they can purchase them from a CHS marketplace in order to meet their certificate retirement obligations.

The certificates sold and retired from this program will have the effect of either lowering the cost of electrification through market stimulation from the need to create certificates, or if CHS obligations are not met, through alternative compliance payments, which should be used to fund electrification and energy efficiency incentives.[xxvi] Utilities

[xxv] Utilities are required to purchase and retire certificates representing the ownership of a megawatt-hour of renewable energy generation equal to utility obligations established in a state's renewable energy portfolio standard.

[xxvi] The CHS is, at time of this report, under development, and the existence of an ACP — and dedication of ACP funds to electrification and efficiency — are not at this time guaranteed.

and delivered fuel providers selling fossil fuels or buying energy produced from fossil fuels will be required to purchase and retire increasing levels of certificates over time, gradually and steadily increasing the cost of delivered fuels and methane gas.

The CHS program, if well implemented, will establish financial incentives that will go a long way toward facilitating equitable implementation of ZEHES. The expected increase in fossil fuel prices from CHS will improve the rate of return for electrification projects — particularly in instances of fuel switching from gas. As is the case with EmPOWER funds, focus should be placed on maximizing funds derived from the CHS to LI households, especially for those LI households switching from gas service delivery. As a market mechanism, CHS has the potential to lower the cost of implementing ZEHES, as happened with the implementation of other market transformation programs, including actions to reduce ozone emissions. Market mechanisms often stimulate competition, which can deliver lower cost solutions.

Green banks

Green banks are another important financial tool and source of funding for ZEHES electrification, but to be successful, they need to leverage resources. For example, the Montgomery County Green Bank was capitalized as a result of a settlement related to the sale of a utility company; state or locally issued bonds are another source of capital that could be leveraged for significant funding.

Two green banks currently exist in Maryland — the Montgomery County Green Bank and the Maryland Clean Energy Center (MCEC) — and they already undertake related types of lending using their balance sheets. For example, the MCEC Clean Energy Advantage pilot program provides financing for homeowners to achieve energy efficiency and electrification through loans leveraged by EmPOWER funds that are interest free for their first two years, after which market rates for interest apply.[30] In 2024, the MCEC lent $2 million to homeowners under this program.[31] The same year, the Montgomery County Green Bank invested $63 million in LI communities, though the proportion of this commitment that would be devoted to residential lending for electrification is also unclear.[32]

Maryland would not be the first state to see success in utilizing financing options for driving electrification and energy efficiency development. For example, Connecticut's Green Bank's $51 million of investments attracted $393 million in other private investments in fiscal year 2024,[33] and a significant portion of that financing went to residential customers. They also raise a significant portion of their funds by selling bonds to Connecticut residents.

If fully implemented, such financing could cover up to $70 million of the annual upfront cost of electrifying all homes using propane and fuel oil, of which $15 million would be to replace propane and fuel oil use in rental homes. By the early to mid-2030s, replacement in methane-burning homes may support financing. Green banks have the potential to finance significant additional residential projects if they receive additional capital, which could then be leveraged for additional lending.

Meter-attached on-bill financing

A number of utilities and other lenders offer meter-attached on-bill financing (MAOF) to cover the upfront cost of electrification for rental properties. This could apply to ZEHES and could expand the sources of financing. A utility or lender pays the upfront cost of electrification. It then amortizes that cost, plus a return on the renters' utility bill. However, MAOF only works for renters when the savings from energy and utility costs will more than cover the monthly payment; if this is not the case, MAOF should not be implemented. There should be no increase in utility rates, other than the on-bill portion financing electrification.

MAOF offers the landlord a way to recoup upfront costs immediately. The meter-attached feature means that the ongoing payments are not an obligation of the renter when the renter reaches the end of their lease and moves. The payment stays with the rental property. Many of these programs have been offered by cooperative utilities and Midwest utilities, many of which operate using a Pay as You Save (PAYS) program.[34]

Maryland will require both robust incentive programs and financing to equitably support ZEHES to ensure that upfront costs are not overly burdensome. It is important that the affirmative requirement of replacements through ZEHES is not an unfunded mandate that disproportionately impacts those least able to afford the incremental cost. As such, Maryland must leverage all available funding sources — EmPOWER, SEIF, CHS, and financing — in a coordinated manner.

Policy Recommendations

Policy Recommendations

Maryland has committed to an equitable approach to achieving its ambitious climate goals that minimizes harms or costs placed on historically disadvantaged communities. This report is intended to dive into the financial and policy details of what this would look like for equitable ZEHES implementation. This section begins with recommendations for actions that can be taken in the years leading up to ZEHES implementation (2029), followed by specific strategies to use during the implementation period.

Building capacity and lowering customer bills through pre-ZEHES electrification

Achieving an equitable implementation of ZEHES will require preparing the ground for electrification in Maryland over the next three and a half years. Focusing on replacing the heating and efficiency sources that have the greatest payback in energy household financial savings during this period will build needed capacity in state agencies and drive market transformation to lower the upfront costs of heat pumps by 2029.

This strategy would initially focus on delivered fuels (oil and propane) and electric resistance heating. Table 3 above highlights the projected payback period based on the incremental cost of an ASHP and is suggestive as to where the state could maximize its initial capacity building and market transformation efforts. During this pre-implementation time, because fuel switching from gas does not have a favorable payback period, state investments would be best directed at replacements with stronger bill savings for customers. This is achievable by maximizing currently unused EmPOWER funds, as well as directing SEIF funds that are not devoted to bill savings, renewable energy, or public education and engagement.

Electric resistance, although not part of ZEHES, represents fertile ground for ASHP replacement, with payoffs of incremental costs in four years and providing significant savings to residents. Replacements in these homes are accordingly a good place for Maryland to engage *now*, prior to ZEHES, to advance market maturity, increase contractor familiarity with and availability for installations, and ramp up agency capacity to provide assistance to LI and other homes. All of these factors will likely contribute to cost savings and streamlining the rollout of ZEHES when it takes effect in 2029. Similarly, delivered fuels replacement will significantly reduce consumer bills and represent an early point of focus for the state.

Replacing electric water heaters with heat pump water heaters is even more attractive, with a payback of the incremental costs within three years. Over 61 percent of water heaters in LI Maryland homes currently employ electric resistance and would quickly benefit from replacement.[35] Tanked heat pump hot water heaters can heat during off-peak hours, holding the hot water until peak morning hours during the winter and peak evening hours during the summer. Because they can schedule operation, these heaters can lower peak electric demand, thus contributing to lower electric rates and reducing grid congestion.

Financing may be especially viable for HPWH replacements in multifamily properties. The incremental cost for a HPWH replacing an electric tank water heater is comparatively low — around $1,100 in 2024 dollars. This may be a fruitful direction for programs such as MCEC's Clean Energy Advantage Program.

Fuel switching from gas and ratepayer protections

The bill savings for gas replacements starting in 2030 are marginal but viable, and the lifecycle payback from savings occurs within 13 years of installation. As ZEHES replacements continue into the mid-2030s, replacement becomes increasingly attractive.[xxvii] While gas prices, as modeled, continue to increase throughout the 2030s, it is important that there is sufficient funding to ensure LI homes using gas are able to fuel switch by the start of ZEHES implementation in 2029. This will ensure that LI households are not held captive for an additional 25 to 30 years due to a missed replacement under ZEHES as gas prices become increasingly untenable.

Although it is beyond the scope of this report, the authors strongly suggest that Maryland should consider stronger protections from projected rate increases, particularly for LI residents. These protections will be necessary both in light of current utility bill increases being experienced by Maryland ratepayers[36] and the projected gas rate increases in the 2030s.

Gas utility rates are projected to increase year over year due to increases in capital costs for the service distribution system, but they will also be impacted as fuel switching occurs and customers leave gas entirely. Those residents who remain on the gas system will have to bear an increasing share of total system costs, which will further drive bill increases.

[xxvii] Because energy prices of all types are volatile, the following recommendation should be revisited closer to 2029 to provide a closer-in-time evaluation of when a replacement under ZEHES for gas equipment should begin.

Maryland currently has in place certain low-income bill assistance programs, such as the Electric Universal Service Program, funded by the SEIF, and the Maryland Energy Assistance Program, which draws money from the federal Low Income Heating Assistance Program. Both programs are administered by the Office of Home Energy Programs (OHEP).

Certain additional rate protections are under consideration by the Maryland Public Service Commission (MD PSC), which is considering rate protections for limited-income utility customers that include supplementing OHEP protections with additional rate relief to cap energy burden for low-income households at a six percent energy burden rate.[37] The MD PSC is also considering the implications of impacts on utility customers during this market shift away from gas.[38] Depending on the outcome of these two matters, the state may need to take additional legislative or regulatory action to ensure that all utility customers in the state have sufficient protections to ensure reasonable rates during this period of energy price volatility.

Heat pump installation on air conditioner failure

While not required by the ZEHES model rule, some advocates and officials propose a modification that any time an air conditioner *or* heating equipment reaches the end of its life, both systems should be replaced by heat pumps. This would speed up the deployment of heat pumps by approximately 175 percent, partially because air conditioners have shorter, 15-year lives, and partially because there are two points of failure to trigger a replacement. Although this rapid implementation rate may sound attractive, the authors recommend against the state adopting such a policy.

For LI households, the annual incremental bill would rise to just over $726 million annually in 2029. This amount will decline yearly as implementation moves toward the 15th year, after which only homes with emitting heating systems but no air conditioning would require replacements. Certain jurisdictions have taken this approach — for example, San Jose, California, is considering a reach code that necessitates heat pump installation on replacement of an air conditioner.[39] However, San Jose has significantly less penetration of both heating and air conditioning systems due to a milder and more uniform climate, reducing the financial impact of an aggressive plan for replacement. Should Maryland policymakers wish to take this approach in ZEHES, the state faces an additional $462 million to fund the program within LI homes for the year 2029, and additional monies in subsequent years. Accordingly, the authors reiterate that the state does not adopt a policy of replacements on air conditioner failure.

Lowering upfront costs and savings from new technology

New technology, including recently available cold climate window heat pumps, can significantly lower the cost of installations, reducing the cost of replacement space heating for apartments and small homes by as much as $4,700, or more than half of the incremental costs for multifamily units.[xxviii] These units install quickly because they operate on a 120-volt electric plug and do not require new wiring.[xxix] Window heat pumps could be installed in many multifamily homes, including those currently using shared heat. If successful, these units could lower the incremental costs of equipment and installation by $23 million and potentially more annually.

In addition to lowering costs, these units are also likely to be a successful tool for ensuring ASHP implementation in buildings (particularly multifamily) where installation of ducted heat pumps is either expensive or impossible due to shared heating or other structural issues. They may also benefit attached single-family homes and smaller single-family homes, though additional data is needed to verify this.

Currently, EmPOWER does not offer incentives for window heat pumps. They are not included in the Mid-Atlantic Technical Resource Manual, which defines what products can be installed under EmPOWER. Developing an alternative pathway for authorization would facilitate deployment of these products in Maryland.

These window units may require proving in Maryland, and EmPOWER (the likely source of funding for these incentives) requires means-testing for the valuation in energy savings. Currently, there are certain concerns within state agencies about the window units being "transient" rather than fixed — that is, that these 140-pound units might easily be removed from a property and therefore not be eligible for the valuation of energy savings. Concerns were also raised about customer satisfaction as compared to traditional heating/cooling units. Addressing these issues may require more testing and a regulatory patch to ensure that they are fundable, as well as requiring public demonstration to ensure customer/stakeholder buy-in. This could be a pilot project funded with SEIF RGGI funds and could be potentially run through MEA's Energy Efficiency Equity (EEE) program. The EEE program is discussed in greater detail in the section discussing customer satisfaction of this report.

[xxviii] Gradient list prices vs. heat pump replacement costs described below, from conversation with Gradient and RMI cost estimates for heat pump replacement costs.

[xxix] $3,800 per heat pump (at list), $500 installation. Two heat pumps per apartment. Gradient's units are only currently available to volume buyers. Volume buyers receive discounts. From an oral presentation by Gradient, July 2025.

Other emergent solutions in early trials include 120-volt heat pump water heaters. These have lower installation costs, but they currently have sufficiently higher equipment costs that we cannot project savings. It is possible that prices of this equipment will drop as sales increase.

Weatherization

Weatherization programs, supported by federal and state funding, have been an integral component of energy efficiency efforts for decades, often providing the most cost-effective strategy. However, modeling conducted for this report suggests that once a household has switched to an energy efficient heat pump and hot water heater, per the ZEHES rules, the financial costs/benefits of weatherizations change significantly.

The costs of weatherization are the same regardless of whether a heat pump is installed concurrently or independently. Weatherization costs total over $7,300 per single-family home and $2,900 per multifamily unit, not including the costs associated with necessary repairs, which have been estimated to apply to 8.4 to 50 percent of homes.[xxx] [40] Between two-thirds and 91 percent of LI homes built before 2000 will benefit to some degree from weatherization, though not every instance of weatherization would be cost-effective or implemented.[xxxi] [41] The total annual estimated upfront cost of weatherization for these homes would be $81 million.

Although upfront costs for weatherization are independent of heating or cooling equipment in the home, the energy savings achieved are impacted by the equipment. The payoffs for weatherization, when paired with heat pump installation under ZEHES, are modest, achieving a payback on average over a 31-35-year period. They are modest because heat pumps have substantially reduced the energy use of these relatively small households. We estimate the annual energy cost savings from weatherization with heat pumps also installed to be $236 per single-family home weatherized and $82 per

[xxx] If 8.37% to 10% (based on DHCD numbers) of the 90% of homes needing weatherization, the total annual cost of pre-weatherization would be an additional $14-$17 million per year. If 50% of low-income homes require repairs at this scale, the cost would be $83-$96 million annually. These funds are not included in our models.

[xxxi] Home vintage comes from the ResStock model. Increased attic insulation to R49 in 2012. Percent that need insulation comes from Maryland, 2012 IECC Code Level Insulation – DOE Zero Energy Ready Home Requirements.

multifamily LI home.[xxxii] [xxxiii] [42] [43] To the extent that weatherization is not required, wanted, or cost-effective, the investment in weatherization should be proportionally lower.

This is not to undercut the value of weatherization or a whole-home approach, which includes customer comfort and satisfaction, but to highlight that implementation of ZEHES changes the financial benefits of existing weatherization programs. Funding sources in Maryland are currently constrained[xxxiv] in part due to the loss of federal resources directed toward weatherization and necessary home repairs. Weatherization, if required to be paired with ZEHES, would add an additional 27 percent cost to electrification (Table 2). Although DHCD does have obligations under its whole-home program, these obligations lie with the agency. Comparatively, ZEHES, as contemplated, places the obligation for replacement on the homeowner.

In the LI context, should state funding not be available to meet at least incremental, if not ideally total costs, this will result in an unfunded mandate that must be borne by Maryland residents least able to shoulder the costs. As such, careful analysis of the financial and other impacts and benefits of investments in LI homes is merited so as to ensure equity and maximize GHG reductions under CSNA given available funding at this time.

A potential "heat pump-first" approach

It is worth investigating a "heat pump-first" approach to evaluate the most meaningful and equitable implementation of ZEHES, particularly in the LI context.

Other states have taken this approach. Maine, in particular (also a NESCAUM signatory), has sought to streamline its heat pump program to maximize heat pump replacement over more complex programs. Efficiency Maine, a quasi-state agency that implements energy efficiency programs in the state, has seen remarkable success in heat pump installations, achieving nationwide leadership in the rate of installs.[44] The state surpassed its initial installation target two years early and expanded its target to a total

[xxxii] ResStock energy data suggest higher levels of savings when a heat pump has not been installed. Installing the heat pump lowers the potential savings achieved by weatherization.
[xxxiii] ResStock 2024.2 release Measure Package 1 and 6 compare similar homes for Maryland, with Package 1 including an air to air heat pump and Package 6 including a similar heat pump and a light touch envelope upgrade, which includes R60 insulation and 30% whole-home reduction in ACH50 (air leakage). The Measure 6 package reduces heating and cooling energy use by 12% to 13%.
[xxxiv] CHS and substantial bond investments may alleviate this to a degree.

of 275,000 new installs by 2027.[45] This is a major success for a state that only has approximately 739,000 total housing units.[46]

As with any state comparative analysis, there are a multitude of factors that contribute to the rate at which Maine has been able to drive heat pump installs — perhaps most notably, the fact that much of Maine's heating fuel source is historically delivered fuel oil. As is the case in Maryland (Chart 6 and Table 3, above), this results in substantial current energy savings and shorter current payoff periods from electrification as compared to transitioning from methane gas. Offsetting the benefits of replacing more expensive fuel oil, Maine must install cold climate heat pumps, which are more expensive.

Differences between the states aside, the successes of Efficiency Maine bear consideration. For one, the program is designed for simplicity, maximizing contractor engagement and rebates, and customer choice. Unlike Maryland, Maine has no requirements for weatherization in conjunction with engaging in a state heat pump incentive program. A customer in Maine may certainly elect to pursue weatherization — either independently of, or in conjunction with, a heat pump installation — but is not required to do so, allowing customers to avail themselves of incentives and financing based on customer priority.

As discussed, this approach is not currently pursued within Maryland, and a pilot program may be merited within the state to evaluate the rate at which such a customer-choice focused program would allow for the state to rapidly advance electrification through heat pump installations. Such a pilot program would assess savings, incentives required, household satisfaction, and GHG (and ideally health) savings from a heat pump-first approach. Successful acceleration of heat pump deployments may be especially true as the energy efficiency (and thus energy savings) of weatherization and ASHPs are complementary, and it is likely that a heat pump-first approach would capture much of the savings from weatherization.[47]

One potentially low-cost approach to this trial would be to estimate, in advance, the benefit of weatherization after installing a heat pump for individual homes. Using existing energy bills for the home, the trial would estimate energy bills after installing a heat pump. If the energy bills are small enough, a heat pump would be installed without weatherization. A cohort of homes without weatherization would be compared with a group of homes with similar starting energy bills that received weatherization.

Given how EmPOWER funds are currently allocated under law, the pilot would need to be funded from sources outside the program, such as the SEIF. The pilot would need to

be implemented as soon as possible so the results can be incorporated within ZEHES implementation in 2029. Having early results from the pilot would have the additional benefit of allowing Maryland to plan to allocate funding to achieve the greatest impact. The results of the pilot could justify additional spending for electrification based on cost-effectiveness through the SEIF, direct monies from CHS, and be incorporated in future EmPOWER cycles.

Non-equipment costs

One of the greatest upfront costs for ASHPs and HPWHs are non-equipment installation expenses, including labor. One path to achieving reductions in these costs would be to focus state investment (for instance, housed in an MEA program) on training for ASHP and HPWH contractors. Greater training would likely lead to competition among contractors in the state and greater competence and comfort in installing heat pumps and reducing costs. Reduced labor costs would lower the amount of financing and incentives required to achieve electrification in the state.

A different option is to focus on market-driven investment as certain other states have. Maine, for example, has basic requirements for installers who wish to participate with state programs for rebates and incentives, requiring only insurance, a U.S. EPA certification to handle refrigerants, manufacturer training (or training provided by Efficiency Maine), and a one-hour certification on heat pumps.

A potential concern of a workforce with only basic certifications is that it would not be well-suited to effectively conduct installations. Maine mitigates against this to a degree by engaging in significant follow ups, including satisfaction surveys, and prioritizes recommendations for well-received installers. However, the authors acknowledge that quality control is crucial to ensure that low-quality installations do not poison the well of public opinion for electrification.

Additionally, the state prioritizes rapid reimbursement of rebates to ease the financial float of installers. This is in taking with Maine's streamlined approach to bolstering its heat pump uptake within the state. Since the inception of the program, Efficiency Maine's verified installers have grown from 20 to 700, largely by word of mouth and interest in the program.

Either a top-down training program or a more laissez-faire approach would increase the number of contractors performing installations in Maryland, though one issue with a top-down approach is the state's current financial constraints. Potentially, HVAC trade

associations could deliver heat pump training to their members, and agencies could work with existing industry programs to develop program design and achieve cost reductions to the state. Ultimately, this is a policy decision for Maryland to make. In either instance, speeding payment of rebates and creating market dynamics will likely drive greater interest from contractors in the state.

Seasonal rates

Another way Maryland could drive heat pump installations is by adopting a seasonal rate program, as Massachusetts has done[48] (with contemplated expansions).[49] Similarly, Maine has adopted a pilot program,[50] and Colorado legislation has directed utilities to work with the public utility commission to establish such a rate program.[51]

A seasonal rate program would lower the electric utility bills for heat pump customers by "right-sizing" their contribution to the costs of the electric distribution system and would, as result, lower their yearly energy costs. In the context of successful adaptation of ZEHES, this has the impact of increasing energy savings for heat pump households and reducing the payback period.

In Massachusetts, this is expected to deliver hundreds of dollars of savings for customers with a heat pump (more if the state expands the scope of the program), and notably, would make fuel switching from methane gas service delivery result in net savings from only 27 percent of homes to 50 percent under current rules (and 74 percent under the proposed expanded rules for the program).[52]

Such a program is neither a subsidy nor an incentive. Maryland's utility rates are based on a volumetric design — the more electricity a home consumes, the more they pay. They are paying not just for the electrons they are purchasing, but also for costs associated with maintenance and capital investment costs of the distribution infrastructure (lines, transformers, etc.) that bring electricity to the end user.

Maryland is a summer peaking state, with the distribution grid designed to meet high demand during this period. While heat pump customers will use more electricity (more volume) in winter months than a neighbor who utilizes methane gas or delivered fuels, they are not putting additional stress on the distribution grid (and hence not contributing to the cost of expansion and upkeep). As a result, under the current system, heat pump customers are subsidizing broader grid costs by paying an unequal share for the distribution system. A seasonal rate program "right-sizes" this.

Functionally seasonal rates only work for grid systems that are designed for a "summer peak." As electrification advances, the impact will ultimately be that Maryland will switch from a summer peak to a winter peak system. A 2023 report conducted for the Maryland Public Service Commission suggests the switch could occur by 2031 or earlier.[53] However, high efficiency investment could mitigate this.

Specifically, by driving a rapid build-out of heat pumps in Maryland targeting low-efficiency electric resistance heating, the state will develop agency capacity to support ZEHES implementation as recommended elsewhere in this report and delay the shift to winter peaking, maximizing the value of adopting seasonal rates. As discussed in the case of HPWHs, shifting the time electric systems pull from the grid will also contribute to a reduction in peak demand.

Customer satisfaction

Customer satisfaction plays a huge part in the success of an electrification program. Numerous factors, including interactions with contractors, cost, and ease of access, impact satisfaction.

Contractor effectiveness is particularly measurable as it relates to the ease of installation and quality of installation. It is in the state's interest to ensure that residents engaging with Maryland ZEHES programs are directed toward well-qualified contractors.

Ease of customer access to program options also strongly dictates customer satisfaction. Using Maine as an example, Efficiency Maine highlights its programmatic success based in large part on maintaining a simplified portal for applying for a home energy loan, checking income eligibility for programs, and setting up scheduling with qualified installers. Their portal organizes installers by their number of successful rebate installations, directing customers to active and well-received contractors. For LI installations in Maryland, DHCD is to be commended for working to adopt a single point of interaction. For non-DHCD interactions, Maryland may wish to streamline available funding and incentive programs under the aegis of a single point of contact.

In order to maximize public uptake of electrification programs, satisfied customers need to be publicized to drive further customer engagement. Public awareness of the benefits of electrification — both in terms of cost savings, health savings, and the more ephemeral aspects of ease of installation and overarching customer satisfaction with heating systems — is crucial to ensuring public engagement and uptake.

Utilities spend millions of dollars on advertising, often for gas projects,[54] in part because there have been instances where educational efforts, which are recoupable through rates, have functionally been advertisements, as well as gas utility interest in broadly promoting in the state. In order to shift this narrative, Maryland needs significant promotion of the benefits of electrification, particularly with a focus on conducting outreach and incorporating the priorities of communities into program design and implementation.[55] The value of community trust and buy-in cannot be understated in successfully implementing a program like electrification.

In Maryland, some of this work currently exists at the local level. Montgomery County, for example, has launched the Electrify MC campaign designed to streamline electrification efforts in the county under one program.[56] Part and parcel of this initiative, Montgomery County evaluated contractors in the region and selected Elysian Energy to work with the county to conduct home audits, engage in promotional activities, and serve as a technical support helpdesk for residents considering or undergoing electrification projects. The county has also worked directly with LI housing developers to advance electrification in LI communities.[57]

Maryland also sees support for this work within the nonprofit sector. The Green and Healthy Homes Initiative, for example, performs excellent work in socializing the benefits of electrification. The Maryland Energy Advocates Coalition, led by Laurel Peltier and its members, also advocates for energy-burdened LI families and for electrification of their homes.

MEA has an Energy Efficiency Equity (EEE) grant program. In fiscal year 2024, this program drew $19.368 million from the SEIF, and it operates to award grants to localities and to nonprofits to drive community-based work to promote electrification and efficiency in low- to moderate-income communities in Maryland. Expanding funding for this program and increasing awareness of its benefits will be beneficial to improving public uptake of electrification.[58] This program may additionally be a means to address certain concerns with emergent technologies, such as window-unit heat pumps, by demonstrating and socializing the value, comfort, and ease (subject to proving) of such units to reduce concerns and barriers to broad adoption of them. In addition, MEA operates a clean buildings hub, a site to promote the value of electrification and provide resources to consumers interested in electrification.

This said, Maryland, at the state level, could benefit from establishing a dedicated "ambassador" program to promote the value and customer satisfaction of electrification. A community-based approach in particular would ensure that the messengers are, fundamentally, trusted ones.

Other states have contemplated such projects. The Washington State Clean Energy Ambassador program is one of these, based on a series of pilot workshop programs designed for representatives from state agencies and utilities to talk to communities about barriers to clean energy (including electrification and efficiency). Although this program highlights effective community-centered design aimed to build trust and engagement, it also is indicative of broader issues in the states that can act as a barrier to programmatic success — specifically, funding.

In the case of Washington, the Clean Energy Ambassador program originally received funding to start operations in FY 2025, but the 2025 supplemental budget eliminated funds in response to state budget shortfalls.[59] Although the program design is instructive as to how Maryland could enact a state outreach and ambassador program to support electrification, it is accordingly also instructive that such a program may require funding from sources other than the general fund and represents another cost-benefit analysis the state must undertake in order to most effectively implement ZEHES.

Renter protections

In implementing ZEHES, or advancing electrification in the lead-up to ZEHES implementation, the costs of heat pump replacements are borne by the homeowner. Comparatively, the energy savings flow to the ratepayer — typically the building resident. For rented homes, either single-family or multifamily units, this potentially presents a mismatch between costs and cost recoupment through long-term energy savings.

It is important to ensure that the capital costs associated with fuel switching do not unduly burden tenants in the state of Maryland through instances where building owners pass all or substantial amounts of the capital cost through to renters. ZEHES, to be achieved equitably, requires substantial incentives and funding to support the LI sector, but policymakers should preemptively avoid creating a housing crisis while addressing energy programs.

To the extent that the upfront costs of ZEHES for LI households — single- and multifamily — are covered in their entirety through incentives (the upfront total costs of electrification), ostensibly the capital costs to the building owner are covered and should not be subject to being passed through to tenants in the form of rent increases. However, this may not always be the case and is something that the Maryland

legislature acknowledged in 2024 within the context of DHCD weatherization programs in the LI rental market.

Maryland law requires DHCD to adopt regulations that direct the benefits of electrification to accrue primarily with LI tenants in impacted homes, and that rents are not increased, nor tenants evicted, as result of investment in weatherization (for instance, under substantial repair or renovation provisions of the housing code).[60] [61] DHCD proposed a regulation to implement these protections through a notice of proposed action in June 2025.[62] These regulations would preclude rent increases or evictions resulting from weatherization investments in instances where the owner has availed themselves of DHCD funds to achieve the work. Penalties for noncompliance require the owner to repay DHCD for the agency's share of weatherization assistance.

DHCD's proposed rules define covered programs as those including energy efficiency and energy conservation measures, though it is unclear whether this specifically includes electrification. As DHCD works to implement ZEHES in the LI context, it is important that they clarify that these protections apply to electrification, and, given the narrow language in the 2024 law that centers on weatherization, that the legislature take necessary action to include electrification if required.

These protections for LI renters, however, would only apply in instances where the owner is availing themselves of a DHCD plan. If the owner finds other sources of funding, protections are/will be limited. Maryland, for instance, has no statewide cap on rent increases. Certain localities do, though there is often a specific exception for rent increases to meet capital investments.[xxxv] [63] Statewide limitations, or constraints, to these exceptions may be worth considering as Maryland is poised to expand capital projects under ZEHES and other programs.

For example, Maryland could establish a statewide program that limits rental increases and ties pass-through rent increases from capital projects to the relative costs and lifespan of the capital investment. New York City has a state/hybrid model that, while not perfect, addresses some of these issues. The ability to ensure compliance and enforcement of these protections remains a question in the face of agency capacities.[64]

[xxxv] Montgomery County, for instance, does have a provision allowing for rent increases to meet capital investments (though they typically have to be time-bound and are tied to the project). For such projects that see energy cost savings, the savings must be passed on to the tenant, and either result in net energy savings to the building or be done in compliance with the law.

Of course, the strength of any rental protection program will depend on its enforcement. For DHCD programs, this will require DHCD robustly applying protections under law and regulation. Within that program and more broadly where protections exist or are developed (at the state or local level), tenants will need access to strong legal assistance.

One such program is the Maryland Access to Counsel in Evictions program, created by statute in 2021, which provides free access to legal counsel to income-eligible individuals facing eviction and is designed to level power imbalances between landlord and tenant in the courts.[65] In Maryland, this program is expected to be fully implemented by October 2025, though questions of capacity and ongoing funding will dictate the efficacy of the program.

Conclusions

Conclusions

Maryland has committed to an equitable approach to achieving its ambitious climate goals while minimizing harms or costs placed on historically disadvantaged communities. Equitable implementation of ZEHES requires low-income households to be able to fully benefit from clean, efficient heating under the program.

One threshold issue is the cost of electrification in Maryland for single-family and multifamily homes subject to ZEHES. Evaluation of costs is crucial to highlighting where dedicated funding (either direct incentives or financing) will be necessary, and such funding will be particularly important for low-income households to achieve ZEHES.

In addition to the costs, a successful ZEHES program and funding design will need to evaluate potential savings over the life of installed equipment to assess the overall financial impact on residents and building owners.

To estimate costs and savings, the authors of this paper have worked with RMI. RMI created a model that estimates total and incremental costs, as well as modeled energy, health, and GHG savings for buildings subject to ZEHES through 2050. Based on the outputs of the model, and following consultation with Maryland stakeholders, this report presents an initial evaluation of the costs and savings from ZEHES, as well as highlighting potential challenges to implementation. In assessing these challenges, the report presents pathways to secure the necessary financing options for reducing costs and improving stakeholder satisfaction with replacements under ZEHES.

Equitably implementing ZEHES for low-income households will require thoughtful application of limited resources. Successful implementation will require Maryland to engage in electrification efforts prior to the ZEHES taking effect in 2029 to build agency capacity and drive market transformation, which will lower upfront costs of implementation. Specific measures that need to be worked on prior to ZEHES taking effect include:

- Building agency capacity to implement ZEHES by installing heat pumps in high-return households, including those burning delivered fuels and those heating with electric resistance
- Training team members at HVAC firms on the benefits of and how to deliver and install heat pumps
- Enacting rate structures that recognize the value of heat pumps and right-size bills for heat pump customers to improve energy savings

As ZEHES deploys in 2029, the scale of resources required to replace fossil fuel equipment with heat pumps in low-income households will be large, approximately $375 million per year. To address those costs, a mix of funding streams will be needed:

- Utilizing RGGI and ACP funding in the SEIF for electrification
- Directing an equitable portion of EmPOWER funds, mostly from unused but budgeted allocations, to support electrification for low-income households
- Lending, including on-bill financing, green bank lending, and bond financing
- Enacting a well-designed CHS

Efforts to lower the cost of ZEHES implementation are important to reduce both the financial impact on the state, as well as individual homeowners. This can be achieved through:

- Evaluating a heat pump-first approach to electrification and energy savings to assess methods to (1) deliver greatest cost savings for the dollar and (2) provide greatest comfort and satisfaction for families
- Testing and deployment of new technologies, including 120-volt window heat pumps
- Expanding competition by training more of Maryland's over 2,000 HVAC contractors to be versed in heat pump installation

Equitable implementation of ZEHES that is at the scale needed will also require a focus on customer experience to drive public uptake and trust in electrification programs, achievable through:

- Conducting outreach through effective communication and implementation by trusted partners
- Ensuring renter protections to avoid disproportionate rent increases that could contribute to housing unaffordability for tenants

If well implemented, ZEHES has the potential to equitably lower energy bills for Marylanders, drive substantial cost savings for the state by avoiding deleterious health impacts to residents, and advance Maryland's greenhouse gas reduction targets by avoiding upwards of 1 million tons of carbon dioxide per year by 2050. If Maryland can work to maximize implementation, any investment in this program represents a substantial return on investment for the state. Accordingly, the state must make this investment in its future.

Appendix

Appendix

MODELING: Maryland ZEHES Cost Model Methodology and Sources

This analysis uses RMI's Green Upgrade Calculator version 2.1 — a tool for energy professionals to analyze the lifetime cost and environmental benefits of residential decarbonization solutions, including heat pump upgrades.

- Home segmentation
    - We used ResStock to segment the number of homes by housing type (single-family, multifamily 1-4 stories), income (LI or non-LI (80% AMI)), ownership (owned or rental), current fuel type (methane gas, fuel oil, electric resistance), and design (furnace or boiler and tank or tankless).
- Annual installations
    - Annual like-for-like furnace, boiler, and water heater installations are estimated based on current inventory in ResStock and assuming a lifespan of 10 years for water heaters and 25 for furnaces and 30 for boilers.
- Upfront costs
    - Upfront costs: HVAC equipment and upfront costs based on contractor quotes from across the country varying equipment size and efficiency. Water heater equipment and upfront costs based on retail prices for equipment and installation time/labor rates/profit from plumbing contractor interviews across the country varying equipment size and efficiency. For both of these, we got confirmation from other sources and from a small number of contractor interviews. When assessing avoided air conditioner upfront costs, we assumed 1/15th of the homes would be avoiding an air conditioner cost each year (assuming 15-year lifespan and equally distributed).
    - Incentives: Incentive values are model inputs based on a percentage of the ASHP, HPWH, or weatherization upfront cost, or incremental cost versus the business-as-usual space heating upfront cost or water heating cost. All federal incentives were assumed to be $0 given the most recent version of the "One Big Beautiful Bill." Because state incentives are likely to change

by 2029, we decided not to include incentives, but rather measure the needed incentives.

- Future costs: All costs in the report are discounted to 2024 dollars. This calculation was not performed by RMI.

- Operating costs

  - Energy usage: Annual energy usage by end use (HVAC and water heating, separately) was based on ResStock for the specific home segmentation variables selected. For current energy use, this uses the current efficiency of the space heating (averaged 0.82 AFUE for gas and oil), space cooling, and water heating system (averaged 0.83 UEF for gas and oil). Future energy usage after installing an ASHP and HPWH is based on Green Upgrade Calculator calculated improvement in system efficiency. This includes the following:

ASHP ducted	7.8 HSPF2, 16 SEER2 (not cold climate rated)
ASHP ductless	7.8 HSPF2, 16 SEER2 (not cold climate rated)
ASHP sizing	Sized to meet at least 95% of the annual space heating load, with electric resistance covering the remainder
New HPWH	3.7 UEF. 330% effective efficiency operating in heat pump mode.

  - Energy rates:

    - Base year 2024 electric and oil volumetric rates ($0.169/kWh and $3.91/gallon) were the Maryland state average from EIA for 2024. Base year 2024 methane gas volumetric rates ($1.45/therm) were the average between OPC's base and high commodity forecast for 2024. For reference, the 2024 state average gas rate was $1.31/therm).

- **RMI did not estimate propane energy rates or equipment costs.** The authors estimated propane by using a rate of $3.30 per gallon for 2024, increasing at 0.8% per year in nominal dollars. (Source: EIA residential rate for 2024 and price increases, in nominal terms, at the 10-year average).

- Electric and gas fixed charges ($9/month and $14/month) were a weighted average across the utilities in Maryland in 2024. Savings from gas fixed charges were applied to 21% of gas homes based on ResStock indicating 21% of gas homes use gas for only space or water heating and would completely get off gas when installing an ASHP and HPWH through ZEHES.

- Future fixed charges were increased at inflation.

- Future electric volumetric rates were increased at 19% for 2025 based on Maryland forecasts, 3% per year rate from 2026 to 2029 based on based on the 10 year average from 2015-2024, -10% in 2030 assuming rates decrease once transmission is installed, and 3% from 2031-2050. There is uncertainty in the energy saving projections as relates to electricity costs. Recent years have seen a marked increase in load demand without substantial increases in supply across the PJM[xxxvi] footprint, which raises the possibility of increasing electricity costs even upon completion of transmission projects.

- Gas distribution prices are estimated based on projections from a February 2025[66] report from the Office of People's Counsel and projected changes regulation based on changes to the law under the Next Generation Energy Act.[67] Gas rates were assumed to increase 6.1% per year from 2024-2030, 3.5% from 2031-2035, 2.2% 2036-2040, 5.9% from 2041-2045, and 0.1% 2046-2050, all based on OPC's gas forecasts. Commodity forecasts based on OPC's high and low commodity forecast, with 0 percent customer defection from 2024 to 2030; 10 percent defection from 2031–2040 and 30 percent defection from 2040 onwards. For homes that can disconnect from the gas system, after removing gas fired space and water heating

[xxxvi] PJM is the Regional Transmission Organization that operates energy markets in Maryland and much of the Mid-Atlantic.

(about 20 percent of homes), the monthly gas fixed charge for connection previously paid by those residents is counted as an energy savings.

- Oil rates are assumed to increase at 0.4% per year based on the 10-year average from 2015-2024.

Endnotes

Endnotes

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