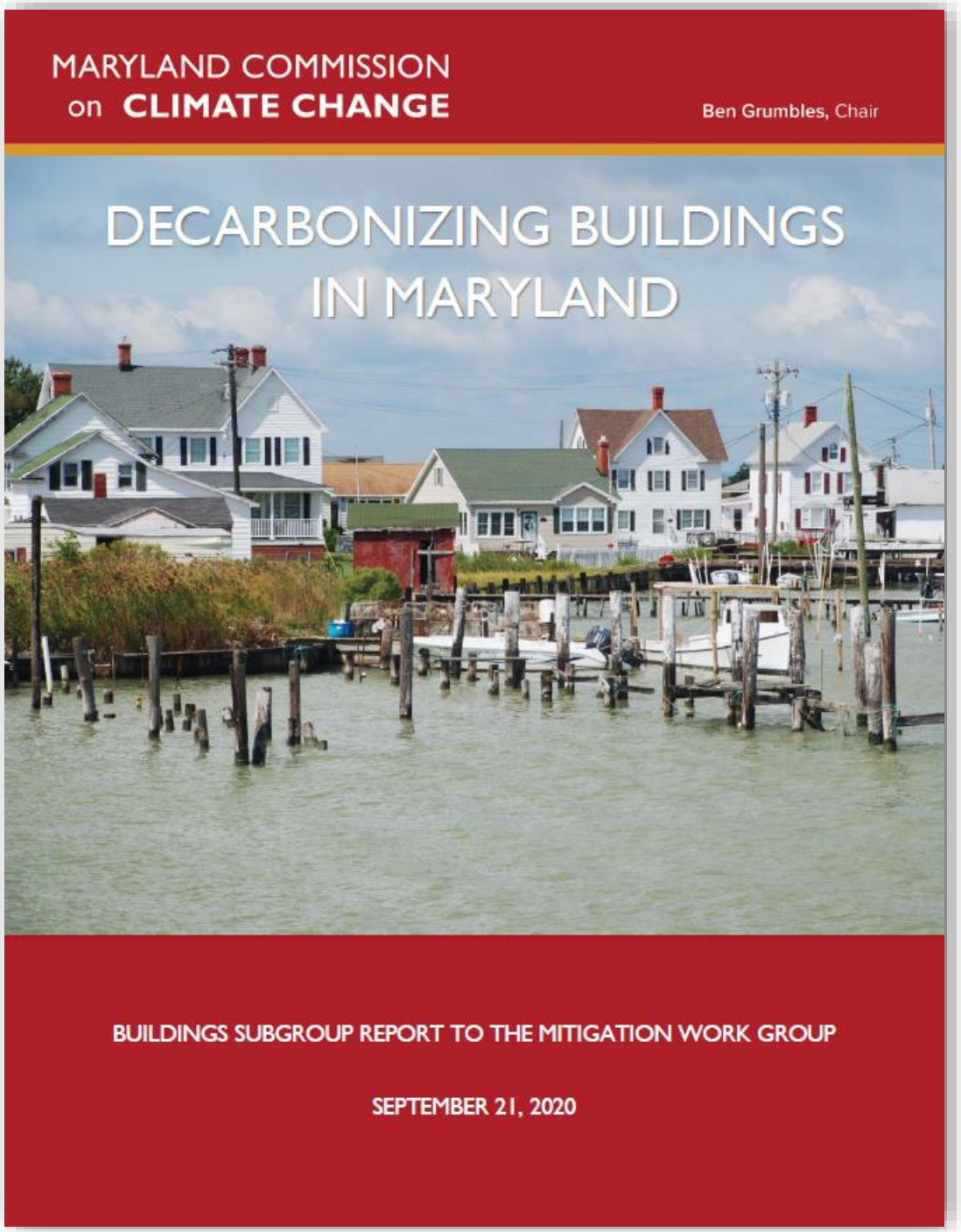
Summary of the Report and Recommendations from the MWG's Buildings Subgroup

September 24, 2020



Disclaimer

- 55 participants – broad representation but no fixed membership
  - 21 representatives of state agencies (MEA, MDE, DGS, DHCD, MSDE, and PSC)
  - 19 representatives of business (WGL, Columbia Gas, MAPDA, BGE, Pepco, NAIOP, MBIA, etc.)
  - 8 representatives of nonprofit organizations (Sierra Club, Energy Futures Group, ACEEE, GHHI, etc.)
  - 7 other (Maryland General Assembly, UMD, Counties, etc.)
- Not a consensus report – a few participants oppose specific recommendations or the subgroup's overall process
- Greater cost/benefit analysis and public input should (and likely would) accompany efforts to implement these recommendations
- Presented here are recommendations that are generally supported by the subgroup

Buildings Emissions: Historical

Between 2006 and 2017, direct emissions from Maryland's buildings decreased 18% due mostly to a halving in emissions from Maryland's industrial sector. Residential sector emissions decreased, on average, around 1% per year while commercial sector emissions increased nearly 2% per year. Combined, residential and commercial building emissions increased slightly between 2006 and 2017.

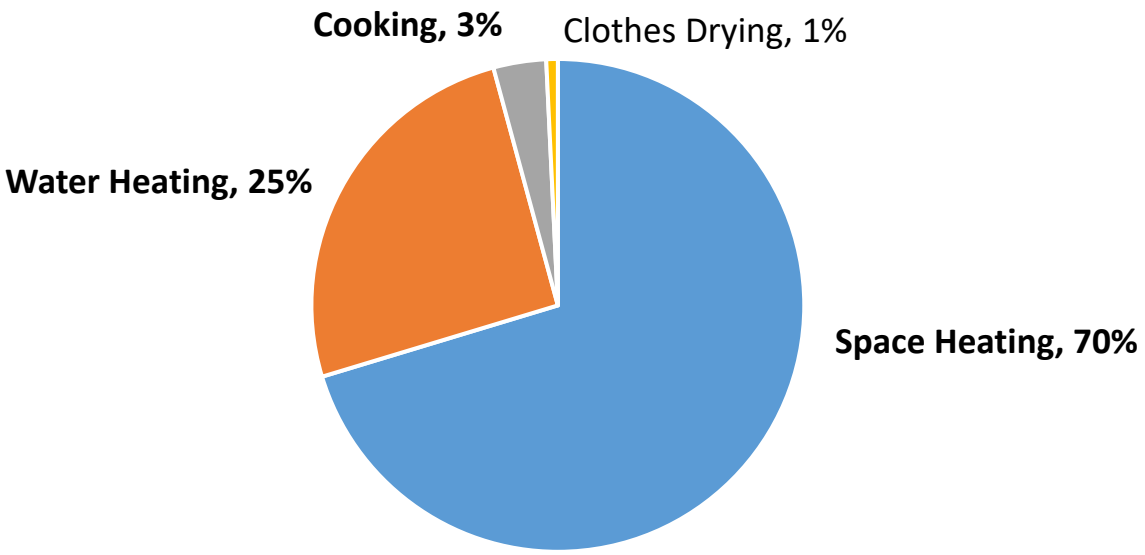
Natural gas use produces 80% of the direct emissions from residential and commercial buildings.

Table 1: Direct Emissions from Buildings in Maryland (MMtCO2e)

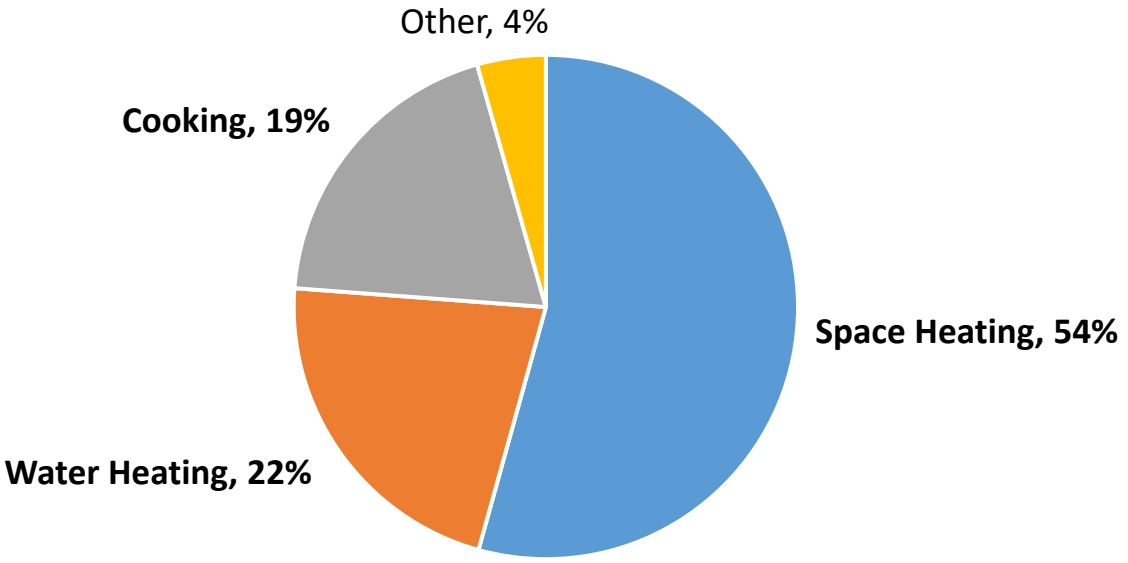
	2006 Emissions (baseline)	2017 Emissions (latest inventory)	Change, 2006-2017	2050 Target (80-95% reduction)
Residential	6.0	5.4	- 10%	
Commercial	4.5	5.3	+18%	
Industrial	6.4	3.2	- 50%	
Total	**16.9**	**13.9**	**- 18%**	**0.8 - 3.4**

Natural Gas End-Use in Buildings

Residential



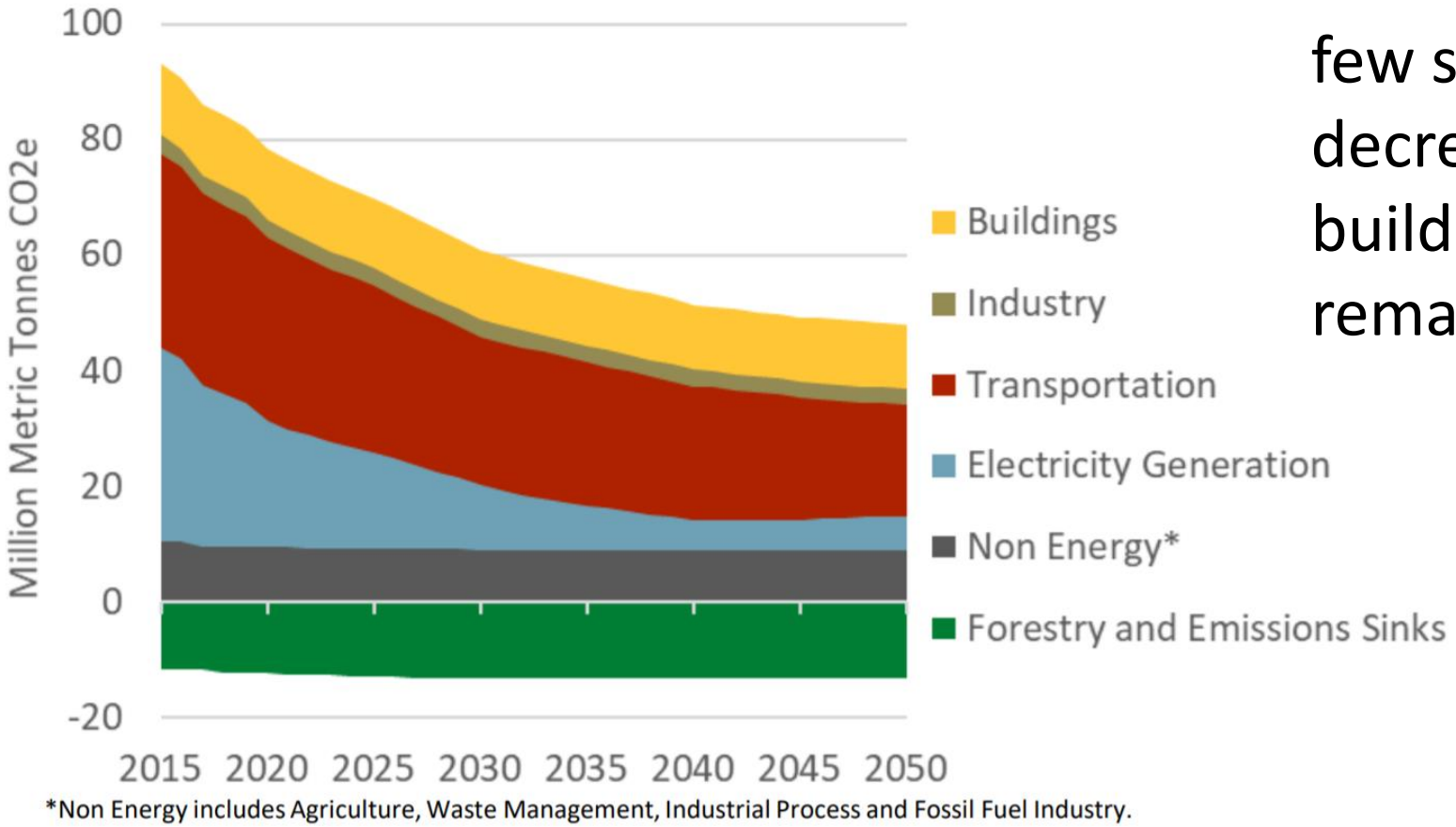
Commercial



Space heating, water heating, and cooking account for 99% of natural gas used in homes and 96% of natural gas used in commercial buildings.

Sources: Residential data comes from EIA RECS 2015, Table CE5.2. Commercial data comes from EIA CBECS 2012, Table 7

Buildings Emissions: Future?



*Non Energy includes Agriculture, Waste Management, Industrial Process and Fossil Fuel Industry.

The 2019 GGRA Draft Plan includes few specific policy measures for decreasing direct emissions from buildings, which are projected to remain constant through 2050.

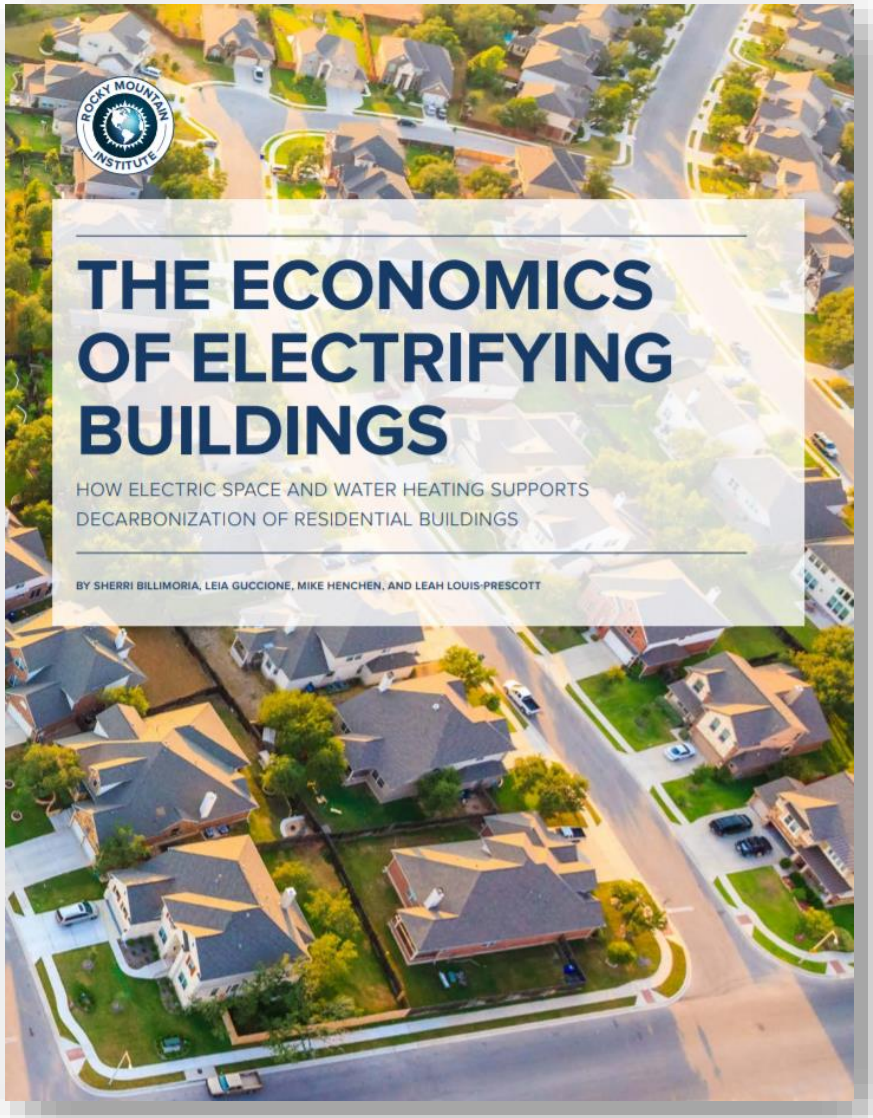
Source: 2019 GGRA Draft Plan Approach to 2050, Slide Deck for the Mitigation Working Group, December 17, 2019

However, the GGRA Draft Plan Proposes a Path Forward

"The 2019 GGRA Draft Plan proposes that the state continue to **invest in energy efficiency** through EmPOWER beyond 2023, at levels of effort roughly consistent with those required to achieve the current program cycle goals. The 2019 GGRA Draft Plan also proposes to begin **incentivizing increased deployment of efficient electric heat pumps to heat homes in Maryland, including in homes that currently use a different fuel for heat, in order to improve the efficiency of residential heating systems, and to transition the energy source for home heating toward increasingly clean electricity**."

Source: 2019 GGRA Draft Plan. Emphasis added.

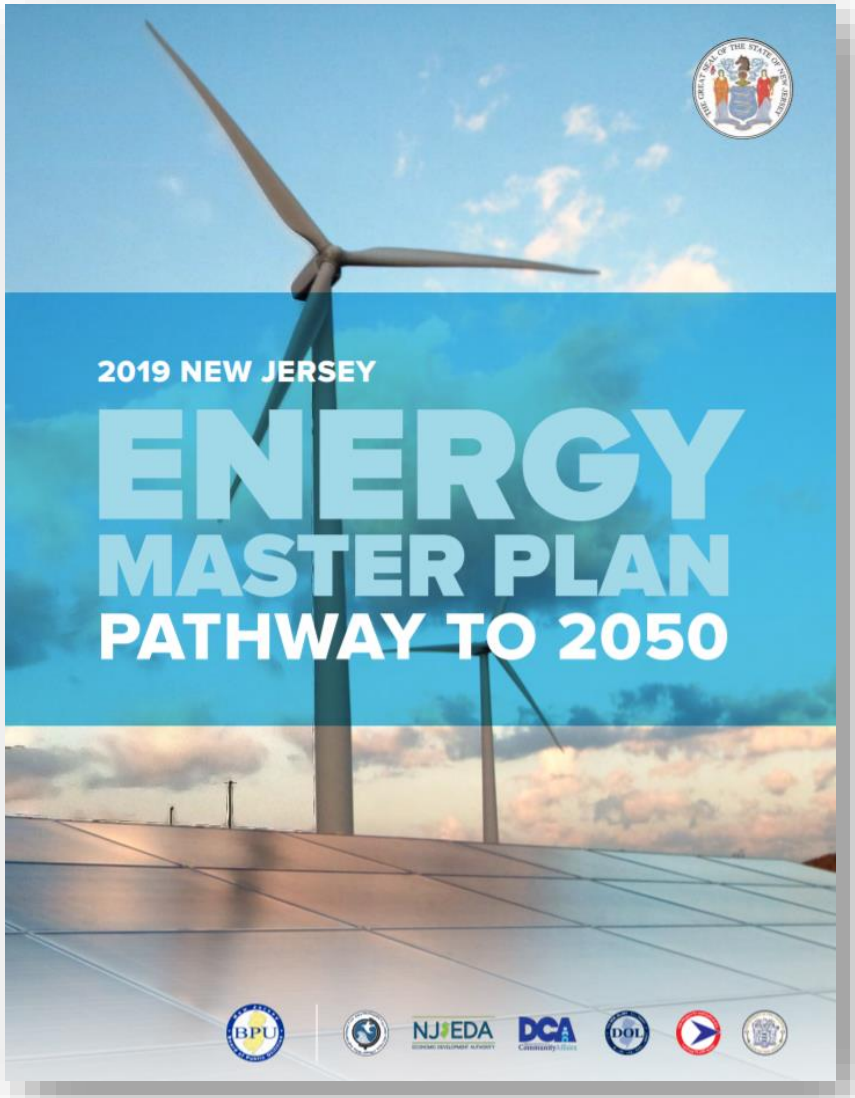
Electrification Can be the Lowest-Cost Option for Homes



"We find electrification is cost-effective for customers switching away from propane or heating oil, for those gas customers who would otherwise need to replace both a furnace and air conditioner simultaneously, for customers who bundle rooftop solar with electrification, and for most new home construction, especially when considering the avoided cost of gas mains, services, and meters not needed in all-electric neighborhoods."

Source: The Economics of Electrifying Buildings, RMI, 2018

Electrification Can be the Lowest-Cost Option for States



California, Oregon, Washington, and New Jersey found that high electrification scenarios are the lowest cost and lowest risk options for achieving those states' GHG reduction targets.

New Jersey – "The building sector should be largely decarbonized and electrified by 2050 with an early focus on new construction and the electrification of oil- and propane-fueled buildings… The state must also develop a transition plan to a fully electrified building sector, including incentivizing appliances like electrified heat pumps and hot water heaters."

Source: New Jersey Energy Master Plan. 2019.

Equipment for a Zero Direct Emissions Home

Air Source (or Ground Source)
Heat Pump

Air Source (or Ground Source)
Heat Pump Water Heater

Induction Range or Cooktop

Electric Heat Pumps Produce the Lowest Emissions

Ground source heat pump (GSHP): 73% lower emissions than natural gas furnace

Air source heat pump (ASHP): 63% lower emissions than natural gas furnace

Table 3: Estimated 15-Year Emissions from Highest Efficiency Residential Heating Systems

	Heating Efficiency[22]	Annual Heating Demand (MMBtu)	Annual Heating Energy Use (MMBtu)	15-year Emissions[23] (MtCO2e)
Ground Source Heat Pump	500%	50	10	**11**
Air Source Heat Pump	370%	50	14	**15**
Natural Gas Heat Pump	140%	50	36	**28**
Natural Gas Furnace	98%	50	51	**41**
Oil Boiler	90%	50	56	**62**

Based on highest efficiency equipment available in 2020. The highest efficiency ASHP in 2020 has a HSPF rating of 14.2 (SCOP 4.2) but efficiency is decreased in this analysis to SCOP 3.7 based on study results showing that efficient ASHPs perform about 12% below their HSPF/SCOP rated values in mixed-humid climates. Assuming a natural gas emissions factor of 0.0532 MtCO2e/MMBtu, oil emissions factor of 0.0744 MtCO2e/MMBtu, and electricity emissions factor of 0.0743 MtCO2e/MMBtu based on projected grid emissions in Maryland from 2021 to 2035.

ASHPs Can have the Lowest Installation and Energy Costs

RMI's *The Economics of Electrifying Buildings* study of four U.S. cities (though none in Maryland's climate zone) found using **standard air source heat pumps for space and water heating had a marginal impact on energy costs (+/- $50 per year) but significant savings on installation costs**. The all-electric package was $2,450 less expensive to install than the standard gas furnace, gas water heater, and electric air conditioner package in new homes and $1,075 less expensive in a retrofit.

Table 4: Average 15-Year Net Present Cost of Water and Space Conditioning in new Single-Family Homes in Four U.S. Cities[27] (Providence, Chicago, Houston, and Oakland)

	New Construction			Retrofit		
	Energy Cost	Fixed Cost	Total Cost	Energy Cost	Fixed Cost	Total Cost
ASHP Space Conditioner and ASHP Water Heater	$4,850	$6,850	$11,700	$11,175	$10,550	$21,725
Gas Space Heater, Gas Water Heater, and Electric AC	$5,475	$9,300	$14,775	$10,575	$11,625	$22,200
Difference	**($625)**	**($2,450)**	**($3,075)**	**$600**	**($1,075)**	**($475)**

Uncertainty on Local Installation Costs

- Interviews with two HVAC installers in Maryland support RMI's findings that an ASHP can be less expensive to install than a gas furnace and electric air conditioning (AC) system, especially when costs for gas fitting, venting, and permitting/inspection are included.
- MBIA provided data from one of its members indicating that upgrading to an ASHP would add cost compared with a gas furnace and AC system for a home in Montgomery County.
- A recent study by the Institute for Energy and Environmental Research estimates that for a 3,500 square foot home in Montgomery County, an ASHP would cost $1,800 more than a gas furnace and AC system. (*Side note: this study is also a good resource on the cost effectiveness of all-electric net-zero energy homes in Montgomery County*)
- Subgroup did not have time to discuss installation costs in commercial buildings.

Institute for Energy and Environmental Research. GOLD ON THE ROOF: THE ECONOMICS OF A NET-ZERO-ENERGY ROOFTOP SOLAR MANDATE FOR DETACHED HOUSING IN MONTGOMERY COUNTY, MARYLAND. September 2020.

Uncertainty on Energy Costs

- Data suggest that annual energy costs should be roughly the same between homes with ASHPs and homes with similarly rated natural gas heaters and central AC systems but more study would be helpful for specifying energy cost impacts for homes.

- NAIOP presented evidence that all-electric commercial buildings can have higher energy costs than conventional gas/electric commercial buildings. More study would be helpful for specifying energy cost impacts for commercial buildings, especially given the diversity of building types and uses within this sector.

Addressing Builder Cost Concerns

The Buildings Subgroup is recommending that the State offer tax credits or other incentives to builders to compensate for cost increases associated with all-electric new construction and waivers if projected costs are too high.

See Recommendation 4, Option A.

Reminder: 2020 MWG Policy Scenario Model Run

Fairly aggressive efficiency and electrification assumptions for buildings:

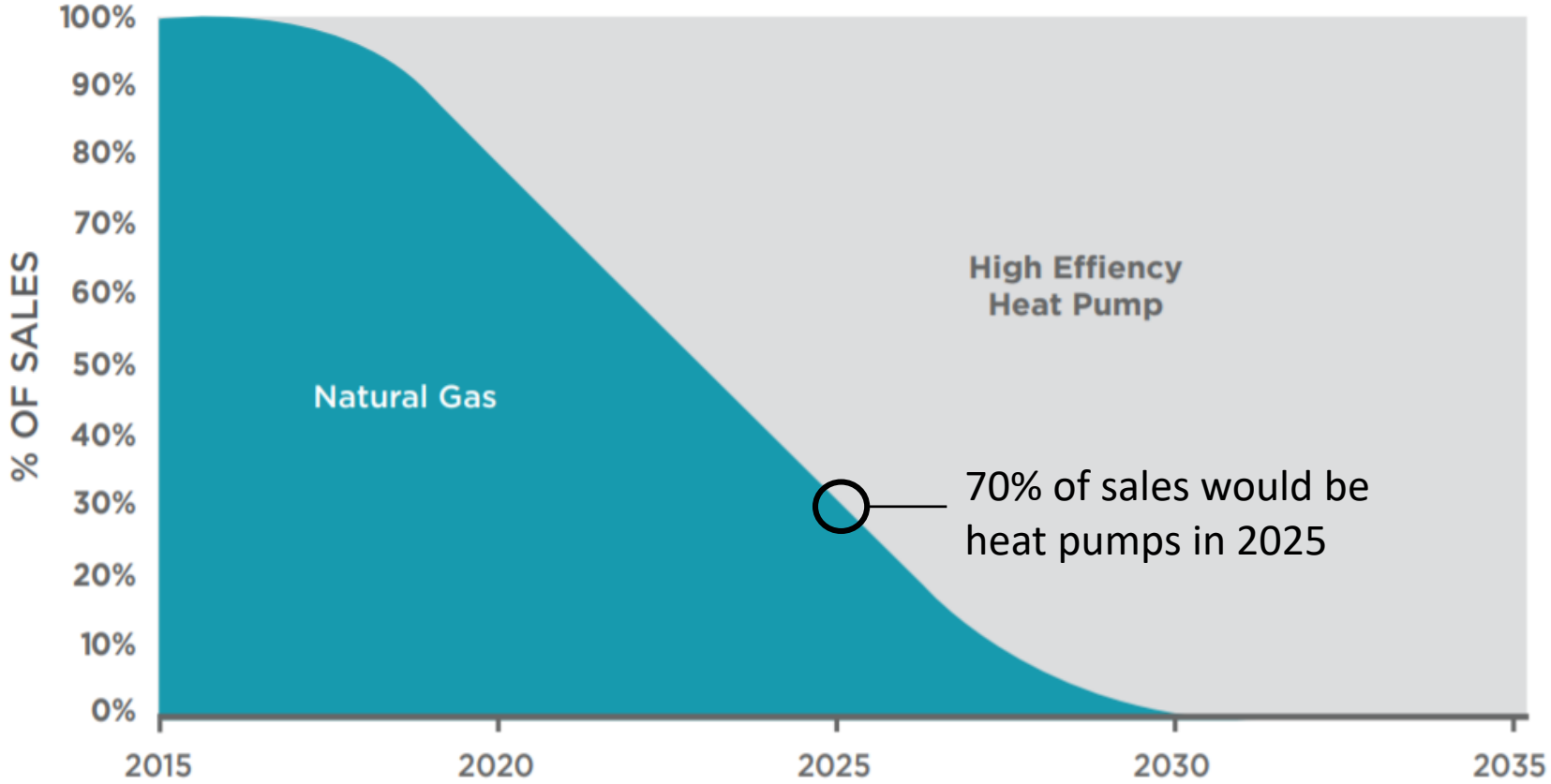
- Increase EmPOWER efficiency goals to 3% annual reduction by 2023 and beyond
- All-electric new construction beginning in 2025
- 1.3 million electric heat pump retrofits in existing buildings by 2050
- 50% of space heater sales in 2030 and 90% in 2050 are electric heat pumps

Would **reduce direct emissions from buildings around 41% by 2050** and, along with the other policy measures modeled, would leave Maryland about 9 MMtCO2e short of its minimum target (80% reduction in gross emissions) in 2050.

It may be necessary to exceed these measures for the State to meet its GGRA goal.

Might Need Faster Heat Pump Adoption for Net-Zero by 2045

The Building Decarbonization Coalition recommends that **100% of sales of new space and water heating systems be electric high-efficiency heat pumps by 2030** to achieve California's net-zero emissions by 2045 law.



Source: A Roadmap to Decarbonizing California Buildings, Building Decarbonization Coalition, 2019

Recommendations

Goal 1: Adapt EmPOWER for Beneficial Electrification

Recommendation 1: Enable Fuel-Switching to let Marylanders Choose Lowest Cost and Lowest Carbon Energy Systems

Justification

- It is cost effective for 99% of homes with propane, 95% of homes with oil, and 20% of homes with natural gas space heating systems in Maryland to switch to an efficient air source heat pump (ASHP) at the point of air conditioning (AC) system replacement.
- It is cost effective for roughly half of Maryland homes with both an AC unit and natural gas furnace near the end of their lives to switch to ASHP.
- Current EmPOWER Maryland incentives for installing electric heat pumps are only available to ratepayers who replace existing electric heating systems.
- Marylanders with fossil fuel heating systems cannot access EmPOWER incentives to replace their systems with electric heat pumps, which could lower their energy costs and reduce emissions.
- Several states already provide guidelines for fuel-switching, including Alaska, California, Vermont, and New York.

Goal 1: Adapt EmPOWER for Beneficial Electrification

Recommendation 1: Enable Fuel-Switching to let Marylanders Choose Lowest Cost and Lowest Carbon Energy Systems

Recommended Action

- The **General Assembly** should amend the Public Utilities Article (PUA) section §7-211 to allow electrification of existing fossil fuel systems through EmPOWER and direct the Public Service Commission to require the electric utilities to proactively encourage customers with propane or oil heating systems to replace those systems with electric heat pumps, especially for homes with central air conditioning, especially for low-income households and consumers.
- **State agencies** should also modify programs they manage to facilitate fuel-switching if not already allowed.
- The **Public Service Commission** should work with utility companies to determine the appropriate cost recovery for electrification programs.

Goal 1: Adapt EmPOWER for Beneficial Electrification

Recommendation 2: Let EmPOWER Facilitate Beneficial Electrification and Greater Energy Efficiency

Justification

- Electrifying fossil fuel end-uses in buildings is necessary for achieving Maryland's long-term emissions reduction targets, electrified systems can offer the most cost effective solutions for space heating and water heating, and several other states found that electrification-focused scenarios are the lowest cost options for achieving those states' emissions reduction targets.
- Electrification of buildings and transportation in Maryland is already called for in the State's GGRA Draft Plan.
- EmPOWER must be adapted to align with the State's many energy related goals, including its GGRA emissions reduction goals.

Goal 1: Adapt EmPOWER for Beneficial Electrification

Recommendation 2: Let EmPOWER Facilitate Beneficial Electrification and Greater Energy Efficiency

Recommended Action

- The **General Assembly** should amend the PUA section §7-211 to change the core objective of EmPOWER from electricity reduction to a portfolio of mutually reinforcing goals, including greenhouse gas emissions reduction, energy savings, net customer benefits, and reaching underserved customers. Massachusetts and New York have taken this approach.
- In so doing, the PUA should allow for beneficial electrification, which is when electrification meets one or more of the following conditions without adversely affecting the other two: 1) saves consumers money; 2) enables better grid management; and 3) reduces negative environmental impacts.
- The **General Assembly** should also direct the Public Service Commission to pursue all cost effective energy efficiency and electrification measures based on the value of avoided carbon, along with other avoided criteria pollutants and other societal benefits of efficiency, and on a schedule that meets GGRA emissions reduction targets.
- See report for additional action items.

Goal 1: Adapt EmPOWER for Beneficial Electrification

Recommendation 3 [Option A]: Target 50% of Space Heater Sales to be Electric Heat Pumps by 2025

Justification

- Rapid adoption of electric heat pumps is necessary for the buildings sector to achieve deep decarbonization in line with Maryland's GGRA targets.
- Currently, around 20% of space heater sales are electric heat pumps (air source or ground source).
- Enabling fuel-switching and beneficial electrification (Recommendations 1 and 2) should improve that rate.
- Incentivizing builders to install heat pumps in new buildings (Recommendation 4) would further improve it.
- A sales target alongside stronger financial incentives would help ensure that incentives are sufficient to encourage building owners and HVAC installers to accept heat pump technology and would help the State achieve its emissions reduction targets.
- DOE analysis suggests that for roughly half of Maryland homes with both an AC unit and natural gas furnace near the end of their lives, switching to an ASHP would be cost effective.

Goal 1: Adapt EmPOWER for Beneficial Electrification

Recommendation 3 [Option A]: Target 50% of Space Heater Sales to be Electric Heat Pumps by 2025

Recommended Action

The **General Assembly** should direct the Public Service Commission to ensure that EmPOWER programs, incentives, and implementation plans are sufficient to for 50% of space heater sales to be electric heat pumps (air source or ground source) by 2025.

or…

Recommendation 3 [Option B]: Establish Residential Heat Pump Retrofit Goals

Recommended Action

The **Mitigation Work Group** should establish annual heat pump retrofit targets for existing buildings sufficient to meet Maryland's 2050 decarbonization goals as part of an Energy Transition Plan described in Recommendation 6.

Goal 2: Construct Carbon Neutral New Buildings

Recommendation 4 [Option A]: Require All-Electric and Energy Efficient New Homes by 2025 and New Commercial Buildings by 2026 with Cost Controls

Justification

- Maryland should continue to be a national leader in adopting the newest construction codes, including appendices for net zero energy/carbon pathways, to ensure that all new buildings meet stringent energy efficiency standards and have low energy costs.
- However, installation of new fossil fuel infrastructure is counterproductive to meeting GGRA targets and creates significant risk of increased cost and stranded assets, especially when natural gas rates are expected to increase faster than electricity rates and fossil fuel alternatives (such as renewable natural gas, power-to-gas, and biodiesel) are in limited supply and more expensive than their fossil fuel counterparts.
- There is some evidence that all-electric new buildings can have lower or equivalent capital and operating costs compared with mixed-fuel buildings.
- Maryland should join the other jurisdictions that are requiring all-electric standards for new buildings.

Goal 2: Construct Carbon Neutral New Buildings

Recommendation 4 [Option A]: Require All-Electric and Energy Efficient New Homes by 2025 and New Commercial Buildings by 2026 with Cost Controls

Recommended Action (1 of 3)

- The **Maryland Building Codes Administration** should require additional energy use reductions relative to the current code, require that "on-site combustion of fossil fuels shall not be permitted for the provision of thermal energy to the building," and determine if any other parts of the codes would need to change in response to this amendment.
- Compliance with the all-electric requirement should begin by 2025 for new single-family homes and 2026 for new commercial buildings but publicly-owned buildings should meet the standard earlier to save taxpayers money and have Maryland government lead by example.
- The **General Assembly or Administration** should adopt requirements for all-electric and energy-efficient new buildings for state funded facilities including requirement to ensure that fossil fuel equipment at the end of its useful life is replaced with cost effective electric heating and cooling options.
- Electric vehicle charging, solar-ready, smart grid, and demand response-ready amendments should also be added to codes as soon as possible.

Goal 2: Construct Carbon Neutral New Buildings

Recommendation 4 [Option A]: Require All-Electric and Energy Efficient New Homes by 2025 and New Commercial Buildings by 2026 with Cost Controls

Recommended Action (2 of 3)

However, the **Maryland Building Codes Administration** should allow on-site combustion of fossil fuels if energy models, specific to the project, show that an all-electric building would have a significantly higher lifecycle cost than a mixed-fuel building.

A. **If the lifecycle cost of the all-electric option is less than or equal to the lifecycle cost of the mixed-fuel option without subsidies, then the all-electric requirement would be upheld.**

B. If the lifecycle cost of the all-electric option is up to X% greater than the lifecycle cost of the mixed-fuel option without subsidies, then **funding from EmPOWER, tax credits, or other sources should be available (without delaying the project schedule) to reach lifecycle cost parity between the all-electric and mixed-fuel options and uphold the all-electric requirement.**

C. If the lifecycle cost of the all-electric option is X% greater than the lifecycle cost of the mixed-fuel option without subsidies, **then the all-electric requirement may be waived**.

Goal 2: Construct Carbon Neutral New Buildings

Recommendation 4 [Option A]: Require All-Electric and Energy Efficient New Homes by 2025 and New Commercial Buildings by 2026 with Cost Controls

Recommended Action (3 of 3)

- Life cycle cost analysis should be part of the Energy Code development process when the State considers future versions of IECC, including 2021 IECC, which will come before the State in 12 to 18 months. Reasonably foreseeable future costs of combustion, such as costs resulting from stranded fossil fuel assets or carbon pricing, should be considered when calculating lifecycle costs.
- Buildings that have uninterruptible energy needs that cannot be met cost effectively with on-site battery storage (using the rules and incentives listed in this recommendation) and buildings that include combined heat and power systems would be exempt from the all-electric requirement. New buildings connected to an existing district energy system would follow the all-electric requirement but the energy source for that district energy system could use fuels other than electricity. New energy sources for new or existing district energy systems should evaluate the lifecycle costs and emissions of alternative designs including an all-electric system.

Goal 2: Construct Carbon Neutral New Buildings

or **Recommendation 4 [Option B]: Require All-Electric and Energy Efficient New Homes by 2025**

Recommended Action (1 of 2)

- The **Maryland Building Codes Administration** should, for new homes, require additional energy use reductions relative to the current code, require that "on-site combustion of fossil fuels shall not be permitted for the provision of thermal energy to the building," and determine if any other parts of the codes would need to change in response to this amendment. Compliance with the all-electric requirement should begin by 2025.
- The **General Assembly or Administration** should adopt requirements for all-electric and energy-efficient new buildings for state funded facilities including requirement to ensure that fossil fuel equipment at the end of its useful life is replaced with cost effective electric heating and cooling options.
- Electric vehicle charging, solar-ready, smart grid, and demand response-ready amendments should also be added to codes as soon as possible. Life cycle cost analysis should be part of the Energy Code development process when the State considers future versions of IECC, including 2021 IECC, which will come before the State in 12 to 18 months.

Goal 2: Construct Carbon Neutral New Buildings

Recommendation 4 [Option B]: Require All-Electric and Energy Efficient New Homes by 2025

Recommended Action (2 of 2)

- In developing the Energy Transition Plan described in Recommendation 6, the **Mitigation Work Group** should consider adoption of a broader all-electric requirement for all new buildings with accommodation for the diversity of commercial, industrial, and institutional buildings, and including appropriate exclusions for buildings utilizing district energy systems and combined heat and power system, for buildings with overriding need for uninterruptable energy needs, and for cases where additional costs of all-electric construction would be unacceptably high.

Goal 2: Construct Carbon Neutral New Buildings

Recommendation 5: Incentivize Net-Zero Energy, Energy Efficient, All-Electric New Buildings

Justification

- All-electric buildings produce zero direct emissions but still have some indirect emissions from conventional electricity supplies until the grid becomes carbon neutral.
- All-electric net-zero energy buildings, on the other hand, are carbon neutral immediately because they produce 100% of their annual electricity demand from on-site or, potentially, near-site zero-carbon renewable energy systems.
- A recent study examining the cost of building net-zero energy all-electric new homes in Montgomery County, in response to the County's initiative for new single-family residential construction to include rooftop solar starting in 2022, found that "new net-zero-energy detached homes with rooftop solar – which annually generate as much electricity as they consume – are more economical than conventional homes. Annual average savings over the life of a 30-year mortgage would be about $1,100 per year relative to a gas-heated house built to the same overall standards."
- Incentives help with early adoption.

Goal 2: Construct Carbon Neutral New Buildings

Recommendation 5: Incentivize Net-Zero Energy, Energy Efficient, All-Electric New Buildings

Recommended Action

- The **Maryland Building Codes Administration** should develop optional codes and standards for all-electric net-zero energy buildings, including allowance of near-site renewable energy systems such as community solar projects, and determine how to incentivize builders to design to those standards.
- This work should be coordinated with the Maryland Department of Housing and Community Development (DHCD) in shaping incentive offerings since DHCD already has a Net Zero Loan Program in place and could provide useful insights on program design and existing market gaps to increase the reach of other incentive efforts.

Goal 3: Develop an Energy Transition Plan

Recommendation 6: Produce an Energy Transition Plan by the end of 2021

Justification

- The State should develop an Energy Transition Plan to coordinate long-term activities and ensure that the overall buildings sector strategy achieves equitable benefits for disadvantaged communities, anticipates and prevents escalating distribution system costs for shrinking pools of natural gas customers, and takes advantage of opportunities for economic growth, including for the agricultural community from renewable fuel development and EmPOWER market optimization.

Recommended Action

- The **Mitigation Work Group** should coordinate a research and planning process that addresses several issues (see report for list of outcomes)

Goal 4: Prioritize Benefits to Underserved and Limited-Income Consumers and Households

Recommendation 7: Prioritize an Equitable Level of Benefits for all Marylanders

Recommended Action

The **Governor, State Agencies, Commissions, and General Assembly** should ensure that all policy decisions to reduce greenhouse gas emissions from the building sector in Maryland, including those within these recommendations, prioritize an equitable level of benefits to limited income households, the state's affordable and multi-family housing stock, and low income ratepayers, and concurrently with the benefits provided to others. This includes policies and programs that prioritize:

A) alignment with other building retrofit programs, like health and safety upgrades;
B) measurable outcomes for which low-income households are better off after participation in programs including metrics to ensure benefits are flowing to increase equity and equitable outcomes, and is triaged by known disparities and gaps; and
C) retrofit implementation at no cost for the state's most financially vulnerable consumers.

Furthermore, the **MWG** should commission a study to determine the impacts on limited income households and small businesses of the electrification programs recommended above.

Goal 4: Prioritize Benefits to Underserved and Limited-Income Consumers and Households

Recommendation 8: Improve Interagency Coordination for Wholistic Building Retrofits

Recommended Action

- The **Governor, via Executive Order, or General Assembly, via legislation**, should revive an Interagency Task Force with the goal of increased and consistent coordination across programs, policies, and funding streams to retrofit the state's existing building stock to achieve healthier, safer, more efficient, and climate-friendly homes and businesses.
- This Green and Healthy Task Force would identify opportunities to align lead, mold, asbestos, and indoor air quality remediation intervention schedules and programs with energy efficiency upgrades and electrification retrofit programs to ensure a more cost-effective, whole-building retrofit program that meets the state's various health, safety, affordability, and climate action goals.
- Progress should be tracked and measured through a public state dashboard.

Appendices

Building Subgroup Objectives

Primary Objectives from the MWG:

- Analyze and determine specific targets and timelines for decreasing emissions from residential and commercial buildings (or, information needed to determine such targets and timelines), including: annual building retrofit targets; specific energy efficiency targets; a timeline for requiring all new buildings be carbon neutral; and a timeline for replacing fossil-fuel heating systems with electric heating or other low-carbon systems.
- Analyze and identify specific mechanisms for decreasing emissions from residential and commercial buildings (or, information needed to determine appropriate mechanisms), including: expanding programs that support upgraded electric heating and cooling system; new programs to encourage combined heat and power; incentives and other strategies that support the replacement of fossil-fuel heating with electrical systems.

Secondary Objectives from the Buildings Subgroup:

- Consider how mechanisms for mitigating emissions from residential and commercial buildings could influence the industrial sector's opportunities and costs for mitigating emissions.
- Analyze and identify specific mechanisms for reducing and eventually neutralizing the carbon intensity of fuels delivered to buildings.