AECOM

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Statewide Cost of Decarbonization Memo

Introduction

In 2022, Maryland passed the Climate Solutions Now Act, a landmark bill that has a set target to reduce GHG emissions by 60% by 2031 and net zero emissions by 2045. As a result of this Act, the Maryland Department of the Environment (MDE) has created the Building Energy Transition Implementation Task Force. Appointed members are tasked with recommending programs, policies, and incentives aimed at achieving net zero direct emissions by 2040 from the building sector which is broken into four subgroups for the purpose of this initiative: large commercial buildings (> 35,000 ft^2) covered by the BEPS, small commercial and institutional buildings not covered by BEPS, market-rate housing (single- and multifamily), and low- or limited-income housing. The Task Force is developing recommendations for commercial tax credits, incentives, programs, and financing mechanisms to achieve statewide building decarbonization. A significant component to developing these recommendations is assessing the upfront and annual costs of decarbonizing the Maryland building sector.

AECOM is supporting the Task Force as the technical analyst partner to MDE providing building data aggregation, analysis, and cost estimation for select Task Force recommendations. The data used in these analyses comes from MDE partners Lawrence Berkeley National Laboratory (LBNL) and Rewiring America. LBNL calculated the estimated cost for decarbonization of BEPS covered buildings in the commercial sector, focusing on updates of, or retrofits to, HVAC systems. Rewiring America calculated the estimated cost of decarbonizing residential buildings, focusing on the cost associated with HVAC electrification and electric panel upgrades. The partners were not tasked with developing data for the cost of decarbonizing the noncovered commercial building sector. AECOM has aggregated the data into the Maryland Cost of Decarbonization spreadsheet, a tool that can be used to estimate the financial impact of programs designed to support building decarbonization throughout the state.

This memo is designed to accompany the tool, elaborating on the data captured in the MD Cost of Decarbonization spreadsheet, describing the methodology of research partners in performing cost estimates, the results of the estimates, and an overview of utilizing the spreadsheet effectively.

Overview of Methodologies

AECOM has aggregated and summarized the results of the cost of building decarbonization analysis from the Task Force research partners. Rewiring America and LBNL used different data sources and estimation sources for their respective building subgroups to evaluate building decarbonization costs. The methodologies for both partners are summarized in this section.

Rewiring America modeled cost savings for both heat pump upgrades (electrification focus) and high efficiency gas furnace upgrades (energy efficiency focus) in addition to electric panel upgrades in residential homes to understand the cost difference between household electrification and making similar upgrades to efficient fossil fuel appliances. Upfront costs for electric and fossil fuel equipment were modeled for all homes in the building stock dataset based on estimated need for heating and cooling capacity. Federal and state incentives to reduce upfront costs were also applied to eligible households. Residential energy modeling and building stock data came from National Renewable Energy Laboratory's (NREL) ResStock[1] and the E3 Maryland Decarbonization Study was used for electricity and gas rates. State and federal incentive eligibility data was retrieved from Federal IRA and Maryland State agencies and incentive program documentation (Maryland Energy Authority, Department of Housing and Community Development, Multifamily Energy Efficiency and Housing Affordability Program, Utility).

[1] ResStock Analysis Tool | Buildings | NREL

Rewiring America estimated costs of building decarbonization for three different income levels. These income levels are defined as:

- Low Income, or households with < 80% Area Median Income (AMI)
- Middle income, or households with 80-150% AMI
- High Income, or households with > 150% AMI

The values for upfront capital costs of upgraded HVAC equipment were based on modeled home estimates and do not reflect actual costs for any given home. Many of the estimates are highly subject to change, as annual operating costs will vary based on actual utility rates and energy usage and utility or other incentive programs may enact new funding levels. The data includes the incremental cost of installing heat pumps and the costs for upgrading electrical panels to support HVAC electrification. Modeling and cost estimation does not include the electrification of non-HVAC household appliances such as gas/electric stoves or water heaters, nor does it include efficiency upgrades such as weatherization or insulation improvements.

The LBNL analysis on the cost of decarbonizing BEPS covered buildings used data from the draft Maryland Covered Building List. The site Energy Use Intensity (EUI) data came from EPA's Energy Star Portfolio Manager dataset and the ratio of fuel used for space and water heating came from NREL's ComStock and Commercial Buildings Energy Consumption Survey (CBECS). LBNL worked with the Pacific Northwest National Laboratory (PNNL) to conduct a Building Performance Standard Retrofit cost study analysis inclusive of energy efficiency retrofit costs, electrification of traditional fossil fuel-fired systems, and business as usual like-for-like replacement costs for fossil fuel-fired systems and equipment. This analysis leveraged a search of existing Building Performance Standard cost studies and energy efficiency and electrification measures with Maryland-specific commercial building data to develop cost curves across different building types. The PNNL cost curves were integrated with the LBNL impact model to quantify cost-benefit and model compliance rates. Key assumptions in this analysis include: all new electric construction, high rates of electrification retrofits for existing buildings, and dual-fuel retrofits for existing commercial buildings reflecting net zero emissions by 2040 in accordance with the Maryland Building Energy Transition Plan. The cost-benefit analysis includes capital costs for electric efficiency, gas efficiency, and electrification as well as ongoing costs for electricity, gas, and additional compliance payments.

Due to limited data availability and the natural uncertainty in future energy usage and energy prices, all datasets and results provided by both Rewiring America and LBNL should be considered best available estimates, subject to change. In addition, the Non-Covered Commercial building sector was not analyzed and does not have existing cost of building decarbonization data.

Results

The results of the research and analysis of both LBNL and Rewiring America are captured in the Maryland Cost of Building Decarbonization spreadsheet and are used for estimating the cost of implementing decarbonization-focused programs. The results of these analyses for both residential and commercial decarbonization are estimates based on historical data and future projections, limited to HVAC electrification and decarbonization. Results are not adjusted for inflation and are not discounted into present value with a discount rate. They do not consider changes in energy prices, changes in building use type, or changes to upkeep or maintenance needs. In addition, the results do not consider future efficiency/electrification technologies that are not currently on the market.

Residential Electrification

Rewiring America studied the incremental cost of heat pump installation and electric panel upgrades compared to the cost of like for like HVAC replacement for both low-income and market rate residential homes across Maryland. Costs were broken down by household income group (<80% AMI, 80%-150% AMI, and >150% AMI) and includes costs savings through IRA tax credits and utility, MEA, DHCD, and IRA rebates. The total remaining cost gap to electrify the entire residential building sector is estimated to be $26.1B, as shown in Table 1. The Inflation Reduction Act tax credits and other rebates are major contributors to reducing the overall cost of decarbonizing residential buildings, most significantly for low-income homes.

Table 1 Estimated Cost of Decarbonization of Residential Buildings

Residential Buildings	**# of Buildings**	**Total Sq. Ft.**	**Average Sq. Ft. per Building**	**Years (2025-2045)**	**Estimated Cost of Decarbonization**
	1,823,247	4,499,595,918	2,468	20	$26.1B
	Low Income Electrification Cost	**Market Rate Electrification Cost**	**Total Difference Electric and Fossil Fuel Upfront Costs**	**Total Costs/year**	**Cost/Sq. Ft./year**
	$7.3B	$18.8B	$26.1B	$1.3B	$ 0.29

Currently, the upfront costs of switching to an electric heat pump are significantly higher than upgrading to high-efficiency gas furnace and AC for all housing types and income levels, other than single-family low-income households eligible for whole-home DHCD rebates who pay nothing for HVAC electrification after rebates (about 530,000 households are eligible). Despite higher upfront costs at the current rebate structure**,** 98% of residential buildings will have lower energy costs over 20 years with if they upgrade to an electric heat pump rather than a high efficiency gas furnace. However, current rebate structures from all contributors including IRA, Utilities, MEA, and the Department of Housing and Community Development, go further in reducing costs for upgrading to high efficiency gas furnaces as opposed to upgrading to heat pumps, indicating possible opportunities to reallocate funds to further incentivize deep electrification rather than just efficiency improvements.

Commercial Electrification

LBNL's analysis of BEPS potentially covered commercial buildings identified that early investments in electrification and energy efficiency will result in significant energy and emissions reductions for covered buildings, particularly as gas prices are expected to increase rapidly over electric prices in the near future. Results of LBNL's analysis and estimations for cost of decarbonization of BEPS potentially covered commercial buildings are shown in Table 2.

Table 2 Estimated Cost of Decarbonization of Commercial Buildings

Potentially Covered Buildings	**# of Buildings**	**Total Sq. Ft.**	**Average Sq. Ft. per Building**	**Years (2025-2040)**	**Estimated Cost of Decarbonization**
	9,259	988,446,176	106,755	15	$15.3B
	Energy Efficiency upgrade cost	**Electrification cost**	**Total Costs**	**Total Costs/year**	**Cost/Sq. Ft./year**
	$8.9B	$6.4B	$15.3B	$1.0B	$1.03

LBNL found that decarbonization of covered buildings will include investments in both electrification and energy efficiency, for a total estimated cost of $15.3 billion. However, this is an average across the entire building sector – some buildings are already efficient and will require little to no investment to achieve BEPS energy consumption targets, while some buildings, particularly aging buildings, will need a large investment to decarbonize.

Utilizing the Spreadsheet

The cost of decarbonization estimates presented in this memo and in the Maryland Cost of Building Decarbonization spreadsheet represent an estimated cost of building decarbonization based on reasonable assumptions on installation costs and building attributes.

These estimates provide insight into the total aggregate cost of building decarbonization and can be used for planning purposes as well as for budgeting and allocating incentive/rebate programs. The spreadsheet presents total cost figures for

BEPS potentially covered buildings and all residential buildings. For recommended grants and incentive programs aiming to reduce a percentage of the total cost, this spreadsheet can be used to estimate the level of incentive that is required. These costs can be broken down over time to estimate the costs per year. For residential buildings, costs are also broken down by income levels. AECOM conducted a separate analysis using cost estimates from this spreadsheet to estimate the total cost to the state if Maryland continues to provide the IRA HEAR rebates after they are expected to run out in 2024 until the entire residential sector is electrified with heat pumps. Similar analysis on incentives recommendations targeting potentially covered buildings or various income levels for residential buildings can also be performed using this tool

The spreadsheet also includes estimates for the number of buildings and floor space for BEPS potentially covered buildings and number of households for residential buildings. These measures can be used to derive high-level estimates for costs per building, costs per square foot, and costs per household. These costs per unit measures can be used as rough proxies to estimate costs for other building stocks or subsets of buildings included in the buildings stock summary. It is important to note that due to the imprecise nature of these cost estimates, they should not be used to budget project ready costs for any particular building or home, but as high-level estimates for a large group of buildings.

Conclusion

The MD Cost of Decarbonization Summary spreadsheet will be used to better inform policy recommendations from the Task Force to the State to achieve decarbonization targets. AECOM has used the data when analyzing the cost of programs recommended by the Task Force to understand their impact to the State. Additionally, Maryland can use this spreadsheet to further breakdown annual costs, savings, benefits, and ultimately plan specifics of widespread building decarbonization. Decarbonization and electrification costs will remain high, but with effective state planning, leveraging of federal resources, and collaboration between utilities, communities, and federal, state, and local governments, significant progress towards meeting State and federal climate targets can be made.