Research Memo: Residential Weatherization & Energy Retrofits

Georgia Institute of Technology

ISYE 6701

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Introduction

The proposed climate pollution reduction program focuses on residential weatherization and energy retrofits as a key strategy to mitigate greenhouse gas (GHG) emissions and enhance energy efficiency in the Metropolitan Statistical Area (MSA) of Atlanta, Georgia. This program aims to address the significant carbon footprint of residential buildings by promoting the adoption of energy-efficient technologies, such as heat pumps, insulation upgrades, and high-efficiency appliances. By retrofitting existing homes and improving building envelopes, the program seeks to reduce energy consumption, lower utility bills for homeowners, and decrease CO2e emissions. The program also includes targeted policies such as contractor training, rebates for energy-efficient products, and financial incentives to accelerate the adoption of these technologies.

The program is designed to build on past experiences with residential weatherization and energy efficiency initiatives, which have demonstrated both the potential and challenges of such efforts. Historically, programs like the U.S. Department of Energy's Weatherization Assistance Program (WAP) and various state-level rebate programs have shown that energy retrofits can significantly reduce energy consumption and GHG emissions. However, these programs have also highlighted barriers to widespread adoption, including high upfront costs, labor shortages, and the need for consumer education. In Georgia, state-funded programs such as the Low Income Home Energy Assistance Program (LIHEAP) and the Home Energy Rebates (HER) have provided financial support to low-income households, but participation rates have often been limited by procedural inequities and lack of awareness.

The proposed program seeks to address these challenges by incorporating lessons learned from past initiatives. It emphasizes equitable access to weatherization services, particularly for low-income households, and includes measures to expand the skilled labor force needed to implement retrofits at scale. By leveraging existing state and federal incentives, the program aims to make energy-efficient upgrades more accessible and affordable, while also driving economic growth through job creation in the construction and energy sectors.

This research memo provides a comprehensive analysis of the proposed program, including its technical potential, financial costs, equity impacts, and co-pollutant considerations. By comparing the program's outcomes to a Business-as-Usual (BAU) scenario, the memo highlights the potential for significant CO2e emission reductions and improved public health outcomes. The findings underscore the importance of a holistic approach to residential weatherization, one that balances energy efficiency goals with environmental and social equity considerations.

Topic 1

BAU Scenario

The BAU scenario is the baseline with which to compare the proposed weatherization and energy efficiency policy changes. It represents a modest projection of as-needed retrofits to buildings that need them year over year with upgraded equipment assuming regular advancements in technological improvements. The BAU scenario was gathered from Energy Innovation LLC’s Energy Policy Simulator (EPS), developed as part of their Energy Policy Solutions project. The project is designed to inform policymakers and regulators about the consequences of their policy decisions regarding climate action so they may consider such factors as greenhouse gas emissions (GHG), economic impact, and public health (Energy Innovation, 2025).

U.S. Energy Information Administration State Energy Data Systems from 2021 make up the main sheets used in the BAU scenario. The 2017 NERL Electrification Futures Study was used to break up total energy consumption into different building end uses like heating and cooling, lighting, etc. The NERL reference scenarios were also used to forecast future energy use and model fuel switching from gas to electric appliances and improvements in performance efficiency. The BAU scenario in the building sector factors in the purchase of new components and the lifespan of most equipment, which they assume to be 14 years. The proposed weatherization and energy efficiency policy changes will be compared to this BAU baseline grounded in 2021 data.

Potential CO2e Emission Reductions

The policy changes analyzed using the EPS include contractor training, rebates for energy efficient products, and retrofitting of existing buildings. Contractor training centers on energy-efficient products and installation practices, most of which focus on envelope components like insulation and air sealing. Rebates for energy efficient products applies primarily to household appliances. The EPS estimates $50-100 for a clothes washer and $25-50 for a refrigerator or dishwasher. Retrofitting existing buildings is defined as upgrades to building systems like heating, cooling, and envelope components.

The contractor training is a necessary policy addition because labor is the largest assumption and biggest inhibitor to a quick execution of the needed retrofits in the MSA area. The rebate program in the EPS is very conservative, which could lead to an underestimation of total emission reductions. The state of Georgia offers rebates and tax incentives ranging from [1]$120 to $18,000 depending on the equipment purchased and household income.

To set up the potential emission reductions simulation using the EPS, both the contractor training and rebate programs were turned on, and the retrofit of existing buildings was set at an ambitious but reasonable rate of execution detailed in the table below.

Table 1. EPS policy setpoints for retrofits of residential buildings

The EPS allows a 50% building retrofit maximum, but it was determined that 70% of residential households could reasonably be retrofit by 2050. Because of this discrepancy, the policy is set to reach 100% completion (50% of buildings) by 2041, and the remaining 20% would be complete in the next 9 years to reach a 70% residential household retrofit total.

Year	Percent of Policy Completion (relative to simulator cap 50% of residential buildings)	Percent of Actual Household Retrofits (relative to MSA)
2025	0	0
2035	76%	38%
2041	100%	50%
2050	100%	70%

These percentages are based on a total of 1.2 M households in need of retrofit in the MSA area (United States Census Bureau, 2020) (U.S. Energy Information Administration, 2023).

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Stakeholder acceptance, assistance programs, labor availability, and current adoption rates were analyzed to determine the feasible number of retrofits in a particular timeline. This involved evaluation of the cost of a deep retrofit (major household systems), area median income (AMI), state rebate and tax incentives, state weatherization programs, and return on investment (ROI) from energy savings. To ensure the best representation of all household types in the MSA area, 4 model Household Types were created based on AMI and eligibility for certain state weatherization programs.

Table 2. Four model household types representative of the MSA area

Cost and Benefits for Retrofit	**Household 1**	**Household 2**	**Household 3**	**Household 4**
Average total cost of retrofit	$26,050.00	$26,050.00	$26,050.00	$26,050.00
Georgia Home Energy Rebates	$18,000.00	$18,000.00	$30,000.00	$30,000.00
LIHEAP	$ -	$ -	$ -	$8,250.00
WAP	$ -	$4,544.00	$ 4,544.00	$4,544.00
Final Cost of Retrofit	$8,050.00	$3,506.00	$ (8,494.00)	$(16,744.00)
Average Income	$74,668.33	$59,867.00	$50,259.00	$ 40,769.00
Burden of Retrofit	11%	6%	-17%	-41%
ROI years from energy savings	5.86	2.55		

The average cost of a retrofit was found by summing the average cost of equipment and installation for three major household systems: heat pumps, hybrid heat pump water heater, and insulation. The Georgia home energy rebates consist of two programs: Home Energy Rebates (HER) and Home Electrification and Appliance Rebates (HEAR). LIHEAP and WAP are state funded programs available to eligible households that fall below 60% of the state's median income and 200% of the federal poverty line respectively (State of Georgia, 2024). AMI was pulled from the Drawdown Georgia Solutions Tracker, and the specific database for AMI came from the U.S. Census Bureau. The burden of the retrofit is a percentage indicating the final cost of the retrofit to the average income of the household. The ROI in years was calculated using average electricity costs in the MSA area and the reported WAP estimated annual energy savings per household.

Table 3. Household type by county

	# of Counties in MSA area	**Project Timeline (yrs/unit)**
Household 1	18	6
Household 2	3	3
Household 3	7	1

Household 4	1	1

Based on the household analysis, 2 out of the 4 Household Types can be fully compensated with existing state programs for the retrofit. With the energy savings from the retrofit, the return on investment would take between 3 and 6 years depending on initial cost. Cost would be the biggest barrier to consumers for the new efficient technologies, especially in the MSA area where the average county AMI is $66,000 (Brown M. e., 2019). The technology of heat pumps is relatively well accepted in Georgia with a 27% penetration rate (U.S. Energy Information Administration, 2023). They are the fifth highest using state of the technology behind Alabama, Mississippi, North Carolina, and Tennessee. Southern states have a climate suitable for the cheaper models of heat pumps making them more attractive than in other areas of the country. There are technicians available to install the new equipment, but labor is the next bottleneck for adopting the retrofit policy. There are only so many technicians, and they have other jobs besides retrofits, like new construction.

Given the issue of labor, the object of cost, and the existing financial incentives, it would be feasible to do Household 2, 3, and 4 Types in the first 10 years of the policy with the right resources available. Th remaining Household 1 Type home could be complete in the following 15 years. This is a little aggressive, and to keep it realistic, given the ROI for the higher income households paying more, it would take twice as long to space out the retrofits, so the remaining households will take 30 years. This timeline translates into the policy allocation shown in Table 1. With these EPS setpoints for weatherization and energy efficiency policies, the total potential emission reductions are 22.71 million metric tons of CO2e between 2025 and 2050.

Table 4. Total potential emission reductions with weatherization and energy efficiency policies (million metric tons)

Year	BAU Emissions	Achievable Emissions	Emission Reductions
2025	149.52	149.34	0.17
2035	118.43	117.23	1.2
2050	115.21	113.98	1.23
Total Abated CO2e 2025-2050 (M metric tons)			22.71

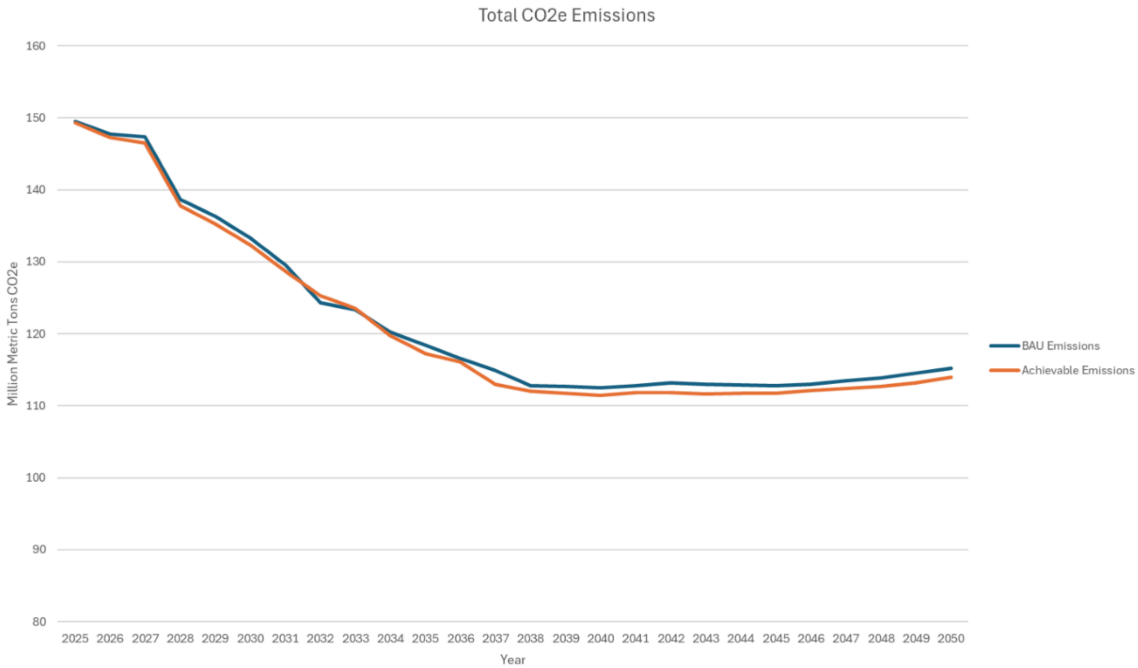

Figure 1. Total CO2e Emissions: BAU compared to Achievable

Topic 2

Technical Potential

The technical potential of a climate solution denotes the extent to which it can be implemented over a given period considering current technology and projected resource availability. Here, the technical potential of residential energy retrofits in the ARC MSA is the number of installations of high efficiency heating and cooling equipment or insulation improvements in homes that can be completed without consideration of financial or user acceptance constraints up to relevant resource limitations. As noted above, labor is the primary resource constraint on adoption of home energy retrofit solutions such as high efficiency heat pump installations. Given that air source heat pumps are highly effective in reducing home energy use and require specialized labor to install, they serve as an analog for understanding the impacts of labor constraints on technical potential.

According to the Bureau of Labor Statistics (BLS), there are approximately 6,610 HVAC mechanics and installers in the 29-county Atlanta-Sandy Springs-Roswell, GA MSA (U.S. Bureau of Labor Statistics, 2023). Given the approximately 1.2 million homes in the MSA in need of HVAC retrofitting by 2035, the required additional installation capacity necessary is 120,000 installations per year or ~18 installations per HVAC technician with each installation taking between 6 hours and 2-3 days (How Long Does it Take to Install a Heat Pump?, 2025). Assuming an average of 1.5 days per heat pump installation, 250 working days per year, and 50% of a technicians working time spent on installations rather than repair and service, a technician can install ~83 heat pumps per year. The Drawdown GA Solutions Tracker tool notes that of the counties in the MSA, Walton County has the highest market penetration of heat pumps at 29.63% (Brown M. e., 2019). So, estimating that at most 30% of the HVAC technician workforce in the MSA is proficient in heat pump installations, the total installation capacity of the regional workforce is ~165,000 heat pumps annually.

HVAC technicians in the region will be responsible for installation of both retrofitted systems and new build installations, meaning this capacity must also account for the growing housing needs of the region. ARC estimates that between 2025 and 2035 a 21-county metropolitan region around Atlanta will increase in population by approximately 500,000 people and extrapolating out to the remaining 8 counties in the MSA projects ~690,500 additional residents (Atlanta Regional Comission, 2024). Georgia has an average of 2.64 people per household, so the 29-county region could see a growth of ~261,500 housing units by 2035 or 26,150 units per year (United States Census Bureau, 2023)Accounting for both retrofit needs and new housing units, the current regional HVAC workforce can technically accommodate the estimated annual demand of 146,150 units/year.

Considerable investment in Georgia's clean energy workforce would ensure a reasonable timeline of adoption for residential energy retrofits. However, skilled labor is not a static resource. The BLS projects 9% growth in HVAC technician employment from 2023 to 2033 due to existing demand for new construction and energy efficiency upgrades to existing housing (U.S. Bureau of Labor Statistics, 2023). Additionally, the assumed 100% user acceptance rate inherent to technical potential calculations represents a stronger market trend in favor of energy efficiency that can drive demand for skilled labor beyond projected business as usual growth. New entrants to the HVAC field are required to undergo a licensure process which may include formal education and/or apprenticeship and typically takes 3-5 years to complete (The Career Path for HVAC, 2023). So, accounting for delayed market response due to education, a high demand scenario reasonably increases the HVAC technician workforce to sufficient levels over the next decade to support the following 15 years of continued market growth if the present heat pump installation capacity is overestimated. Therefore, the technical potential of retrofits is functionally 100% of homes in need by 2035 and 2050.

EPS Example

In this section, we turn to the simulator, and in the previously created scenario, the implementation time is adjusted to reach 100% by 2035. Based on the results obtained from the graphs, CO_2 emissions decrease considerably until 2039, then increase slightly. In the case of emissions by sector, a similar trend can be observed for buildings, transportation, and electricity. However, in the case of industry, they continue to increase, while in the case of land, they remain unchanged.

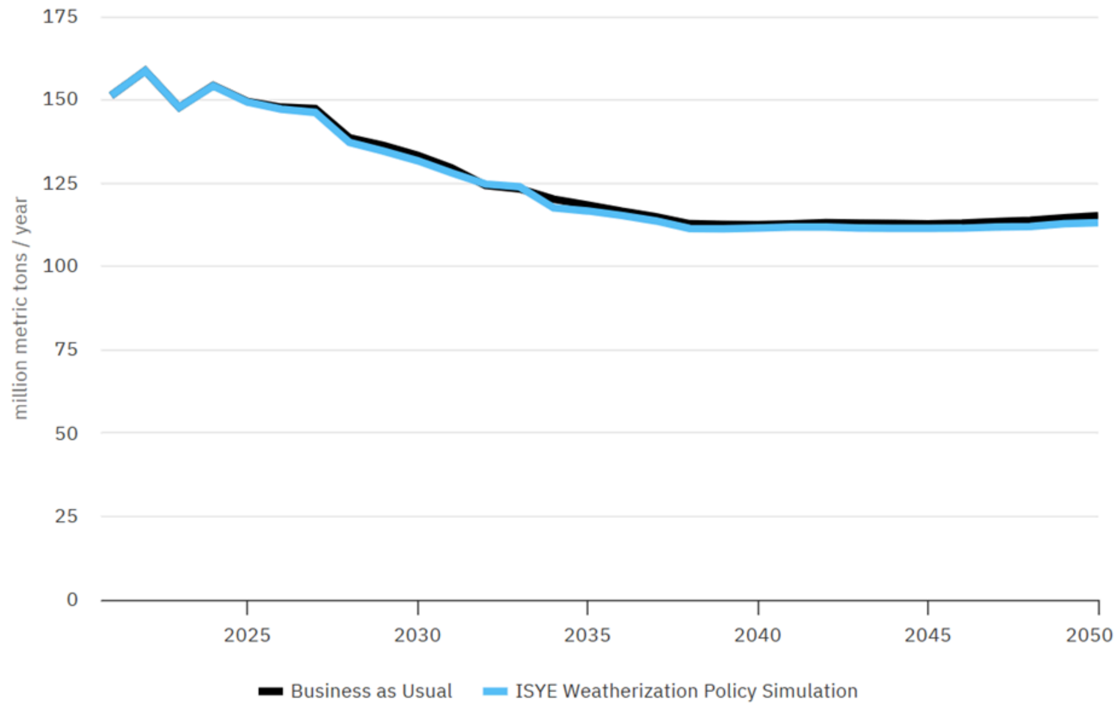

Figure 2. Total Emissions from policy at 100% completion by 2035

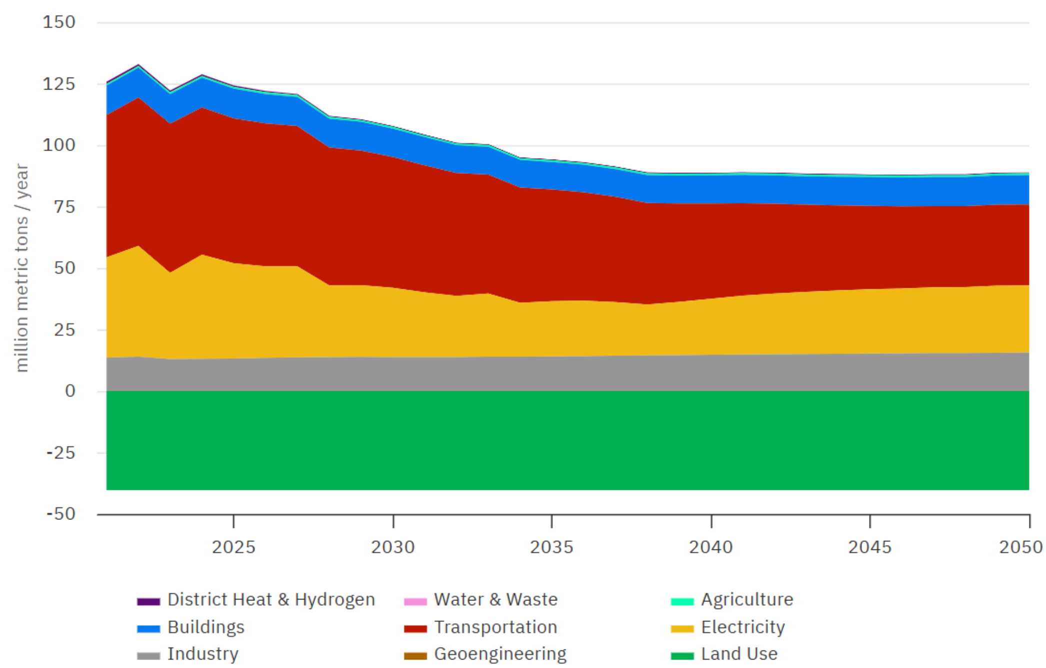

Figure 3. Emissions by pollutant from policy at 100% completion by 2035

Topic 3

Co-Pollutants in Retrofitting Single-Family Homes

Retrofitting single-family homes is a crucial strategy for improving energy efficiency, reducing carbon dioxide emissions, and easing pressure on the power grid. However, while these benefits are clear, the process also introduces co-pollutant trade-offs, particularly in relation to fine particulate matter (PM2.5) and volatile organic compounds (VOCs). Addressing these unintended consequences is essential to ensuring that the improvements in energy efficiency do not come at the cost of indoor air quality or environmental health. A comprehensive approach to retrofitting must account for these co-pollutant effects and incorporate strategies that mitigate their impact.

One of the most significant benefits of retrofitting single-family homes is the reduction of PM2.5 emissions in the atmosphere. In the Metropolitan Statistical Area of Atlanta, annual PM2.5 emissions declined from 4.48 thousand metric tons in 2024 to 4.13 thousand metric tons by 2050 because of home retrofits. This reduction is critical for improving outdoor air quality, as exposure to PM2.5 is closely linked to respiratory and cardiovascular diseases. While this decline in ambient PM2.5 levels is a clear benefit, the shift toward mechanical ventilation in retrofitted homes raises concerns about indoor air quality. Unlike natural ventilation, which allows air to passively enter through cracks and openings in a home's structure, mechanical ventilation systems actively pull in outdoor air at a higher rate. Studies have shown that this increased air exchange rate raises the infiltration coefficient, meaning a greater percentage of outdoor PM2.5 can enter and remain indoors (Brągoszewska, Mainka, & Mucha, 2024). Although PM2.5 levels in the broader environment decrease, individuals living in retrofitted homes may face increased exposure if proper air filtration is not in place. Given that indoor air pollution contributes to millions of premature deaths worldwide, addressing these potential health risks is critical. One effective solution is the use of high-efficiency air filtration systems, such as HEPA or MERV-rated filters, to remove fine particulate matter from incoming air. Additionally, real-time air quality monitoring can help regulate ventilation rates during periods of high outdoor PM2.5 concentrations, ensuring that retrofitted homes do not become unintended hotspots for air pollution exposure.

While PM2.5 reductions in the atmosphere provide clear environmental benefits, retrofitting single-family homes also leads to an increase in VOC emissions, particularly within the industrial sector (EPA, 2024). The demand for construction materials and renovation products necessary for large-scale retrofits has driven VOC emissions in the industrial sector from 39.6 thousand metric tons in 2024 to 74.5 thousand metric tons by 2050. VOCs, which are found in paints, adhesives, insulation, and various building materials, are known to contribute to air and water pollution (EPA, 2025). When released into the environment, these compounds can leach into groundwater, contaminating drinking water supplies and posing serious health risks (EPA, 2025). VOC exposure has been linked to neurological disorders, respiratory diseases, and an increased risk of cancer (EPA, 2024). In retrofitted homes, exposure to VOCs can be heightened due to off-gassing from new materials, and mechanical ventilation may exacerbate the issue by increasing the rate at which these pollutants circulate indoors.

To mitigate the effects of increased VOC emissions, retrofitting policies should prioritize the use of low-VOC or VOC-free materials in construction and renovation projects. Many modern building materials are designed to emit fewer harmful chemicals and incorporating them into retrofitting efforts can significantly reduce indoor air pollution. Additionally, installing air purification systems that use activated carbon filters can help remove VOCs from indoor air, improving overall air quality for residents (Stiehler, 2024). Monitoring systems that track VOC levels in real-time can provide further protection by allowing homeowners to take corrective action when necessary. As with PM2.5, ensuring that ventilation and air purification systems work together is essential to maximizing the health benefits of retrofitting while minimizing unintended consequences.

The overarching goal of retrofitting single-family homes is to improve energy efficiency while reducing greenhouse gas emissions, but the presence of co-pollutants like PM2.5 and VOCs complicates this transition. While outdoor air quality benefits from reduced PM2.5 emissions, the increased infiltration of particulate matter into retrofitted homes and the rise in VOC emissions from industrial production present challenges that must be addressed. A well-balanced approach to retrofitting must integrate air filtration technologies, promote the use of low-emission building materials, and incorporate real-time air quality monitoring to ensure that both indoor and outdoor environments remain safe. By aligning energy efficiency goals with air quality protections, policymakers can ensure that home retrofitting is a holistic climate solution that enhances both sustainability and public health.

Topic 4

Financial Costs of Reduced Emissions

The financial costs per metric ton of CO2e avoided through residential weatherization in Metro Atlanta can be estimated based on the average reduction in emissions per year. Given fluctuations in funding, material costs, and implementation rates, the costs for key milestone years averaged to provide a more consistent projection. This approach assumes a steady increase in weatherized homes, with investments distributed accordingly. The cost of weatherization per home was adjusted using the average annual inflation from 2000 through 2024 (U.S. Bureau of Labor Statistics, 2025)to account for rising material and labor costs over time. The number of homes weatherized annually was multiplied by the average cost of weatherization and divided by the corresponding reduction in CO2e emissions to determine the cost per ton of emissions avoided.

Table 5. Cost of Reduced Emissions

Year	Average Homes Weatherized per year	Average Cost of Weatherization per Home ($)	Average Reduced Emissions per Year (metric tons of CO2)	Average Cost per Emissions Reduced ($/ton)
2030	45,600	6379.38	1,054,000	281.29
2035	45,600	7043.35	1,168,000	285.62
2040	24,000	7776.43	1,021,000	193.51
2050	26,667	9479.42	1,219,000	228.02

While the upfront costs of reducing emissions through residential weatherization are higher than the EPA’s estimated social cost of carbon of $190. These estimates reflect only direct costs associated with weatherization measures, including insulation upgrades, HVAC improvements, window replacements, as well as their impact on CO2e reductions (The US Environmental Protection Agency's New Social Cost of Carbon, 2023). However, there are several secondary benefits, such as lower energy consumption and reduced utility costs for homeowners that further enhance the value of these investments. The long-term financial and implicit savings from energy retrofits significantly reduce the financial burden on homeowners.

Financial Savings from Reduced Emissions

Beyond direct cost reductions, energy retrofits also create substantial savings for homeowners that can be estimated. On average, Atlanta homeowners spend about $253 per month on electricity which equates to over $3000 a year (Cost of electricity in, 2025). The Department of Energy estimates that each weatherized home can save up to 30% of energy consumption annually. As more homes are weatherized over time, these savings increase, and the cost per ton of emissions reduced declines.

Table 6. Average Savings from Reduced Emissions per Year

Year	Average Homes Weatherized Per Year	Average Savings for Weatherization per Home ($)	Average New Reduced Emissions per Year	Average Savings per Emissions Reduced ($/ton)
2030	45,600	1049.17	1,054,000	45.39
2035	45,600	1180.57	1,168,000	46.09
2040	24,000	1328.43	1,021,000	31.23
2050	26,667	1682.01	1,219,000	36.80

Financial Incentives

Despite high initial costs, energy retrofits significantly reduce long-term financial burdens. Various rebates, tax credits, and incentive programs in Atlanta further offset these costs, making weatherization more affordable. The Georgia Environmental Finance Authority (GEFA) offers Home Energy Rebates, providing up to $4,000 for efficiency upgrades and up to $16,000 for electrification improvements (State of Georgia, 2025) while Georgia Power's Home Energy Improvement Program grants rebates up to $1,250 for eligible upgrades (Home Energy Improvement (HEIP) Testimonial, 2024). Additionally, the WeatheRISE ATL pilot program supports energy-burdened homeowners with up to $6,000 in weatherization assistance (WeatheRISE ATL, 2025) and federal tax credits allow homeowners to claim 30% of qualifying energy efficiency expenses. Programs like LIHEAP also assist low-income households with energy-related improvements, making sustainable home upgrades more accessible and affordable.

Job Creation and GDP Impact

Residential weatherization initiatives are also an important driver of job creation and economic growth. As demand for weatherization services increases, jobs in construction, energy auditing, materials manufacturing, and technology development will expand. In the early years of implementation, challenges like policy uncertainty and workforce readiness may initially slow growth. However, once the policy picks up momentum, job creation accelerates as weatherization programs expand, leading to a significant increase in demand for skilled workers in HVAC systems, insulation, and energy-efficient windows.

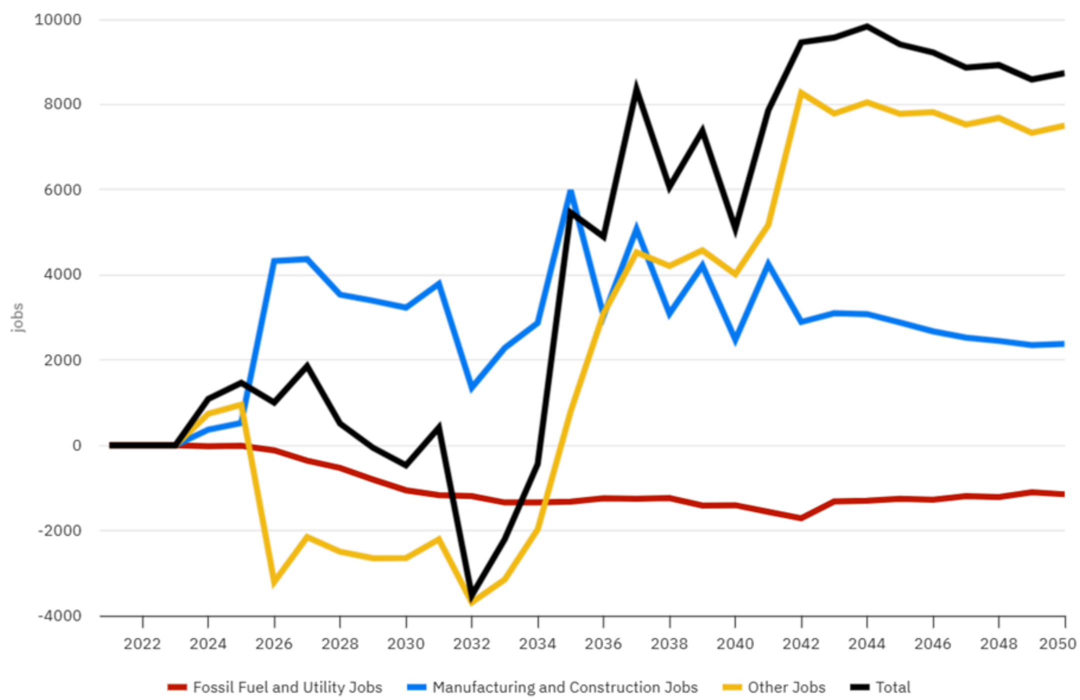

Figure 4. EPS Change in Jobs from Residential Weatherization

The economic impact of weatherization is also reflected in Georgia's GDP. As fossil fuel and utility jobs decline due to reduced energy demand, new industries focused on energy efficiency and renewable technologies will contribute to long-term economic growth. Overall, the shift toward weatherization will drive substantial benefits for both the economy and the environment in Metro Atlanta, offering a sustainable path toward a greener, more resilient community.

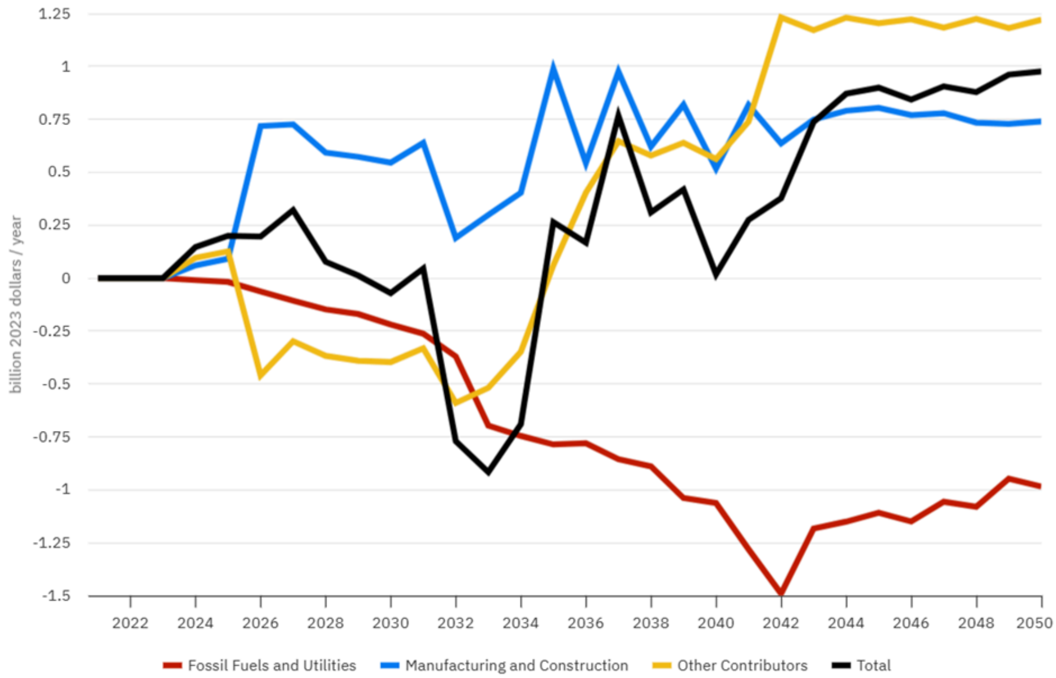

Figure 5. EPS Change in GDP from Residential Weatherization

Topic 5

Equity Impacts

Equitable implementation of our carbon reduction measure requires a look at the upfront cost barriers that community members face. Residential weatherization and retrofits are financial investments that produce long-term benefits. Low-income households do not have the financial flexibility to afford improvements like insulation upgrades or heat pumps, whereas wealthier homeowners can afford these upgrades and receive the long-term benefits of lower utility bills.

Energy policy interventions made to support these barriers may worsen inequities rather than alleviate them. Without specific targeting, energy subsidies are more beneficial for wealthier homes that consume more energy. While low-income households receive a smaller share of subsidies by consuming less energy overall. With weatherization and retrofit implementation low-income households still spend a larger percentage of their income on energy costs. So, while programs like LIHEAP may bear some of the financial burden, they may remain unable to access weatherization programs leaving them with inefficient appliances, poor insulation and higher monthly bills, re-instilling their energy insecurity. It is important to note that subsidy programs like this are short term solutions to energy problems that require high financial commitment. These groups may also lack resources to take advantage of incentive programs like subsidies and remain underserved.

Despite financial barriers, program design and administrations further disadvantage low-income households and marginalized groups. We see procedural inequities in rental homes where landlords are less incentivized to pay the upfront costs of weatherization and retrofits when renters already cover utility bills. This results in residents remaining locked in inefficient housing with high energy costs, unable to benefit from retrofits. The programs available to support weatherization and retrofitting experience lower participation rates in low-income residents meaning they tend to have less representation in decision making processes where policies may fail to address specific barriers these communities face.

Investments in weatherization have significant long-term outlooks for future generations in energy security, environmental sustainability and economic stability. It is important to prioritize structural investments that address long-term affordability through home retrofitting to mitigate vulnerabilities. Poorly weatherized homes are vulnerable to extreme temperature and air quality issues. Equitable access to energy efficiency programs would pivot the observed long-term health risks in disadvantaged communities. Breaking this cycle with targeted polices to ensure weatherization access will allow low-income households to overcome disproportionately higher energy burdens, and generational wealth disparities. Otherwise, future generations will inherit proportionally less efficient housing and increased financial strain as energy costs continue to increase.

Data Analysis

The energy policy simulator analyzes the equity impacts of the carbon reduction measure of residential weatherization and energy retrofits and how implementation of these measures can benefit communities. Findings show that residential homes do not emit an egregious amount of carbon emissions, we wanted to highlight the general contributions it makes to the quality of daily life. Thus, we have translated our equity impact metrics into real figures for the Metro Atlanta Area. Population assumptions from the United States Census Bureau and the Metro Atlanta Chamber estimate that Metro Atlanta contains approximately 56% of Georgia's population. These estimates to conceptualize equity impacts of our reduction measures into real numbers.

Analysis concludes that changes will produce a .0005% reduction in overall deaths by 2035. While this number may seem small the tangible impact becomes clearer when translated into number or lives saved.

Table 7. Lives saved from the potential emission reductions

2035	Georgia	Metropolitan Statistical Area
Lives Saved	5,590	3,130

Along with energy savings, residential weatherization has critical health benefits for respiratory conditions. Heavily insulated homes trap moisture and limit air exchange which can trigger or exacerbate respiratory symptoms, asthma or bronchitis. Residential weatherization increases ventilation and reduces build-up of indoor air pollutants like mold or dust mites. By 2041 we see a peak in avoided cases of adverse health outcomes:

Table 8. Morbidity decreases because of the potential emission reductions

2040	Georgia	Metropolitan Statistical Area
Respiratory Symptoms & Bronchitis	428	271
Asthma Attacks	287.9	161.2

Additionally, we see an increase of almost 10,000 jobs from the need for trade specialists (construction workers, HVAC technicians, energy auditors, insulation specialists and policy analysts). If expansion of energy efficiency is made equitable and accessible through regulation and policy initiatives, workforce development programs may be put in place to expand access to these jobs creating long-term economic mobility.

Conclusion

This analysis of residential weatherization and home energy retrofits centers the importance of household-level climate solutions in driving equitable economic development while delivering positive human health impacts in the 29 county Atlanta MSA. As shown above, home retrofits, whether implemented at modest or aggressive adoption rates, can sizably reduce regional carbon emissions by reducing energy demand. In Georgia, where the energy mix includes coal-fired power plants, reductions in energy use also translate to decreased respiratory illness. Additionally, increased adoption of energy retrofits drives workforce development and GDP growth as the market grows relevant industries to meet new demand. Overall, our findings reflect that residential weatherization and home energy retrofit solutions deliver vast benefits to Atlanta and surrounding communities.

While this analysis models potential impacts of reasonable projected adoption scenarios, the underlying assumptions and influences on adoption rates present opportunities for further study. Namely, labor availability remains the most significant unknown. The sizable metro-Atlanta HVAC workforce suggests that rapid adoption is feasible, but absent a thorough understanding of contractor expertise and acceptance of energy retrofit technologies, accurately modeling the capability of the workforce to execute this scenario proves difficult. In future studies of residential weatherization and home energy retrofits, we plan to investigate technology-specific certification rates amongst contractors to deepen understanding of the current labor landscape.

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Appendix A. Retrofit Adoption Rate Assumptions & Calculation Aids

Calculation of Number of Single-Family Homes in Atlanta MSA

- County level data for Georgia does not provide single family breakdown and totals housing units at **2,532,518 units** (United States Census Bureau, 2020)
- According to the American Community Survey, Georgia has ~66.2% single family detached housing and 4.5% single family attached housing which together is ~70% (U.S. Census Bureau, n.d.)
- Single-family homes in 29-county area: 0.7 x 2532518 = **~1.8M**

Calculation of Number of Homes Requiring Retrofit by 2035

- Given EIA data on AC equipment types and age (U.S. Energy Information Administration, 2023):
    - If you assume equipment older than 10 years is inefficient enough to warrant replacement, for all homes in the US, ~65% will need new HVAC equipment in the next decade
    - Applied to ARC MSA's 1.8M homes: **1.17M homes or ~1.2M**

Table 9. Heat pump prices (Carthan, 2025)

Heat Pump Type	Usage	Equipment Cost	Installed Cost*
Mini-split heat pump (air-source)	A single room or area in your home	$1,000–$3,500	$1,500–$5,000
Central heat pump (air-source)	Your whole home	$2,000–$5,500	$8,000–$15,000
Premium central heat pump (air-source)	Your whole home	$6,000–$12,000	$12,000–$20,000
Geothermal heat pump	A small or medium home	$4,000–$8,000	$12,000–$25,000
Geothermal heat pump	A large home	$8,000–$15,000	$30,000 or more

Table 10. Heat pump prices (Kasch, 2024)

Capacity (Tons)	Size of House (Square Feet)	Average Price
2	1,000	$3,500–$5,500
2.5	1,500	$3,700–$5,800
3	2,000	$3,900–$6,200
3.5	2,500	$3,900–$6,400
4	3,000	$4,000–$7,300
5	3,500	$4,500–$8,800

Appendix B. Financial Cost Analysis Methodology

Consumer Price Index for All Urban Consumers (CPI-U)
12-Month Percent Change

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	HALF1	HALF2	FULL
2000	2.0	2.2	2.4	2.3	2.4	2.5	2.5	2.6	2.6	2.5	2.6	2.6	2.3	2.5	2.4
2001	2.6	2.7	2.7	2.6	2.5	2.7	2.7	2.7	2.6	2.6	2.8	2.7	2.6	2.7	2.7
2002	2.6	2.6	2.4	2.5	2.5	2.3	2.2	2.4	2.2	2.2	2.0	1.9	2.5	2.2	2.3
2003	1.9	1.7	1.7	1.5	1.6	1.5	1.5	1.3	1.2	1.3	1.1	1.1	1.7	1.3	1.5
2004	1.1	1.2	1.6	1.8	1.7	1.9	1.8	1.7	2.0	2.0	2.2	2.2	1.6	2.0	1.8
2005	2.3	2.4	2.3	2.2	2.2	2.0	2.1	2.1	2.0	2.1	2.1	2.2	2.2	2.1	2.2
2006	2.1	2.1	2.1	2.3	2.4	2.6	2.7	2.8	2.9	2.7	2.6	2.6	2.2	2.7	2.5
2007	2.7	2.7	2.5	2.3	2.2	2.2	2.2	2.1	2.1	2.2	2.3	2.4	2.4	2.3	2.3
2008	2.5	2.3	2.4	2.3	2.3	2.4	2.5	2.5	2.5	2.2	2.0	1.8	2.3	2.3	2.3
2009	1.7	1.8	1.8	1.9	1.8	1.7	1.5	1.4	1.5	1.7	1.7	1.8	1.8	1.6	1.7
2010	1.6	1.3	1.1	0.9	0.9	0.9	0.9	0.9	0.8	0.6	0.8	0.8	1.1	0.8	1.0
2011	1.0	1.1	1.2	1.3	1.5	1.6	1.8	2.0	2.0	2.1	2.2	2.2	1.3	2.0	1.7
2012	2.3	2.2	2.3	2.3	2.3	2.2	2.1	1.9	2.0	2.0	1.9	1.9	2.2	2.0	2.1
2013	1.9	2.0	1.9	1.7	1.7	1.6	1.7	1.8	1.7	1.7	1.7	1.7	1.8	1.7	1.8
2014	1.6	1.6	1.7	1.8	2.0	1.9	1.9	1.7	1.7	1.8	1.7	1.6	1.8	1.7	1.8
2015	1.6	1.7	1.8	1.8	1.7	1.8	1.8	1.8	1.9	1.9	2.0	2.1	1.7	1.9	1.8
2016	2.2	2.3	2.2	2.1	2.2	2.2	2.2	2.3	2.2	2.1	2.1	2.2	2.2	2.2	2.2
2017	2.3	2.2	2.0	1.9	1.7	1.7	1.7	1.7	1.7	1.8	1.7	1.8	2.0	1.7	1.9
2018	1.8	1.8	2.1	2.1	2.2	2.3	2.4	2.2	2.2	2.1	2.2	2.2	2.1	2.2	2.1
2019	2.2	2.1	2.0	2.1	2.0	2.1	2.2	2.4	2.4	2.3	2.3	2.3	2.1	2.3	2.2
2020	2.3	2.4	2.1	1.4	1.2	1.2	1.6	1.7	1.7	1.6	1.6	1.6	1.8	1.6	1.7
2021	1.4	1.3	1.6	3.0	3.8	4.5	4.3	4.0	4.0	4.6	4.9	5.5	2.6	4.5	3.6
2022	6.0	6.4	6.5	6.2	6.0	5.9	5.9	6.3	6.6	6.3	6.0	5.7	6.2	6.1	6.2
2023	5.6	5.5	5.6	5.5	5.3	4.8	4.7	4.3	4.1	4.0	4.0	3.9	5.4	4.2	4.8
2024	3.9	3.8	3.8	3.6	3.4	3.3	3.2	3.2	3.3	3.3	3.3	3.2	3.6	3.3	3.4
															2.39%

Cost Analysis Spreadsheet:

total homes	1200000
avg. annual inflation	2.39%

year	Total Homes Weatherized	Avg. Homes Weatherized per year	Avg. Cost of Weatherization per Home	Avg. Reduced Emissions per Year	Avg. Cost per Emissions Reduced
2030	228000	45600	6501.64	1054000	281.29
2035	456000	45600	7315.91	1168000	285.62
2040	576000	24000	8232.15	1021000	193.51
2050	840000	26667	10423.27	1219000	228.02

year	Total Homes Weatherized	Avg. Homes Weatherized per year	Avg. Savings from Weatherization per Home	Avg. Reduced Emissions per Year	Avg. Savings per Emissions Reduced
2030	228000	45600	1049.17	1054000	45.39
2035	456000	45600	1180.57	1168000	46.09
2040	576000	24000	1328.43	1021000	31.23
2050	840000	26667	1682.01	1219000	36.80

Excel Spreadsheet Value	Corresponding Value in Equations
Year	$year$
Total Homes Weatherized	$total.homes_{year}$
Avg. Homes Weatherized per year	$annual.homes_{year}$
Avg. Inflation	$avg.inflation = 2.39\%$
Avg. Weatherization Cost per Home	$cost_{year}$
Avg. Weatherization Savings per Home	$savings_{year}$
Avg. Cost per Emissions Reduced per Year	$cost.per.CO2reduced_{year}$
Avg. Savings per Emissions Reduced per Year	$savings.per.CO2reduced_{year}$

$$annual\_homes_t = \frac{total.homes_{year_2} - total.homes_{year_1}}{year_2 - year_1}$$

$$cost_{2025} = \frac{\$8050 + \$3506}{2} = \$5778$$

$$cost_{year} = cost_{2025} \cdot (1 + avg.inflation)^{year-2025}$$

$$cost_{year} = cost_{2025} \cdot (1 + 0.0239)^{year-2025}$$

$$cost_{year} = 5778 \cdot (1.0239)^{year-2025}$$

$$cost.per.CO2reduced_{year} = \frac{annual.homes_{year} \cdot cost_{year}}{avg.CO2reduced_{year}}$$

$$savings_{2025} = 30\% \cdot (253 \cdot 12) = \$910.80$$

$$savings_{year} = savings_{2025} \cdot (1 + avg.inflation)^{year-2025}$$

$$savings_{year} = savings_{2025} \cdot (1 + 0.0239)^{year-2025}$$

$$savings_{year} = 910.80 \cdot (1.0239)^{year-2025}$$

$$savings.per.CO2reduced_{year} = \frac{annual.homes_{year} \cdot savings_{year}}{avg.CO2reduced_{year}}$$