Research Memo:

Building Performance Standards-
Increase Energy Efficiency in
Industrial & Commercial Buildings

ISYE/PUBP 6701, Fall 2025

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Introduction

Curtailing Greenhouse Gas Emissions (GHG) requires adjusting all facets of energy consumption and infrastructure. This includes adjusting designs and standards of existing and new buildings to aid in mitigating emissions. In 2002 alone, a study evaluated 7.85 Gt of carbon dioxide was released from building sectors. This amounts to 33% of total energy related emissions.[1] Energy consumption from buildings since this study has increased to approximately 9.8 Gt a year in 2022.[2] Consumption forms such as HVAC systems, specifically air conditioning, are projected to increase drastically from rising global temperatures. However, heating in commercial and residential buildings still requires attention as space and water heating remain the largest form of energy consumption. Heat reduction innovative measures include insulation, window design, and air tightness. Building positions and design such as north and south facing windows are additionally integral. These measures have shown to reduce heading energy use by up to 80% in the United States and Canada.[3] Cooling loads can be reduced by increasing shade presence, increasing building albedo, design position and passive heat sinks like evaporative coolers and underground earth piping.

In Atlanta, as a city located in a region vulnerable to climate change, there are many opportunities to implement designs and standards as mentioned above. These measures will not only help mitigate GHG emissions but improve public and ecological health. The economic savings alone from designing for future climate conditions far outweigh lack of action. In the following report, numerous models and reports are referenced that will be incorporated within build code implementation projections. These findings would include standards with certain measures, namely: HVAC systems, optimal envelopes, appliances, lighting, and insulation. In developing codes with these improvements, followed by local and State government adoption, finalizing with building compliance, energy savings in the building sector can be realized. Pertinent to the Atlanta area, the Atlanta Metropolitan Statistical Area's Priority Climate Action Plan seeks to produce many initiatives will combat climate change, including building energy efficiency and design. This will be overseen and implemented by numerous local agencies, the State and other relevant stakeholders. These actions would help prepare the Atlanta Metropolitan area for impending climate change consequences by creating grid resiliency, lowering energy burdens, and overall curtailing the costs of future disaster.

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[1] Ürge-Vorsatz, Diana, L. D. Danny Harvey, Sevastianos Mirasgedis, and Mark D. Levine. "Mitigating CO2 emissions from energy use in the world's buildings." *Building Research & Information* 35, no. 4 (2007): 379-398.
[2] "Buildings - Energy System." IEA. Accessed March 2025. https://www.iea.org/energy-system/buildings.
[3] Ürge-Vorsatz, Diana, L. D. Danny Harvey, Sevastianos Mirasgedis, and Mark D. Levine. 2007

Topic 1.

Business As Usual Scenario

The Business as Usual (BAU) scenario assumes calculates CO_2e emissions barring any special action taken to improve energy efficiency outside of general equipment replacement due to normal wear and tear. Replacement of old equipment and systems will naturally lead to the inclusion of more efficient products based on newer models. However, the emissions are still dominated by old equipment following outdated building standards. Knowing this, it is expected to have a baseline level of annual energy savings as buildings age. Thus, the energy code impacts in this scenario can be considered conservative.

The Rocky Mountain Institute's (RMI) Energy Policy Simulator (EPS) can be utilized to model emission scenarios.[4] The model calculates energy savings from building energy efficiency standards by breaking down a building into six components: heating, cooling and ventilation, envelope, lighting, appliances, and other energy-using components. Electricity use of all categories, except for envelope, is tracked on a BTU basis and is modified by policy changes. The building envelope component describes the building's ability to maintain its indoor climate, including doors, windows, and insulation. The main policy impact here is on the efficiency of heating and cooling systems in both old and new buildings, and improved insulation in new buildings. For the BAU scenario, building envelope is set to a factor of 1.[5] Figure 1 details the CO_2e emissions for the BAU scenario from 2019-2050.

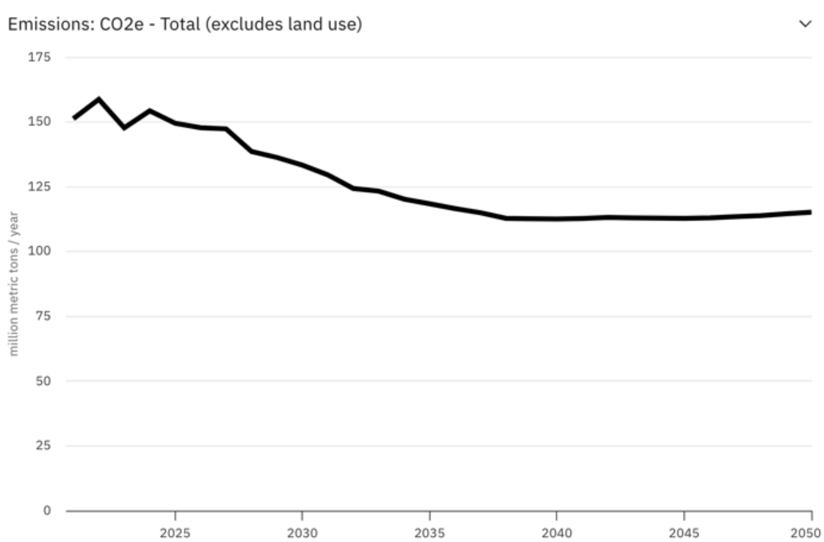

Fig.1 Building Performance Standards, BAU Scenario[6]

[4] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2," Energy Innovation, accessed March 5, 2025, https://energypolicy.solutions/simulator/georgia/en.
[5] Rocky Mountain Institute, "Buildings Sector (Main)," Energy Policy Simulator Documentation, accessed March 5, 2025, https://us.energypolicy.solutions/docs/buildings-sector-main.html.
[6] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.

Georgia mandatory state codes regarding building performance, adopted in January of 2020, are the 2015 International Energy Conservation Code (IECC) for commercial buildings and 2013 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) for residential buildings. These codes are adopted into the Georgia state legislature. However, a 2024 study of status of the state energy code adoption by the EERE, determined that Georgia operates at a level equivalent to the 2013-ASHRAE commercial and the 2009-IECC residential standards.[7] The state is therefore operating under building performance standards a decade behind the most efficient standards. Entities motivated by cost savings replace and update their technology and appliances at a much faster rate than the state standards.

The effect of building performance standards on emission reductions is expanded upon in the 2023 report "Impacts of Model Building Energy Codes" by the Pacific Northwest National Laboratory (PNNL) commissioned by the US Department of Energy.[8] This report gauges the influence of prospective building performance codes from 2010 to 2040. It details the adoption process of new codes throughout the 2010-2016 periods and extrapolates to estimate adoption of more stringent codes in relation to energy, monetary and CO2-e savings. The phases of code adoption and their effect on the analysis framework, measured in energy use intensity (EUI) are detailed below in Figure 2.

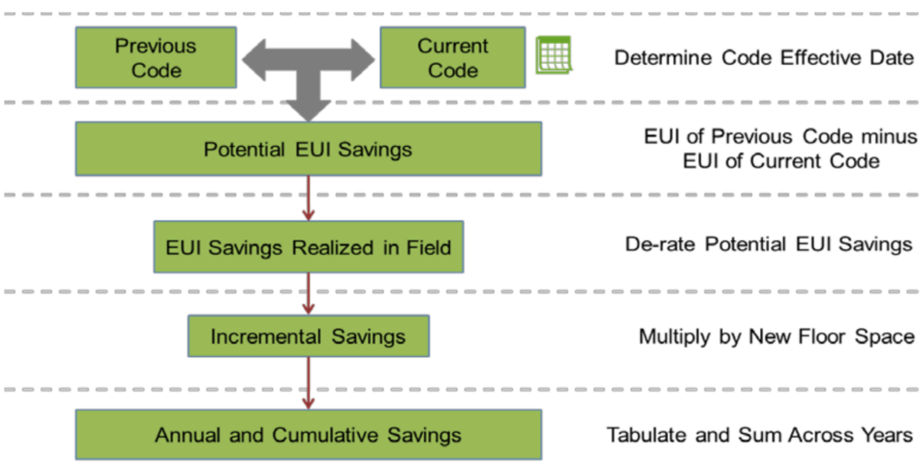

Fig. 2 Code Impact on Analysis Framework[9]

The PNNL framework for calculating BAU monetary savings and avoided emissions is based around these code adoption habits and the following variables. The calculations consider the site energy savings between code versions, year of adoption and length of adoption, and annual increase in square footage of buildings. For both residential and commercial code adoption, Georgia is considered a slow adopter. Appendix A shows these classifications for the state. Table 1 shows the BAU values for Georgia derived from the PNNL model.

[7] "Georgia | Building Energy Codes Program," State Energy Code Methodology, accessed March 5, 2025, https://www.energycodes.gov/status/states/georgia.
[8] M Tyler et al., "Impacts of Model Building Energy Codes", November 2023, https://www.energycodes.gov/sites/default/files/2023-12/Impacts_of_Model_Energy_Codes_2023.pdf.
[9] M Tyler, 2023.

Table 1 Georgia Residential and Commercial Building Performance Savings Totals[10]

Year	Commercial Avoided CO2 emissions (MMT)	Residential Avoided CO2 emissions (MMT)	Total Avoided CO2 emissions (MMT)
2030	0.81	0.66	1.46
2040	1.02	0.78	1.80
2010-2030	9.27	9.05	18.3
2010-2040	18.5	16.3	34.8

The PNNL only extrapolates to 2040. Using the footprint expansion methodology and maintaining the degree of energy savings from 2040 until 2050, a conservative estimate which is supported by the RMI EPS assumptions, the values for 2050 are calculated. Appendix B includes the explicit methodology for these assumptions. Values are shown below in Table 2.

Table 2 Georgia Residential and Commercial Building Performance Totals[11]

Year	Commercial Avoided CO2 emissions (MMT)	Residential Avoided CO2 emissions (MMT)	Total Avoided CO2 emissions (MMT)
2030	0.81	0.66	1.46
2040	1.02	0.78	1.80
2050	1.12	0.88	2.20
2010-2030	9.27	9.05	18.3
2010-2040	18.5	16.3	34.8
2025-2035	2.30	2.25	4.55
2030-2050	19.5	17.3	36.8

Achievable Potential Scenario

To assess the achievable potential of the more stringent building performance codes, adopted at more timely paces, we can also reference RMI's EPS tool. Citing the Edison Foundation, the potential electric savings from new appliance and equipment standards and building performance codes could reach a moderate 30% or aggressive 40-45% reduction in whole building energy use.[12]

To accurately reflect these achievable potential reductions, the implementation schedule from the Atlanta Metropolitan Statistical Area's Priority Climate Action Plan (Atlanta MSA

[10] Tyler, "Impacts of Model Building Energy Codes", 2023.
[11] Tyler, "Impacts of Model Building Energy Codes", 2023.
[12] Alexander Cooper and Lisa Wood, "Energy Efficiency: A Growing Utility Business Solution to Reliability, Affordability, and Sustainability" (IEE Issue Brief, September 2013).

PCAP) was added to the EPS tool. The Atlanta MSA PCAP is prepared by the Atlanta Regional Commission (ARC). Project implementation lasts from 2024 to 2029. To reflect the complex and sometimes precarious rollout of similar multimodal and inter-organization projects and extend the schedule to 2050, the implementation schedule inputs are 5% in 2024, 75% in 2029, and 100% in 2050.

This rollout schedule should allow for the Atlanta MSA PCAP's building efficiency goal of a "2% energy efficiency improvement per year for the first 10 years and a 1% per year thereafter" through an initially slow implementation schedule, but that still allows for growth in the beginning years and gradually increases to reflect complete fulfillment of the project (ARC 2024) (American Progress 2023).[13,14] The graph below, Figure 5, compares the BAU scenario for building performance codes versus a 30% and 45% potential reduction scenario.

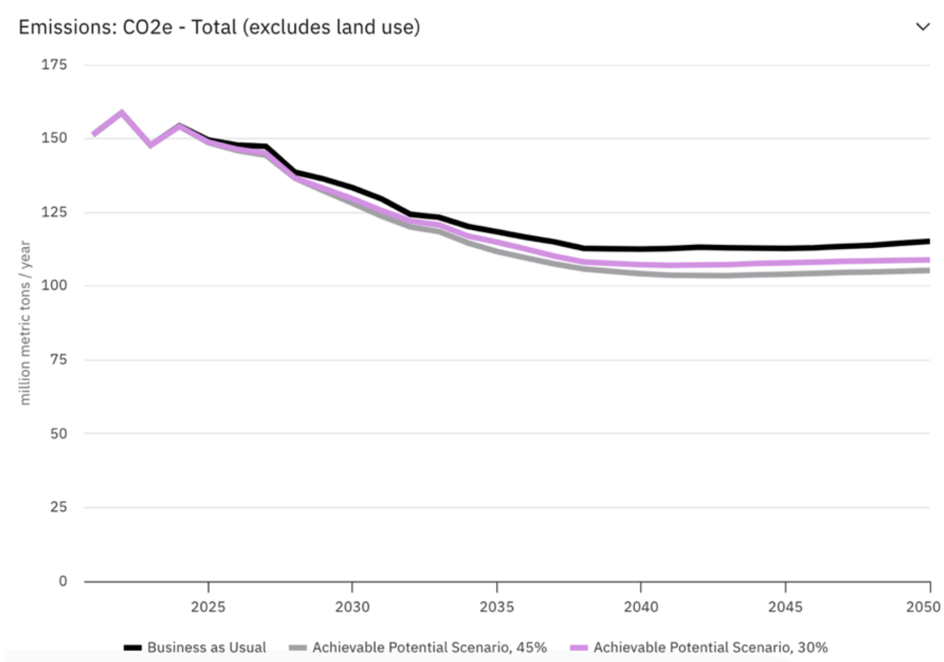

Fig.4 Building Performance Standards, BAU vs. Achievable Potential Scenarios.[15]

Furthermore, the MSA PCAP provides target CO2 reductions for the measure "Increase Energy Efficiency in Industrial and Commercial Buildings (including Multifamily)".[16] These values are calculated by Greenlink Analytics and shown in the Total Avoided CO2 emissions

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[13] "Priority Climate Action Plan Atlanta Metropolitan Statistical Area " (Atlanta: Atlanta Regional Commission, March 5, 2024).
[14] Sam Ricketts et al., "Implementing America's Clean Energy Future," Center for American Progress, July 11, 2024, https://www.americanprogress.org/article/implementing-americas-clean-energy-future/.
[15] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.
[16] "Priority Climate Action Plan Atlanta Metropolitan Statistical Area", 2024.

(MMT) for 2025-2035 and 2030-2050. In a comparison effort with the BAU scenario, these remaining values are extrapolated to reflect the PNNL framework from Table 2.

Table 3 Georgia Residential and Commercial Building Performance Totals[17]

Year	Commercial Avoided CO2 emissions (MMT)	Residential Avoided CO2 emissions (MMT)	Total Avoided CO2 emissions (MMT)
2030	0.95	0.68	1.63
2040	1.62	1.24	2.87
2050	1.79	1.40	3.19
2025-2030	2.37	2.33	4.70
2030-2050	31.1	27.6	58.7

To assess the achievable aspects of this plan, the intended policy options must be critiqued. The Inflation Reduction Act of 2022 invests significant funds into building energy efficiency. It is giving dedicated state funds to: 1) reducing the installation cost and price of improving the energy envelope of buildings, 2) Home Efficiency Rebates (HER), a state-run home rebate program offering $2,000 to $4,000 for participating residential households, and 3) tax credits to new buildings who prioritize high energy efficiency devices.[18] While these credits will not vanish under the new presidential administration, funds may be rolled back and cancelled over time. This will affect state programs focused on financial reward.

Other than federal incentives, the Atlanta MSA PCAP intends to attain target reduction levels through "building energy ordinances, energy audits, and benchmarking programs" for all commercial, including multi-family, and industrial, excluding process, in the applicable region.[19] The City of Atlanta has implemented a Commercial Buildings Energy Ordinance for "requires municipal buildings above 10,000 square feet, and commercial and multifamily buildings above 25,000 square feet" to record and report overall energy usage annually.[20] This ordinance also requires a level 2 ASHRAE energy audit every 10 years. These results of these programs are analyzed to generate the figure below, which categorizes participating buildings by their ENERGY STAR score. Their numerical value indicates the percentage of buildings they operate at a more efficient level than.

[17] "Priority Climate Action Plan Atlanta Metropolitan Statistical Area", 2024.
[18] David Smedick, Rachel Golden, and Alisa Petersen, "The Inflation Reduction Act Could Transform the US Buildings Sector," Rocky Mountain Institute, December 21, 2023, https://rmi.org/the-inflation-reduction-act-could-transform-the-us-buildings-sector/.
[19] "Priority Climate Action Plan Atlanta Metropolitan Statistical Area", 2024.
[20] "Atlanta Energy Benchmarking," Touchstone IQ, accessed March 9, 2025, https://touchstoneiq.com/atlanta-energy-benchmarking.

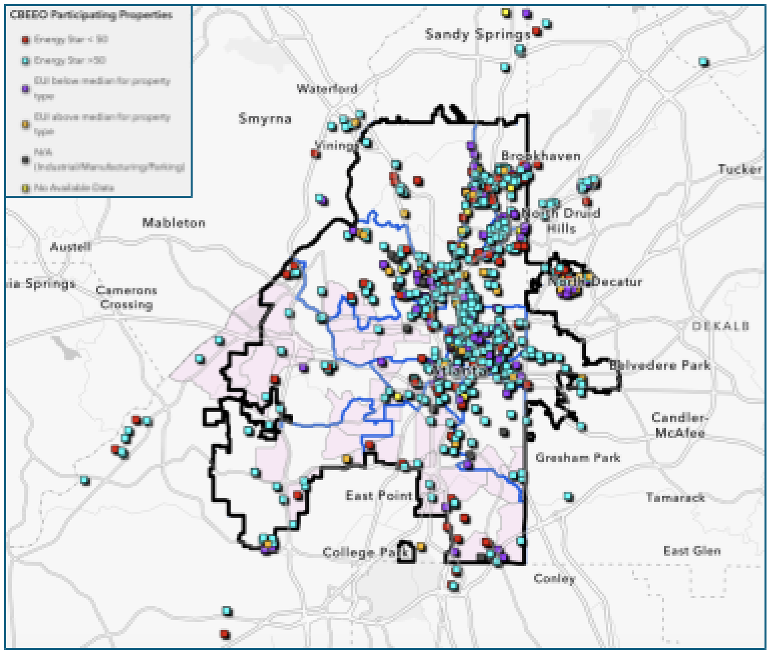

Fig.5 ATL Moving Forward: ENERGYSTAR Audit Data [21]

Though there are a combination of federal, state and non-government entities offering programs which will benefit residential and commercial building owners, there is more required to meet these ambitious energy reduction targets. Federal incentives will fluctuate, but through continued local education and incentives, participating buildings will be able to reduce their operating cost and emissions.

[21] "Mayor's Office of Sustainability and Reliability, Moving Atlanta Forward. Atlanta Energy Benchmarking Map" (Atlanta, Georgia: https://gis.atlantaga.gov/CBEEO/, 2023).

Topic 2.

Technical Potential Scenario

There are numerous hinderances to policy that prevent effective adoption and execution for energy savings. These include factors such as energy efficient distribution, demand-side grid resilience, physical limitations of retrofitting old buildings, overall upfront economic costs, reliability of new energy technologies (i.e. renewables), and proper funding. According to the February 2016, "Building Energy Codes Policy Overview and Good Practices" by the Clean Energy Solutions Center, markets and builders typically have low incentive to incorporate energy efficient measures due to the upfront costs. The savings from energy efficiency will not be realized for years, while investors and builders typically seek immediate profits rather than long-term savings. This results in political barriers from private construction firms to reduce the regulatory enforcement of energy efficient standards. There also exists misinformation and lacking information availability for consumers, further hindering building choices from new property owners. These barriers and more can be seen in Figure 6 below.

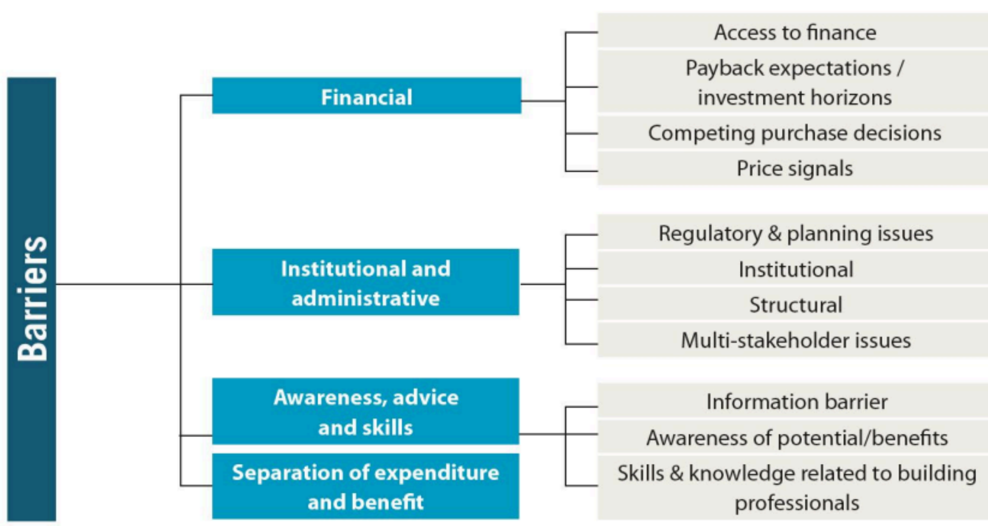

Fig.6 Barriers to Effective and Efficient Building Code Policy [22]

In this scenario, these barriers will be neglected for the sake of finding the maximum technical potential of energy savings. This scenario seeks to exemplify the emission savings if buildings were to be converted as immediately as possible, without regard for complications concerning building design limitations, construction and deconstruction. Maximum resource utilization is factored in this scenario with an assumption of no future depletion in building construction materials. Complete conversion of old buildings and incorporation of new

[22] Building Energy Codes: Policy overview and good practices. Accessed March 13, 2025. https://www.nrel.gov/docs/fy16osti/65542.pdf.

constructions have updated HVAC systems, optimal envelopes, appliances, lighting, and insulation are assumed to be accounted for. According to Appendix C of the U.S. Department of Energy's "Impacts of Model Building Energy Codes", an additional 22% of CO2e and primary energy savings can be met in a maximum potential scenario.[23] This specific number is a percent increase from the original percentage of savings, not baseline energy and emissions. Using this number, assuming rates of increase are projected similarly to the State of Georgia, if all codes are to have an immediate 100% adoption and realization rate starting from 2035 to 2050 there would be a consistent 54% energy use reduction. Figure 6, below, demonstrates CO2 emissions offset by maximum adoption of building efficiency standards for residential and commercial sectors, along with industrial electricity efficiency standards in Georgia.

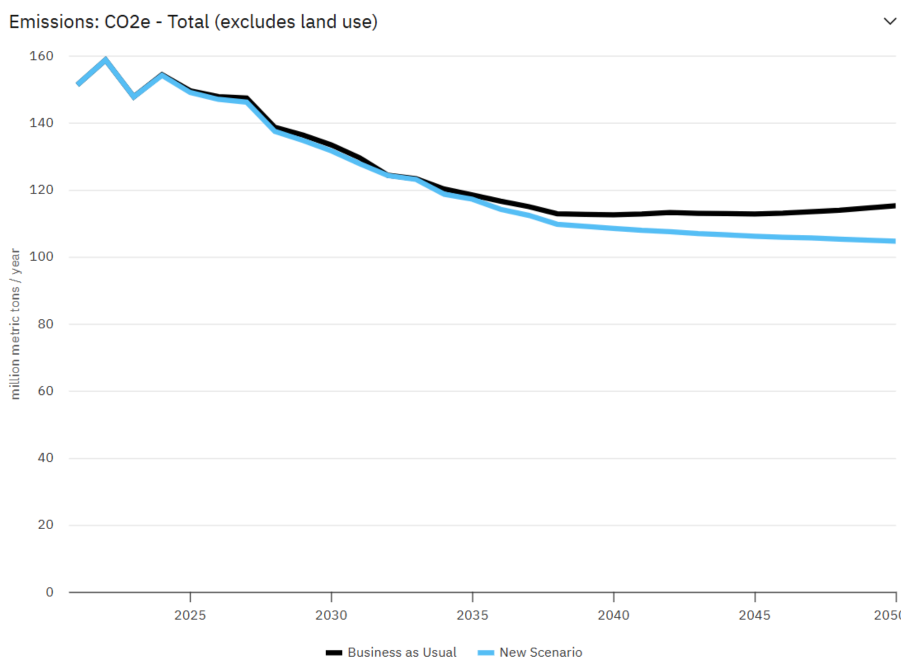

Fig. 6 CO2e for Maximum Technical Potential Scenario for Building Performance Standards and Energy Efficiency 2035 to 2050 [24]

By 2035, CO2 emissions will only be 117.2 MMT as opposed to 118.4 MMT in the BAU scenario. In 2050, emissions will then be down to 104.2 MMT compared to 115.2 MMT in the BAU scenario. Specified differences for building sources can be seen in Figure 7 below.

[23] Tyler, M, E Poehlman, D Winiarski, M Niemeyer, and M Rosenberg. Impacts of model building energy codes, November 2023. https://www.energycodes.gov/sites/default/files/2023-12/Impacts_of_Model_Energy_Codes_2023.pdf.

[24] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.

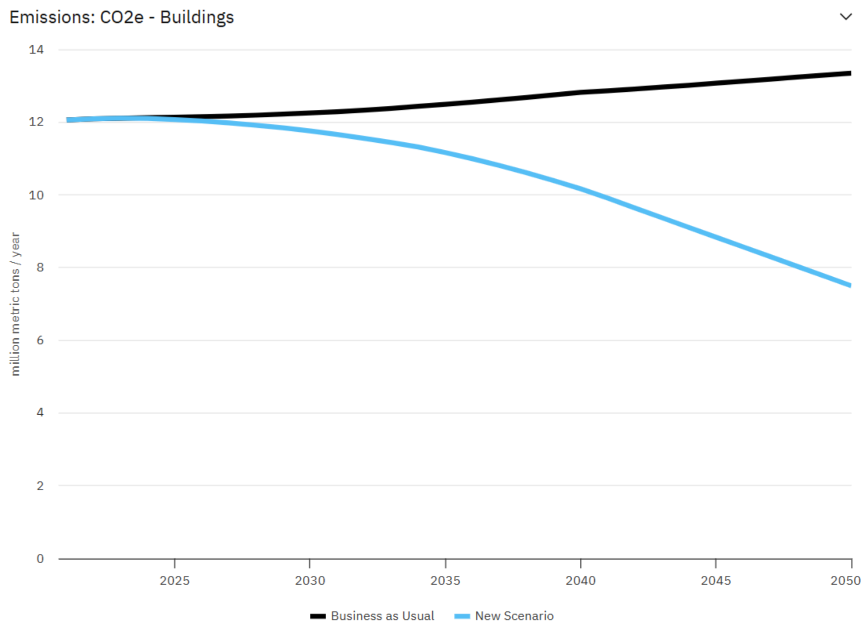

Fig. 8 Building-Specific CO2e (MMT) in Maximum Technical Potential Scenario vs. BAU [25]

A massive reduction in CO2 emission rates from the building sector is apparent from the model above. In the BAU scenario, rates only increase until there are 13.35 MMT of CO2 emissions per year by 2050. In the new technical potential scenario, CO2 emissions are reduced to 7.50 MMT in the year of 2050.

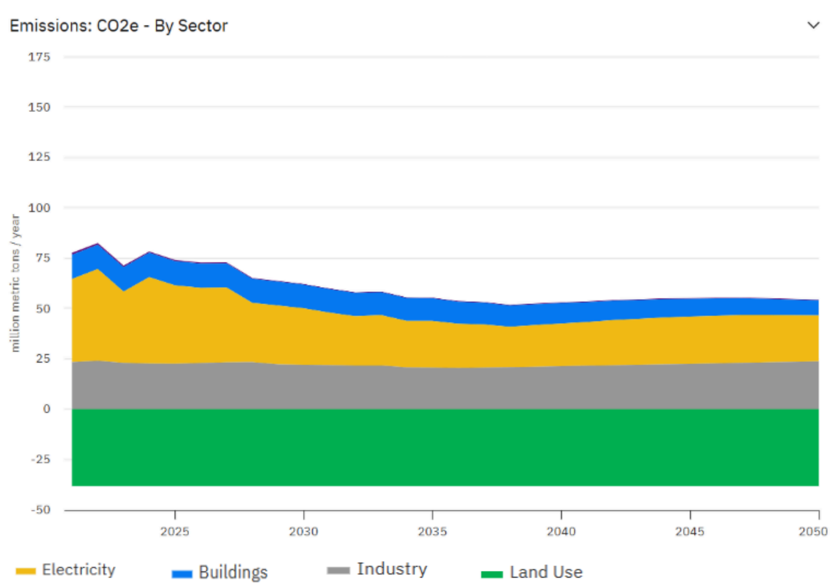

Fig. 9 Specific Energy-Related Emissions (in MMT CO2e) by sector [26]

[25] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.
[26] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.

Contributions of building emissions can be seen as significantly reduced, along with emissions from general electricity consumption. Emissions from the industrial sector then appear to remain consistent. This may be due to other contributing factors such as other forms of fossil fuel-based energy consumption that increasing electricity efficiency within manufacturing processes alone cannot account for.

Table 4 Maximum Potential Scenario: Total Avoided CO_2e from Commercial, Industrial, Residential Buildings

Year	Total Avoided CO_2e emissions (MMT)
2035	1.2
2050	10.6
2035-2050	92.9
2030-2050	98.2

Compared to the Achievable Potential Scenario, the Maximum Potential Scenario could save almost double the amount of CO_2 emissions. These numbers are unrealistic for the reasons mentioned above. However, it is important to outline what is possible if all resources are to be allocated to one cause. A rapid increase of policy adoption to 100% by 2035 would place a significant dent in the total CO_2e from Georgia, however many other factors related to the source and supply of electricity must be considered for wholistic, nuanced building emission reductions.

Topic 3.

In this section, the benefits of increasing commercial and industrial building performance standards on co-pollutant emissions, community health and local environment will be discussed. As of 2021, in Georgia, these are the most impactful non-CO_2 emissions from buildings. Data is taken from the RMI EPS.[27]

- Nitrogen Oxides (NO_x) – 10 thousand Metric Tons
- Particle Matter 2.5 (PM2.5) – 4.46 thousand metric tons
- Particle Matter 10 (PM10) – 4.7 thousand metric tons
- Black Carbon (BC) – 0.21 thousand metric tons
- Organic Carbon (OC) – 2.61 thousand metric tons
- Volatile Organic Carbon (VOC) – 2.5 thousand metric tons
- Carbon Monoxide (CO) - .017 million metric tons

These are significant amounts of emissions that will contribute to global warming and our carbon footprint. The Priority Climate Action Plan's achievable and moderate goal is for a 30% increased energy efficiency in buildings by 2050. Additionally, the plan would include a 5% implementation in 2024 and 75% implementation by 2029.[28] Here are the expected emissions in 2050 for each co-pollutant, also charted in Figure 10.

- Nitrogen Oxides (NO_x) – 7 thousand metric tons (-30%)
- Particulate Matter 2.5 (PM2.5) – 3.12 thousand metric tons (-30%)
- Particulate Matter 10 (PM10) – 3.3 thousand metric tons (-30%)
- Black Carbon (BC) – 0.14 thousand metric tons (-33%)
- Organic Carbon (OC) – 1.84 thousand metric tons (-29%)
- Volatile Organic Carbon (VOC) – 1.7 thousand metric tons (-32%)
- Carbon Monoxide (CO) - .011 million metric tons (-35%)

[27] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.
[28] "Priority Climate Action Plan Atlanta Metropolitan Statistical Area", 2024.

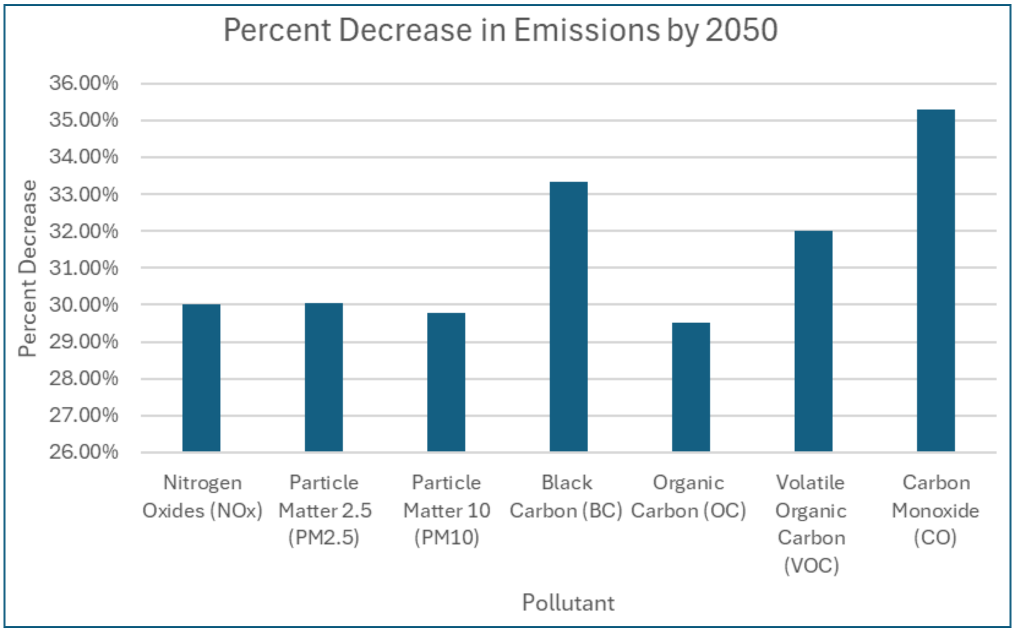

Fig. 10 Pollutant Emissions Percent Decrease from 2021 to 2050 [29]

Since the policy tool looks across Georgia, this level of decrease cannot be expected for the ARC PCAP impact; however, a similar percentage decrease can be expected for the MSA. The main effect of increasing energy efficiency and raising performance standards in buildings is using less electricity. While the Atlanta Regional Commission is still conducting a study on the area's energy shed and electricity generation sources, Georgia's energy sources can be examined to understand where the emissions are coming from. Data from the United States Energy Information Administration breaks down Georgia's energy sources and these are the major contributors: Natural Gas, Nuclear, and Coal.[30] It is well known that nuclear energy contributes minimally to air pollutants, so most emissions come from Natural Gas and Coal electricity production. By increasing commercial and industrial building energy standards, Atlanta can expect a significant drop in electricity use and therefore a significant change in co-pollutant emissions.

Emissions do not just affect global climate change but can directly affect the health of local communities. According to the ARC PCAP, increasing energy efficiency in buildings will lead to "improved air quality" that will, in turn, lead to "reduced asthma, heart attacks, and strokes". Using the EPS tool with the same scenario and policy implementation schedule, the expected avoided deaths by 2050 is 30 across the state as seen in Figure 11. Since the Atlanta MSA is 57% of the population of Georgia, the expectation is about 17 avoided deaths per year in the area. The value of those saved lives is incalculable.

[29] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.
[30] "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." EIA. Accessed March 6, 2025. https://www.eia.gov/state/?sid=GA.

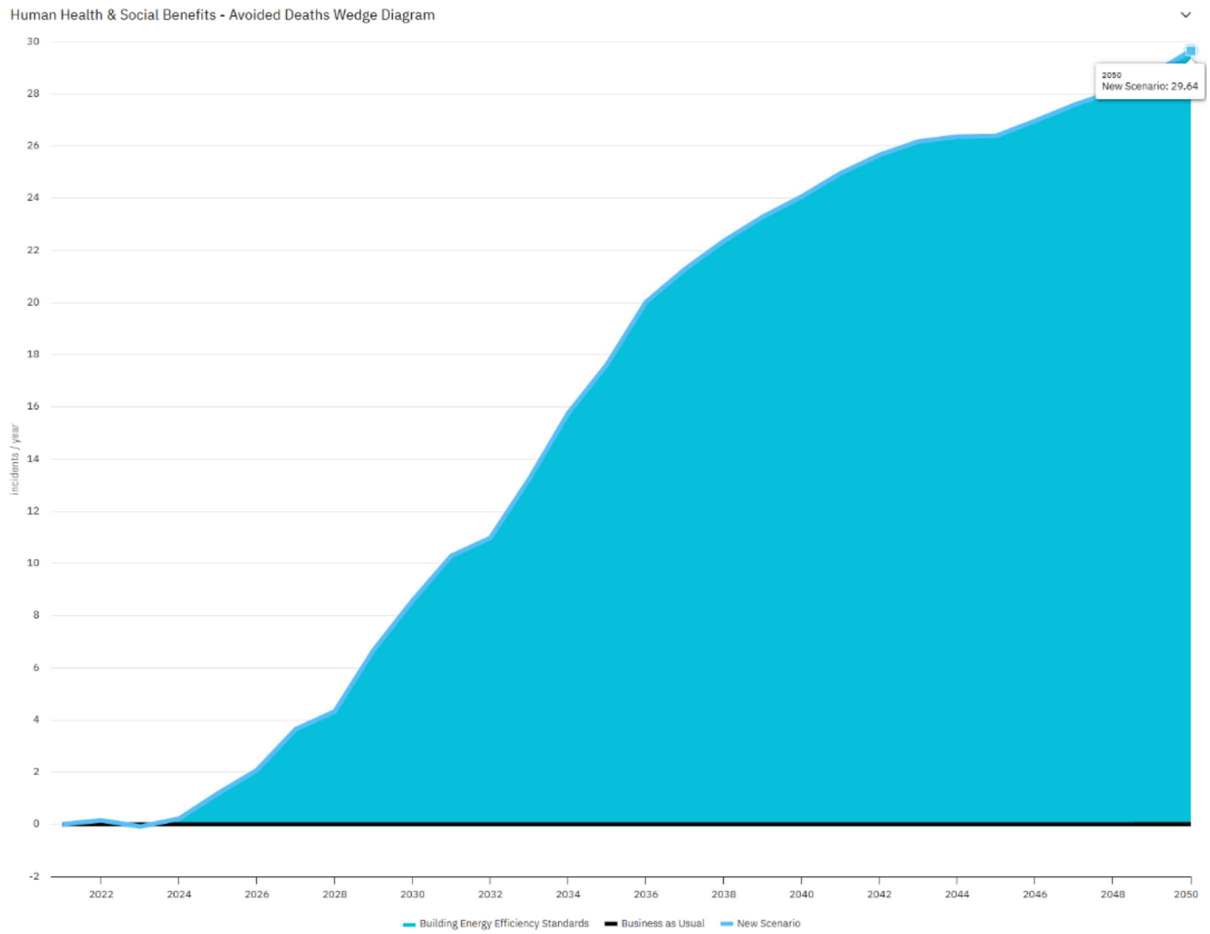

Fig. 11 Predicted Avoided Deaths Across Georgia[31]

Another key health indicators provided by the EPS tool include asthma attacks reduced, as shown in Figure 12. The tool predicts a decrease of 360 asthma attacks for the Atlanta MSA. This is a great benefit to the local residents, especially to those closest to emission centers like coal power plants. Coal plants are a major source of PM2.5 pollutants which are a major contributor to respiratory issues. The National Institute of Health reported on a study that found that for every 1 microgram per meter cubed of PM2.5 in the air results in a mortality rate increase of 1.12%.[32] While coal plants have improved their emissions through new technology, the decrease electricity load of buildings will lead to less PM2.5 in the air.

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[31] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.

[32] Doctrow, Brian. "Deaths Associated with Pollution from Coal Power Plants." National Institutes of Health, December 21, 2023. https://www.nih.gov/news-events/nih-research-matters/deaths-associated-pollution-coal-power-plants#:~:text=Coal%2Dburning%20power%20plants%20are,%2C%20mortality%20increased%20by%201.12%25.

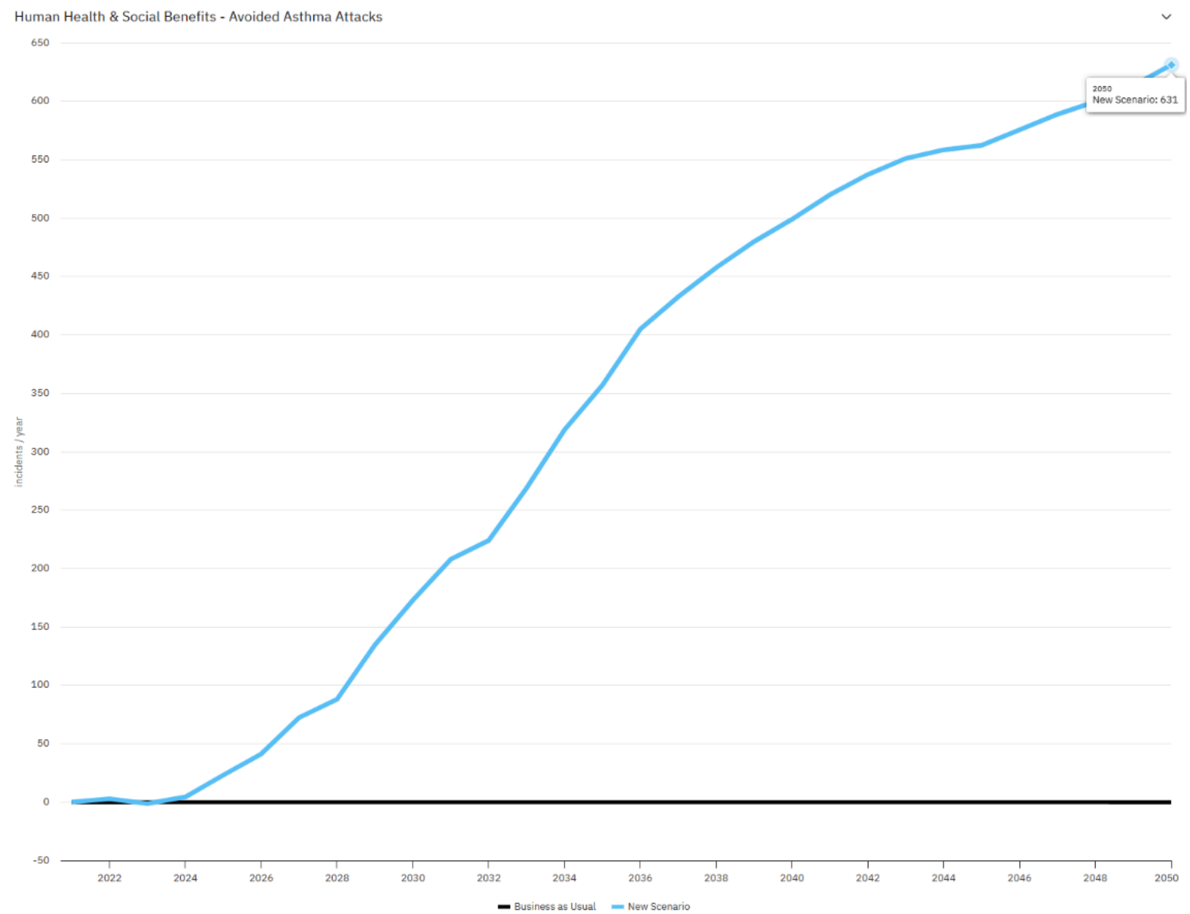

Fig. 12 Predicted Avoided Asthma Attacks Across Georgia [33]

The PCAP states that the potential $MTCO_2e$ reduction by 2050 for increasing energy efficiency in commercial and industrial buildings is 58,700,000 tons.[34] While this reduction is small on a global scale, the local environment can still be positively improved via a reduction in acid rain and improved air quality for the local fauna. Nitrogen and sulfur oxides can bind with the rain and lead to acidification. This leads to a breakdown of key nutrients in the soil such as magnesium and calcium and will negatively impact the plants that need those.[35] Reducing emissions of any of the aforementioned chemicals will lead to a healthier environment for plants and animals.

[33] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.
[34] "Priority Climate Action Plan Atlanta Metropolitan Statistical Area", 2024.
[35] "Why Is Acid Rain Harmful." EPA. Accessed March 5, 2025.
https://www3.epa.gov/acidrain/education/site_students/whyharmful.html#:~:text=Acid%20Rain%20Harms%20Forests&text=Acid%20rain%20that%20seeps%20into,trees%20to%20take%20up%20water.

Topic 4.

Estimated Cost

Funding for this initiative will be sourced from a combination of federal grants, state government support, NGOs, and private entities. The primary federal funding stream for the CPRG comes from Environmental Protection Agency (EPA) grants, with awards of up to $500 million available specifically for implementing greenhouse gas (GHG) reduction programs, policies, or measures identified in a PCAP developed under a CPRG planning grant.[36]

In addition, Georgia has already secured $7.6 million through the Department of Energy's 2023 Building Codes Implementation for Efficiency and Resilience Program. These funds will support workforce development and expertise in implementing stricter building codes, along with other energy efficiency initiatives across the state.

While contributions from NGOs and private entities are more difficult to predict, a survey conducted for the Atlanta MSA Priority Climate Action Plan indicated strong potential for additional funding—32% of interested stakeholders represented nonprofits/NGOs, while 20% came from private organizations.[37] However, to ensure reliability and simplicity in cost estimates, only guaranteed federal funding will be considered. Assuming the receipt of a $500 million EPA grant alongside the existing $7.6 million, the minimum implementation budget would be approximately $508 million.

Estimated Savings

The Social Cost of Greenhouse Gases (SC-GHGs) represents the monetary value of the net impact on society from an additional metric ton of emissions in a given year or the benefit of preventing that increase. Ideally, SC-GHGs account for all climate change-related effects, including (but not limited to) shifts in agricultural productivity, human health impacts, property damage from floods and natural disasters, disruptions to energy systems, risks of conflict, environmental migration, and the loss of ecosystem services. It reflects the societal value of increasing or decreasing emissions of a specific greenhouse gas by one metric ton. SC-GHGs serve as the appropriate metric for conducting benefit-cost analyses of policies that influence CO_2 emissions. The estimated savings of this proposal may be quantified through the social cost of carbon as described in the PNNL.[38] The Annual SC-CO2 Values from 2021 Interagency Update in 2021$ per Metric Ton CO2 avoided were provided and multiplied by the Avoided CO2 emissions (MMT) as summarized in Figure 4: Georgia Residential and Commercial Building Performance Savings Totals. As outlined in the February 2021 SC-GHG Technical Support Document (TSD), the Interagency Working Group (IWG) recommended that agencies return to using the same four values for the Social Cost of Greenhouse Gases (SC-GHGs) that were applied in regulatory analyses from 2010 to 2016 and underwent public review. These values are derived from SC-GHG distributions based on three discount rates. To determine them, the IWG averaged results across models and socioeconomic emissions scenarios, giving each scenario equal weight. The recommended values include the average SC-GHG estimate for each of three

36 "Priority Climate Action Plan Atlanta Metropolitan Statistical Area", 2024.
37 "Priority Climate Action Plan Atlanta Metropolitan Statistical Area", 2024.
38 M Tyler, 2023.

discount rates—2.5%, 3%, and 5%—as well as a fourth value, representing the 95th percentile of estimates based on a 3% discount rate.[39] This fourth value is intended to capture the potential for greater-than-expected economic damages from climate change. The total social cost of carbon in 2021 U.S. Dollars (2021$), ergo total savings from avoided carbon emissions, is summarized in below.

Table 5 Total SC-CO2 in Millions of 2021$

Year	Discount Rate			
	0.05	0.03	0.025	0.03
	Average	Average	Average	95th Percentile
2030	405	1295	1882	3846
2035	712	2167	3096	6502
2040	1084	3168	4585	9586
2050	1990	5562	7966	16710

With the estimated lowest cost for this initiative being $508 million, the cost benefit analysis of implementation clearly shows that for all scenarios other than a 5% discount rate in 2030, this project is cost-effective.

Impacts on Jobs

The awardence of the EPA CPRG grant is contingent on that project explicitly has goals to create high-quality jobs and spur economic growth. The Georgia Energy Policy Simulator (EPS) was used to model the net change in jobs that would be impacted increased building energy efficiency standards using a conservative 30% total reduction and the same implementation schedule as used previously: 5% in 2024, 75% in 2029, and 100% in 2050[40]. Figure 13 below shows the change in jobs in the fossil fuel and utility, manufacturing and construction, other, and total career fields that would be impacted.

[39] M Tyler, 2023.
[40] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.

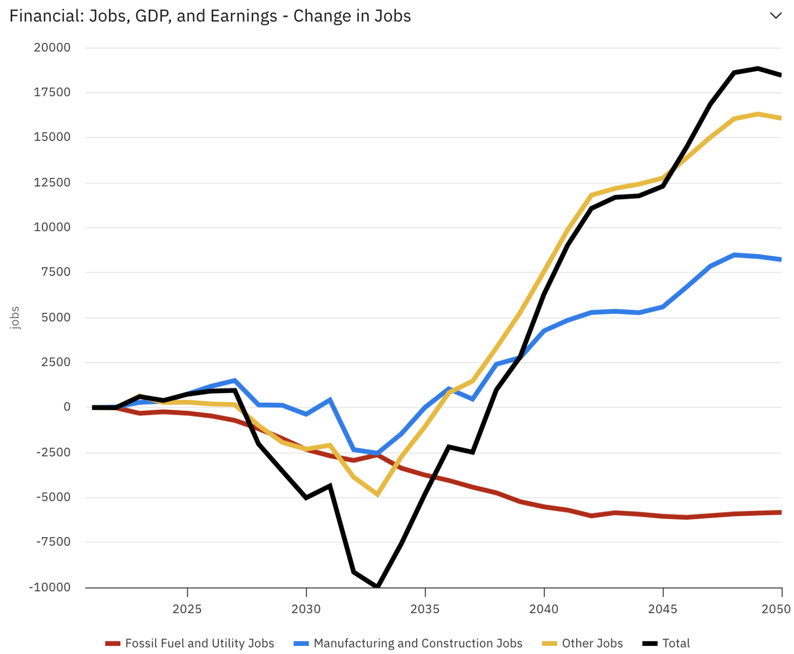

Fig. 13 EPS Modeled Change in Jobs [41]

While the fossil fuel and utility industry will steadily decline, overall job market will increase by over 17500 jobs in 2050. The CPRG intends for these jobs to go primarily to individuals in low-income and disadvantaged communities through the Building Georgia Workforce Partnership (BGWP).[42] The BGWP The aims to bridge the gap between the state's current workforce and the growing demand for infrastructure construction jobs under the Infrastructure Investment & Jobs Act (IIJA). With an estimated 136,000 job openings over the next five years, this initiative will be the first in the U.S. to utilize IIJA transportation funding for workforce development.[43] The program focuses on industry-driven training, employer-job seeker matching, early skilled trades promotion, and securing long-term funding to sustain workforce growth.

Impacts on Economic Development

The model takes in data from all major economic sectors, including: transportation, electricity supply, buildings, industry, agriculture, land use, hydrogen supply, district heat, waste management, geoengineering, etc[44]. The impact of the increased building efficiency on

[41] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.
[42] "Priority Climate Action Plan Atlanta Metropolitan Statistical Area", 2024.
[43] "Priority Climate Action Plan Atlanta Metropolitan Statistical Area", 2024.
[44] "Introduction: About the Energy Policy Simulators." Energy Policy Simulator Documentation. Accessed March 12, 2025. https://docs.energypolicy.solutions/.

governmental budgeting, based on the aforementioned implementation schedule, is shown in Figure 14 below.

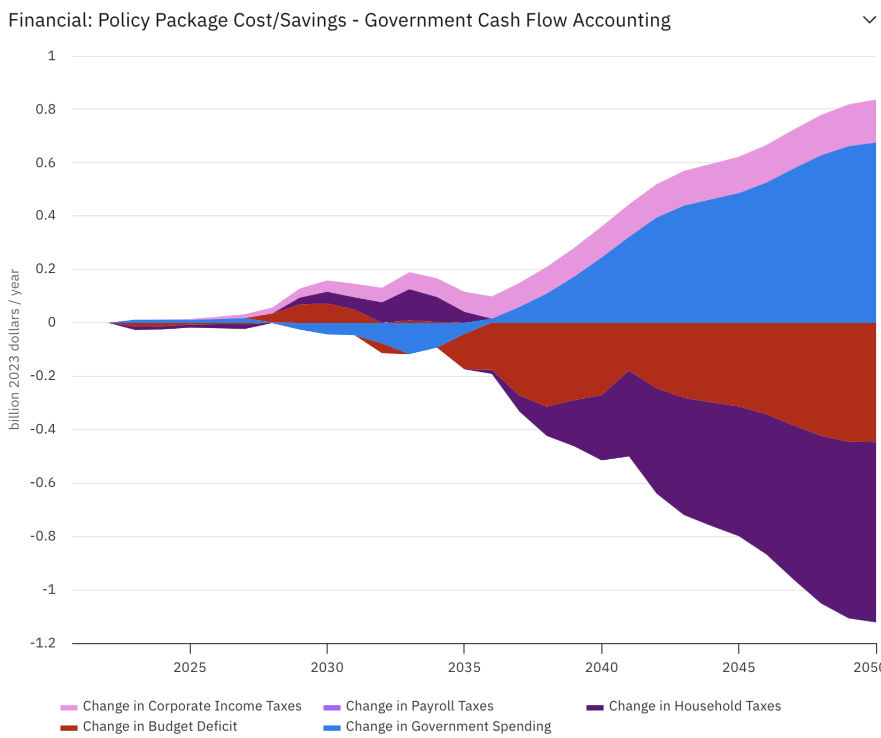

Fig. 14 EPS Modeled Governmental Cash Flow Accounting [45]

This figure illustrates the projected financial impacts of increased building energy efficiency on government cash flow. Over time, the policy leads to higher corporate income taxes (pink) and payroll taxes (purple), indicating economic growth and job creation. Despite an initial increase in government spending (blue) and a rise in the budget deficit (red), these costs are outweighed by growing tax revenues and reduced expenditures, ultimately strengthening the economy and promoting long-term fiscal sustainability.

Impacts on GDP

Gross Domestic Product (GDP) is determined by calculating the monetary value of goods and services provided from all economic agents across 3 main sectors: households, businesses, and the government.[46] The change in GDP due to increased building efficiency, based on the aforementioned implementation schedule, is summarized in Figure 15 below.

[45] Rocky Mountain Institute, “Energy Policy Simulator 4.0.2,”, 2025.
[46] “Gross Domestic Product.” Encyclopædia Britannica. Accessed March 12, 2025. https://www.britannica.com/money/gross-domestic-product.

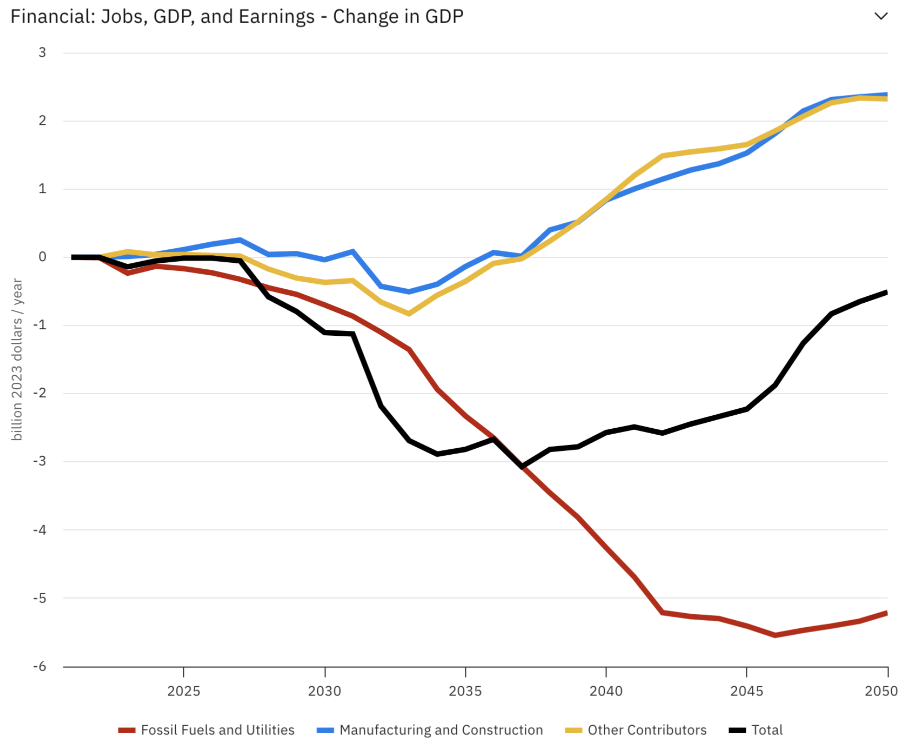

Fig. 15 EPS Modeled Change in GDP [47]

While the fossil fuels and utilities sector (red) experiences a decline, the manufacturing and construction (blue) and other contributors (yellow) drive overall economic growth. Despite initial losses, the total GDP (black) rebounds after 2035, showing relatively minimal net GDP change by 2050 as opposed to 2023 levels. Since this model only takes into account internal changes in building efficiency within Georgia, if the country as a whole shifted to increased energy efficiency in all buildings and focused on producing an excess of green energy for export, these wide reaching changes could greatly increase the national GDP, boosting economic development and job creation.

[47] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.

Topic 5.

The ARC prioritizes equitable carbon reduction strategies in the CCAP by addressing the needs of low-income and disadvantaged communities (LIDACs) identified using the Climate and Economic Justice Screening Tool (CEJST) and EPA's EJScreen. To better understand community priorities, ARC partnered with Georgia's EPD Air Protection Branch to distribute a statewide CPRG stakeholder survey in 2024, with over 54% of respondents from the Atlanta MSA. Key benefits identified by respondents include improved public health through reduced air pollution, enhanced transportation options, and increased community resilience to extreme weather events—aligning with ARC's goal of ensuring that climate strategies provide both environmental and social benefits to under-resourced communities.[48]

The EPS tool was used once again to model how different communities would be impacted by the implementation of this project using the same parameters as mentioned previously. The EPS model estimates emissions reductions for 12 pollutants, including NOX, SOX, and particulate matter (PM), which have harmful health effects. Since most climate policies also reduce these pollutants, they provide direct health benefits. To assess health impacts, emissions changes are first modeled using air quality tools like GEOS-Chem or CMAQ to estimate pollutant concentrations. Then, epidemiological concentration-response functions (CRFs) determine how these changes affect health outcomes, such as premature mortality, allowing policymakers to quantify the health benefits of emissions reduction policies.[49] Below, Figures 16-18 show the percent change by gender, race and Hispanic/ Latino status, respectively, with 0 being the business-as-usual value for all years.

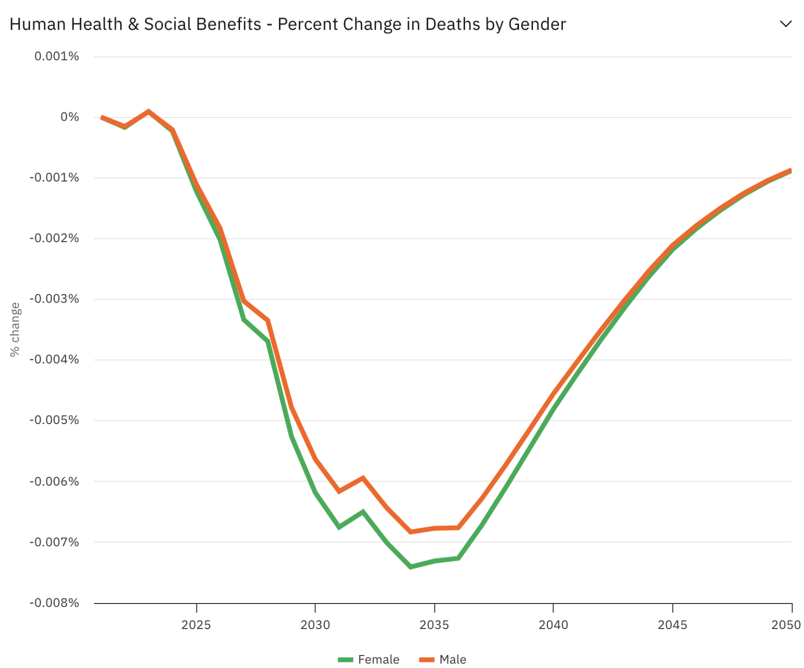

Fig. 16 EPS Modeled Avoided Deaths by Gender in Incidents per Year [50]

[48] "Priority Climate Action Plan Atlanta Metropolitan Statistical Area", 2024.
[49] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.
[50] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.

The female proportion (green) shows slightly greater decrease in deaths as a result of this project as opposes to the male proportion (orange). This implies women's heath will benefit more from the reduced emissions and bettered environmental conditions in the Atlanta area.

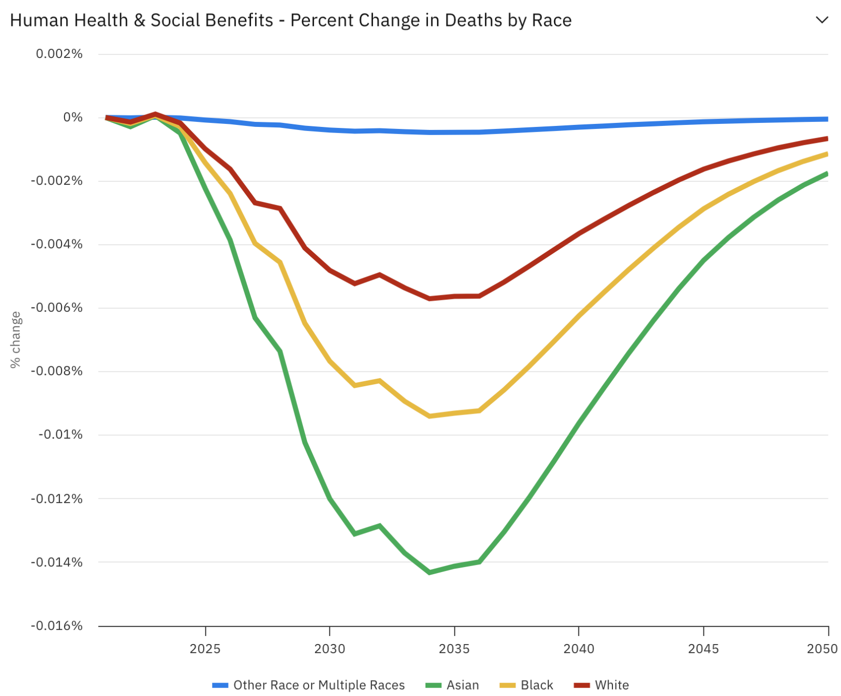

Fig. 17 EPS Percent Change in Deaths by Race in Incidents per Year [51]

The Asian population (green) shows the greatest decrease in deaths as a result of this project, followed by the Black population (yellow), then the White population (red), and Other Races or Multiple Races (blue) having the least reduction in deaths. as opposes to the male proportion (orange). This implies persons of minority races will benefit more from the reduced emissions and bettered environmental conditions in the Atlanta area.

[51] Rocky Mountain Institute, "Energy Policy Simulator 4.0.2,", 2025.

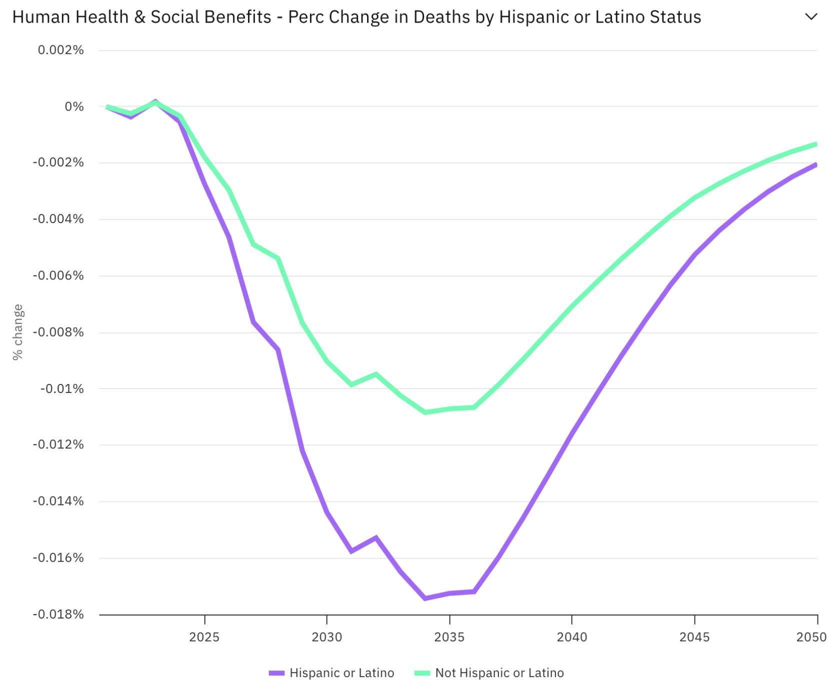

Fig. 18 EPS Modeled Avoided Deaths by Race in Incidents per Year [52]

The Hispanic or Latino proportion (purple) shows slightly greater decrease in deaths as a result of this project as opposes to the male proportion (orange). This implies the Hispanics or Latinos will benefit more from the reduced emissions and bettered environmental conditions in the Atlanta area.

Aside from health impacts, distributing the benefits from the CPAP equitably can also be achieved through diversifying the workforce that would be directly impacted. As Figure X above showed, there will be over 7500 new jobs in construction and manufacturing by 2050. The distribution of race and ethnicity within construction occupational group in 2020 is shown in Figure 19 below.

[52] Rocky Mountain Institute, “Energy Policy Simulator 4.0.2,”, 2025.

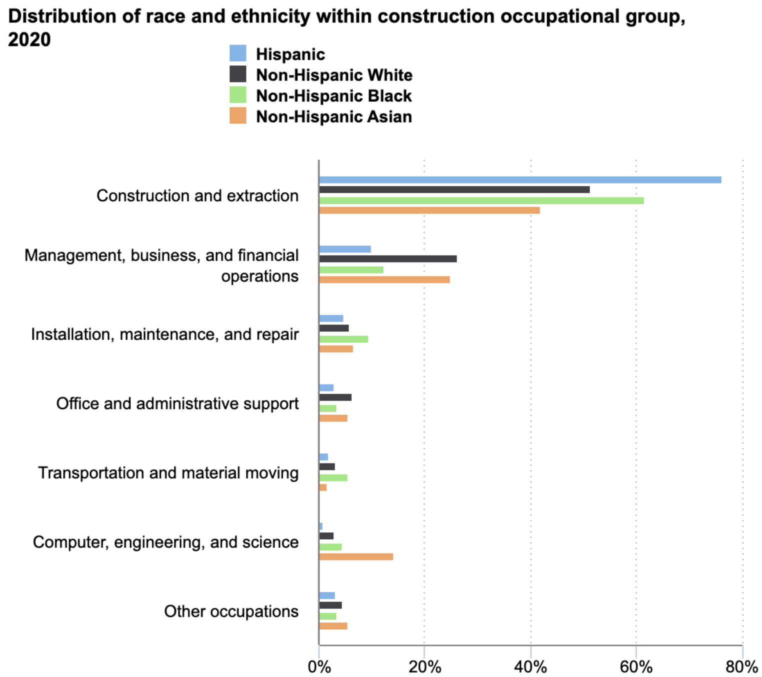

Fig.19 Distribution of Race and Ethnicity within Construction Occupational Group in 2020 [53]

If the majority of the new jobs are given to those in LIDAR communities, the workforce will see greater diversity and the CPAP will achieve its goal of Building Georgia Workforce Partnership.

[53] "Map: States' Share of Hispanic Construction Workers." Map: States' Share of Hispanic Construction Workers - Structural Building Components Association, July 5, 2022. https://www.sbcacomponents.com/media/map-states-share-of-hispanic-construction-workers.

Conclusion

The implementation of enhanced Building Performance Standards (BPS) by the PCAP is a critical step toward improving energy efficiency and combatting climate change is the Atlanta Metropolitan Statistical Area. The achievable policy measures could reduce greenhouse gas emissions by 36.8 million metric tons (MMT) of CO2e by 2050, compared to business-as-usual scenarios. While aggressive policy intervention can reduce greenhouse gas emissions by up to 54% by 2050, equating to a total of 98.2 million metric tons (MMT) of avoided CO2 emissions. Additionally, the 30% reduction in building energy consumption scenario could decrease nitrogen oxide emissions by 3,000 metric tons and prevent 17 annual premature deaths. Financially, the projected savings from reduced emissions, calculated using the Social Cost of Carbon, range from $1.3 billion in 2030 to over $5.5 billion in 2050. The availability of $508 million in federal grants, including $500 million from the EPA, supports implementation. Additionally, energy efficiency policies will generate over 17,500 new jobs in the construction and manufacturing sectors by 2050, offsetting losses in fossil fuel industries.

The economic, environmental, and public health benefits of enhanced BPS underscore the urgency of policy adoption. With strategic investments and regulatory compliance, Atlanta can achieve a more sustainable and resilient built environment, fostering long-term prosperity. To maximize the impact of improved BPS policy, continued work should focus on innovation in energy-efficient technologies, adaptive policy measures, and shorter policy adoption cycles. To maintain progress, participating agencies must collaborate to expand incentives to encourage broader participation across sectors.

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Appendix A

Table A.1. Commercial Codes Adoption Classification by State

State	Adoption Classification	Adoption Lag Years	90.1-2001	90.1-2004	90.1-2007	90.1-2010	90.1-2013	90.1-2016	90.1-2019	90.1-2022	90.1-2025	90.1-2028	90.1-2031	90.1-2034	90.1-2037
Code Year			*2000*	*2006*	*2009*	*2012*	*2015*	*2018*	*2021*	*2024*	*2027*	*2030*	*2033*	*2036*	*2039*
Alabama	Slow	7	start		2013		2016		2024	2031	2034	2037	2040	2043	2046
Arizona	Moderate	4	start			2013		2019	2025	2028	2031	2034	2037	2040	2043
Arkansas	Slow	7	start	2013	2015	2019	2022		2025	2031	2034	2037	2040	2043	2046
Colorado	Moderate	4	start		2012	2017		2020	2024	2028	2031	2034	2037	2040	2043
Connecticut	Moderate	4		start	2012	2016	2018		2022	2028	2031	2034	2037	2040	2043
Delaware	Moderate	4			start	2014		2020	2024	2028	2031	2034	2037	2040	2043
District of Columbia	Moderate	4			start	2014	2020		2024	2028	2031	2034	2037	2040	2043
Florida	Moderate	4		start	2012	2015	2018	2021	2024	2028	2031	2034	2037	2040	2043
Georgia	Slow	7		start	2011		2020	2025	2030	2031	2034	2037	2040	2043	2046

PNNL, Impacts of energy Codes 2023

Table A.2. Residential Codes Adoption Classification by State

State	Adoption Classification	Adoption Lag Years	IECC 2003	IECC 2006	IECC 2009	IECC 2012	IECC 2015	IECC 2018	IECC 2021	IECC 2024	IECC 2027	IECC 2030	IECC 2033	IECC 2036	IECC 2039
Code Year			*2003*	*2006*	*2009*	*2012*	*2015*	*2018*	*2021*	*2024*	*2027*	*2030*	*2033*	*2036*	*2039*
Alabama	Slow	7		start	2013		2016		2024	2031	2034	2037	2040	2043	2046
Arizona	Moderate	4				start		2019	2025	2028	2031	2034	2037	2040	2043
Arkansas	Slow	7	start			2019	2022	2025	2028	2031	2034	2037	2040	2043	2046
Colorado	Moderate	4		start	2012	2017		2020	2024	2028	2031	2034	2037	2040	2043
Connecticut	Moderate	4		start	2012	2016	2018		2022	2028	2031	2034	2037	2040	2043
Delaware	Moderate	4			start	2014		2020	2024	2028	2031	2034	2037	2040	2043
District of Columbia	Moderate	4			start	2014	2020		2024	2028	2031	2034	2037	2040	2043
Florida	Moderate	4	start		2012	2015	2018	2021	2024	2028	2031	2034	2037	2040	2043
Georgia	Slow	7		start	2011		2020	2025	2030	2031	2034	2037	2040	2043	2046

PNNL, Impacts of energy Codes 2023

Appendix B

Code cycle adoption from "Impacts of Model Energy Codes" PNNL 2023

"Energy codes follow a three-phase cycle that starts with the development of a new model code, proceeds with the adoption of the new code by states and local jurisdictions, and finishes when buildings comply with the code. The development of new model code editions creates the potential for increased energy savings. After a new model code is adopted, potential savings are realized in the field when new buildings (or additions and alterations) are constructed to comply with the new code. Delayed adoption of a model code and incomplete compliance with the code's requirements erode potential savings. The contributions of all three phases are crucial to the overall impact of codes, and are considered in this assessment."

Table 2. Example Calculation of Incremental, Annual, and Cumulative Savings for One State

Row	Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	Code Edition	1	2	2	2	3	3	3	3	4	4	4
2	Code-to-Code Savings, kBtu/sf	-	7.0	7.0	7.0	6.0	6.0	6.0	6.0	5.0	5.0	5.0
3	Realization Rate	-	0.7	0.8	0.9	0.7	0.8	0.9	0.95	0.7	0.8	0.9
4	Realized Savings, kBtu/sf	-	4.9	5.6	6.3	4.2	4.8	5.4	5.7	3.5	4.0	4.5
5	New floor space added, thousand sf	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
						Savings, billion Btu						
	Year of accounted savings →	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	↓ Year floor space is added											
6	2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	2011	0.0	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
8	2012	0.0	0.0	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
9	2013	0.0	0.0	0.0	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
10	2014	0.0	0.0	0.0	0.0	4.2	4.2	4.2	4.2	4.2	4.2	4.2
11	2015	0.0	0.0	0.0	0.0	0.0	4.8	4.8	4.8	4.8	4.8	4.8
12	2016	0.0	0.0	0.0	0.0	0.0	0.0	5.4	5.4	5.4	5.4	5.4
13	2017	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7	5.7	5.7	5.7
14	2018	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	3.5	3.5
15	2019	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	4.0
16	2020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5
17	Incremental	0.0	4.9	5.6	6.3	4.2	4.8	5.4	5.7	3.5	4.0	4.5
18	Annual	0.0	4.9	10.5	16.8	21.0	25.8	31.2	36.9	40.4	44.4	48.9
19	Cumulative (sum of Annual Savings from 2010 through 2020)											280.8

Note: Generic values are used in this table to demonstrate the calculation.

Appendix C

From "Impacts of Model Building Energy Codes" Appendix C

Maximum Potential Savings

Currently, DOE is conducting residential and commercial field studies that are designed to determine the impact of education and training activities on reducing lost energy savings in the field. These studies can be used to calculate the additional savings that can be achieved if all potential savings from codes are realized in the field. The savings realization rate inputs described in section 2.1.5 are modified to analyze such a scenario. The realization rate is changed to 100% immediately after adoption for both residential and commercial codes. Table C.1 shows the result of this scenario. Potential cumulative site energy savings of up to 7 quads, primary energy savings of 16 quads, consumer cost savings of $151 billion, and a CO_2 reduction of 1,028 MMT is possible for the 2010-2040 period if the realization rate is 100%. Compared to the results presented in section 3.0, additional cumulative savings from 2010-2040 are 2.83 quads (22%) of primary energy, 24.81 billion dollars (20%), and 187 MMT (22%) of avoided CO_2 emissions.

Table C.1. Summary of Energy Codes Impact with 100% Compliance

Sector	Site Energy Savings (Quads)	Primary Energy Savings (Quads)	FFC Savings (Quads)	Energy Cost Savings (2016 $ billion)	CO_2 Reduction (MMT)
Commercial					
Annual 2030	0.14	0.38	0.39	3.19	24.97
Annual 2040	0.18	0.46	0.48	3.62	30.50
Cumulative 2010-2030	1.70	4.50	4.73	39.62	299.22
Cumulative 2010-2040	3.34	8.71	9.15	73.98	578.71
Residential					
Annual 2030	0.15	0.29	0.31	3.24	18.96
Annual 2040	0.18	0.34	0.36	3.56	22.16
Cumulative 2010-2030	1.93	3.73	3.98	42.52	241.94
Cumulative 2010-2040	3.58	6.93	7.39	76.77	449.33
Total					
Annual 2030	0.30	0.67	0.71	6.43	43.94
Annual 2040	0.36	0.80	0.85	7.18	52.66
Cumulative 2010-2030	3.62	8.24	8.71	82.14	541.15
Cumulative 2010-2040	6.92	15.65	16.55	150.74	1028.04

Note: The following states are excluded from the analysis: AK, CA, HI, KS, MO, MS (residential only), ND, OR, SD, and WA. See section 2.1.3 for details.

Table 3. Summary of Energy Codes Impact

Sector	Site Energy Savings (Quads)	Primary Energy Savings (Quads)	FFC Savings (Quads)	Energy Cost Savings (2016 $ billion)	CO_2 Reduction (MMT)
Commercial					
Annual 2030	0.10	0.26	0.28	2.24	17.57
Annual 2040	0.13	0.32	0.34	2.54	21.48
Cumulative 2010-2030	1.18	3.14	3.30	27.53	208.78
Cumulative 2010-2040	2.34	6.10	6.41	51.59	405.51
Residential					
Annual 2030	0.15	0.28	0.30	3.14	18.38
Annual 2040	0.17	0.33	0.35	3.45	21.46
Cumulative 2010-2030	1.87	3.62	3.86	41.19	234.52
Cumulative 2010-2040	3.48	6.72	7.17	74.34	435.43
Total					
Annual 2030	0.25	0.55	0.58	5.37	35.96
Annual 2040	0.30	0.66	0.69	5.98	42.93
Cumulative 2010-2030	3.06	6.76	7.16	68.72	443.30
Cumulative 2010-2040	5.82	12.82	13.58	125.93	840.94

Note: The following states are excluded from the analysis: AK, CA, HI, KS, MO, MS (residential only), ND, OR, SD, and WA. See section 2.1.3 for details.

Confirming 22% increase: Total from appendix C (res and comm total): 1028.04 MMT saved 2010-2040

840.84 MMT saved 2010-2040 total from Table 3. Multiply by 1.22 (22% increase) = 1025.8

Confirmed.

Assume 22% increase savings across the board with the adoption.

GA 2010-2040 emissions saved: 34.78 MMT

22% increase save applied to an existing 45% immediate, aggressive scenario: 9.9%, total 54.4%