

ISYE 6701 – Energy Technology and Policy

Team 5 Final Report

**Georgia Home Energy Rebate Programs and Their
Applicability to Italian Policies**

By Colleen Boyle and Dylan Reichert

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Abstract

This paper serves to investigate the two Home Energy Rebate Programs offered in the United States and how they would, if implemented, positively influence various aspects for Georgia. This includes greenhouse gas emissions, costs to homeowners, and way-of-life for residents. To expand upon this, we will compare these policies to that of a similar nature already implemented in Italy.

Introduction to the Georgia Rebate Programs

On January 20, 2021, the United States officially rejoined the Paris Agreement which aims to create frameworks and policies for the 196 nations to combat climate change and GHG emissions [1], [2]. The targets are to limit global warming to 1.5°C by 2030 and to have GHGs peak by 2025 with a 43% decrease by 2030 [2].

Georgia's residential sector emits an average of 1.6 metric megatons (Mt) greenhouse gases (GHGs) per month, or 22.2Mt annually. This makes up 22.5% of the total net monthly GHG emissions for all of Georgia. It is the third largest emissions by sector, falling behind the transportation and industrial sectors. This works out to be 1,397 pounds of GHG emissions per person monthly [3]. To help reduce GHG emissions, on August 16, 2022, President Joseph Biden introduced the Inflation Reduction Act (IRA) which has \$8.8 billion allotted to home energy rebate programs that incentivize homeowners to upgrade outdated, non-energy efficient appliances with newer, energy-efficient ones [4]. 13 of the 56 U.S. states and territories have applied for Early Administrative Funding, which is described as "States and territories can apply for this funding to begin developing their programs. When applying, states and territories are eligible to receive up to 2.5% of their total allocations from each program, capped at \$2.5 million per program, or \$5 million total. States may bypass this application and receive these funds as part of their full program funding" [5]. 25 U.S. states and territories have applied and been approved for Early Administrative Funding. Only 4 states and territories have an application status for Program Funding, which is stated to provide "full funding to launch their programs. All participating states and territories must submit applications for full program funds" [5]. Georgia falls under the funds awarded for the Early Administrative Funding. Though no state or territory has launched their programs yet, the DOE expects many to start this year in 2024 and is projected to save households annually up to \$1 billion on energy bills [4].

The two policies offered under the Home Energy Rebates Programs are the Home Efficiency Rebates (HER) and the Home Electrification and Appliance Rebates (HEAR). Both programs are offered nationally with an allotted amount of funding per state. Georgia has been given over \$200 million for both programs with \$109 million assigned to the HEAR program [6], [7].

For the HER program, the IRA does not establish a specific list of eligible products and building materials for this program. Instead, the program provides rebates for various energy efficient appliances and building installations that together can save at least 20% of a household's total energy usage [8]. For the HEAR program, there are income requirements that must be met to be considered eligible for the rebate. If the household is low-income, making less than 80% of the area median income (AMI), then they are qualified to have up to 100% of their energy efficient upgrade costs covered. For households labeled as

middle-income, 80%-150% AMI, they are qualified for up to 50% of their energy efficient upgrade costs being covered. When discussing multifamily households, half the residents must be considered low-income for 100% of costs covered and half the residents considered middle-income for 50% cost coverage. There are specific types of appliances and cost caps that apply to the HEAR program that applicants must adhere to [9]. Table 1 illustrates the requirements for the HER Program while Tables 2-3 show that for the HEAR Program. Here, “AMI” refers to Average Median Income while “LMI” is Low and Moderate Income.

Home Efficiency Rebate Program		
Modeled Energy Savings	Income Level	Rebate Amount
Single Family		
20% - 34%	< 80% AMI	Lesser of \$4k or 80% of project costs
	≥ 80% AMI	Lesser of \$2k or 50% of project costs
≥ 35%	< 80% AMI	Lesser of \$8k or 80% of project costs
	≥ 80% AMI	Lesser of \$4k or 50% of project costs
Multi-Family		
20% - 34%	half the households < 80% AMI	Lesser of \$4k per dwelling or 80% of project costs
	half the households ≥ 80% AMI	Lesser of \$2k per dwelling or up to \$200k per building
≥ 35%	half the households < 80% AMI	Lesser of \$8k per dwelling or 80% of project costs
	half the households ≥ 80% AMI	Lesser of \$4k per dwelling or up to \$400k per building

Table 1: HER Program Requirements [9]

Home Electrification and Appliance (HEAR) Rebate Program		
Upgrade Type	Qualified Product	Rebate Amount Not to Exceed
Product Rebates		
Appliance	Heat Pump Water Heater	\$1,750
	Heating Pump for Space Heating / Cooling	\$8,000
	Electric Stove / Cooktop / Range / Oven / Heat Pump Clothes Dryer	\$840
Building Materials	Electric Load Service Center	\$4,000
	Insulation / Air Sealing / Ventilation	\$1,600
	Electric Wiring	\$2,500
Maximum Rebate:		\$14,000

Table 2: HEAR Program Requirements for Appliances and Building Materials [9]

Home Electrification and Appliance (HEAR) Rebate Program		
Eligible Rebate Recipient	Income Level	Rebate Amount Not to Exceed
Rebate Limitations		
LMI Household / Eligible Entity Representative Representing LMI Household	< 80% AMI	100% of Qualified Project Cost
	80% - 150% AMI	50% of Qualified Project Cost
Owner of Multifamily Building / Eligible Entity Representative Representing Owner of Multifamily Building	half the residents with income < 80% AMI	100% of Qualified Project Cost

	half the residents with income of 81% - 150% AMI	50% of Qualified Project Cost
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Table 3: HEAR Program Requirements per Household Type [9]

In this paper, we will discuss these programs specifically as they pertain to Georgia projected from today through the milestone years 2030, 2040, and 2050. Particularly, we will investigate GHG CO₂-e emissions projections without the rebate programs as well as with the rebate programs at an achievable rate and an ideal (technical) rate. We will also research the pollution reduction benefits towards cost savings and the people. In expansion of this, we will compare these programs to an existing tax credit scheme already implemented in Italy.

Georgia vs. Italy: Residential CO₂-e Emission Reduction Scenarios Comparison

The IRA’s Home Energy Rebate Program has the potential to significantly reduce Georgia homeowner’s residential CO₂-e emission levels while also lowering their monthly energy bills. Analyzing Italy’s failed Superbonus 110 heat pump (HP) rebate program can provide valuable insight into how Georgia should best implement its own HP rebate program. Before a direct analytical comparison can be made, it’s important to acknowledge the similarities and differences between the two cases. For instance, Italy’s heating infrastructure is significantly more reliant on gas and oil boilers, whereas Georgia has a much higher percentage of electric heaters. Also, in Italy, it is common for space heaters and water heaters to be combined into a single heat pump system. In Georgia, households generally have two separate systems, one for space heating and the other for water heating. Consequently, the results from Georgia used in this comparison factor in both HP and HPWH system data (such as CO₂-e emissions) into the final calculations.

One other key difference is population growth – Italy’s population is shrinking (even with current and projected immigration patterns considered) while Georgia’s is growing at a steady rate. This changes the calculations significantly. Much of Georgia’s potential for rapid heat pump adoption comes from the new residential buildings that will be required to accommodate for its growing population. In contrast, new residential construction in Italy is more limited due to its shrinking populace which, when combined with its surplus of older buildings, means that heat pump adoption is driven more heavily by retrofitting. The differences in the two areas’ residential construction markets affect how a rebate program should best incentivize heat pump uptake. Italy might find more success heavily incentivizing retrofitting older heating systems where GA might have better luck subsidizing new, energy efficient housing.

Despite these notable differences, the two regions are comparable in ways that provide valuable insight for Georgia’s future rebate policies. For instance, since both regions experience a varied range of temperatures, regular use of both heating and cooling systems is commonplace in both, making CO₂ emissions comparisons reasonable. Certain countries, such as Singapore, have similar rebate programs to Italy but are not comparable due to their consistently high temperatures reducing the need for space heating.

Much like the IRA home energy rebate program, Italy's Superbonus 110 rebate program is tiered, giving stronger financial incentives to lower income households. That said, it is more aggressive than most proposed implementations of HER. Its titular 110% rebate caused a massive spike in rebate applications and heat pump purchases, which in turn cost the government 110 billion from 2021 to 2023, causing the program to be shut down early.

To examine the efficacy of Italy's Superbonus 110 program and see how it could inform Georgia's implementation of the HER program, 3 scenarios were modeled for both Georgia and Italy. The main outcomes forecasted were the percentage of residential households with heat pumps and the total (cumulative) CO₂e savings (metric tons) from residential heat pumps per capita through 2050. CO₂e values were calculated per capita to control for the difference in population sizes between Georgia and Italy, as the latter has roughly 6 times more populous and thus has far more CO₂e emissions.

The Environmental Policy Simulator's "Rebate for Efficient Products" policy cannot be adjusted to accurately reflect the rebates offered by the Home Energy Rebate Program or the Superbonus 110 program, meaning it could not be used for modeling this comparison. Instead, we manually created a mathematical model to calculate and project CO₂-e emissions to 2050.

With regards to the Georgia model, The Business as Usual (BAU) scenario examines the market trends for HP and HPWH without and IRA appliance rebate programs implemented. The trends are projected out to 2050 and CO₂e measures are calculated. In the Achievable scenario, a realistically plausible case is modeled where Georgia focuses on aggressively implementing the IRA's Home Energy Rebate Program to promote the uptake of HP and HPWH. It models a non-deal scenario that reflects the real-world difficulties and inefficiencies that are inherent to of the implementation process, such as a lack of participation by eligible households, appliance failure rates, and other accessibility issues – especially as it pertains to Low Income/Disadvantaged Communities (LIDAC). With proper marketing and a concert effort to improve accessibility for eligible households, the achievable scenario modeled is plausible and follows a similar trajectory to that of Rewiring America and other literature [10]. The technical model, on the other hand, captures the ideal scenario where the HER is implemented perfectly with complete legislative support and funding, minimal appliance failure, and enthusiastic engagement from target communities. All 3 assume that no other major legislation or future technological innovation upends the HP/HPWH market. They also assume that all new homes after 2023 are built with HP and HPWH and that a certain percentage of older homes will be retrofitted with new heating using the rebate every year.

Data collected from Drawdown GA indicates that, the average Georgia household emits roughly 6.57 metric tons of CO₂-e annually [3]. Literature suggests that for a pre-2006 home – which are a sizable share of the ones in need of retrofitting -- switching to a HP in Georgia reduces CO₂-e emissions by around 51% [11]. Other studies indicate that on average, households that switch to a HPWH reduce their CO₂-e emissions by 0.842 metric tons annually when compared to those using a conventional gas or electric water heater [12] [13]. This calculation is based on the weighted average for annual household gas and electric water heater emissions. Other water heating appliances were not considered as those two make up most of the water heating market and are the most significant contributors to CO₂-e emissions. Using this information, we then projected how Georgia's residential CO₂-e emissions will change based on the HP and HPWH adoption rate and the current and projected number of

households with/without them. Using this data collection and mathematical modeling process, we projected CO₂-e emissions out to 2050 for the 3 different scenarios – BAU, Achievable, and Technical.

The Italy models are similar, though different in distinct and important ways. The baseline HP household adoption rate for all 3 Italy models was roughly 8% in 2022 based on current market research [14][15]. From there, the HP market share back to 2018 was calculated using Italian annual HP sales data [16]. HP market share was projected from 2023 to 2050 using different data and assumptions that will be discussed for each model. CO₂e emissions were calculated based on data from the European Heat Pump Association which indicated that in 2022, HPs saved Italy more 5.4 Mt of CO₂e [17]. It was also found that switching from a gas boiler to a HP saved around 1400 kgs (about 3086.47 lb.) of CO₂e annually per household on average [18]. These data points, combined with the HP market share forecasts and projections of Italian population/household growth, were used to calculate an average CO₂e savings per HP and then CO₂e savings per capita. This assumes that the efficiency of heat pump technology will not increase between now and 2050 which is unlikely to be true.

The BAU model makes similar general assumptions as the Georgia one, but in this case. It follows the real-world conditions where the Italian Superbonus rebate program was implemented and then canceled due to overwhelming costs. After cancelation, the HP adoption rate returns to pre-rebate levels and continues until 2050. This is visible on Figure 1, where the “Italy: BAU” line slopes up during 2021-2023 only to return to its pre-rebate trend, which is then projected out to 2050. By 2050, Household HP adoption is at only 37.4%, far short of EU climate goals. This scenario has the worst adoption rate of the 6 presented by far, as well as the lowest CO₂e savings per capita as seen in Figure 2.

Italy’s technical scenario also makes similar assumptions as the Georgia version, except in this case it assumes that the HP adoption rate continues its trajectory under the Superbonus 110 rebate program through to 2050. Under these conditions, the HP adoption rate climbs quickly and reaches 100% by 2031. Of the 6 scenarios modeled for this paper, the Italian Technical Scenario resulted in the quickest climb to 100% saturation, which is not surprising given the immense 110% tax rebate incentivizing consumers to upgrade to a HP. Such a rapid climb comes at an immense cost, which is why the rebate program was shuttered in the first place and why this scenario is an idealized scenario that is unlikely to occur. Still, it does show that rebates can be quite effective at driving consumer purchasing habits if they’re high enough and sufficiently well marketed. Italian consumers were clearly very eager to engage with this program because it was lucrative and well-advertised. Though the proposed GA HER policy only covers 100% of HP cost for low-income housing, not 110%, if it was marketed aggressively to those low-income households and the rebate was applied at point of purchase, perhaps GA could achieve similar levels of target group engagement. Both the GA and Italy Technical Scenarios end up with roughly the same Total Residential CO₂ Savings per capita despite the growth rate of the latter being significantly faster.

The achievable scenario for Italy takes a slower, more measured approach to growth that has the potential to be financially viable for the government – unlike the Superbonus 110 program. Rather than shooting for 40%+ year over year HP market share growth, this model assumes the adoption rate increases by 10% every year. At that rate, Italy would reach HP saturation in 2039. Despite reaching saturation before the GA Achievable scenario, its CO₂e emission savings are less. This could be because switching to a HP saves more energy in GA per household -- perhaps because the slightly colder climate

increases the benefits of heating efficiency. This paints an optimistic picture that if GA transitions quickly, it can make a large dent in its carbon footprint.

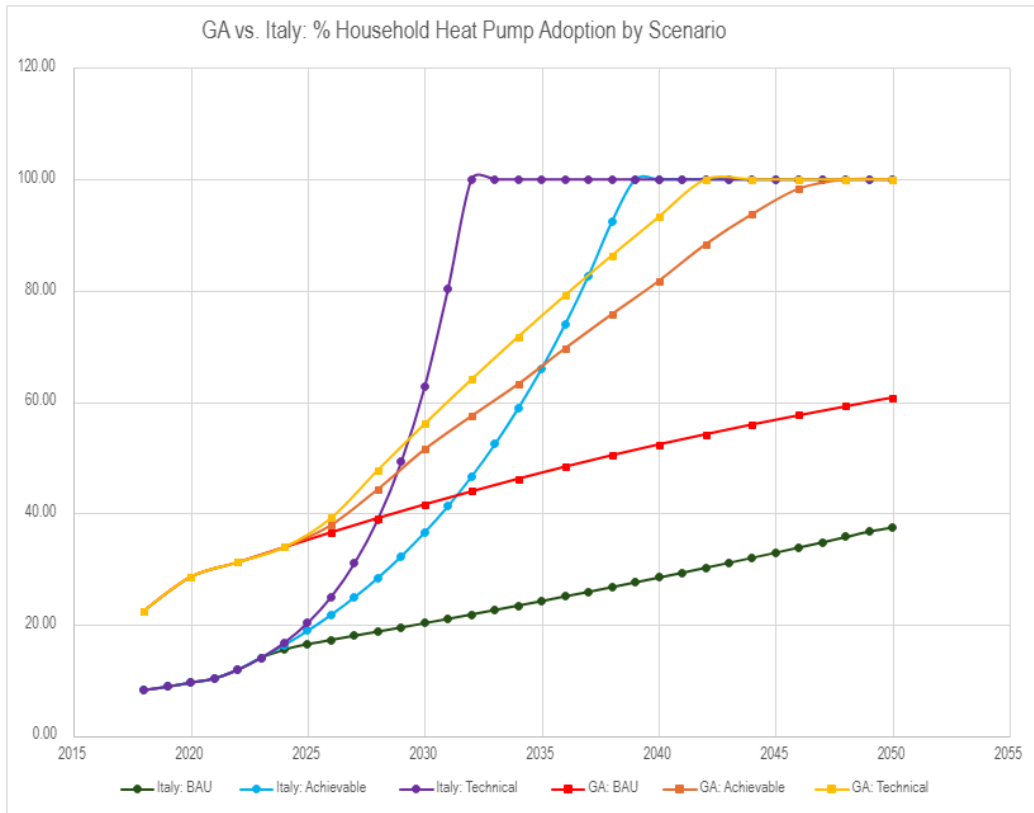


Figure 1: Georgia vs Italy - Percentage of Households with Heat Pumps by Projection Scenario Through 2050

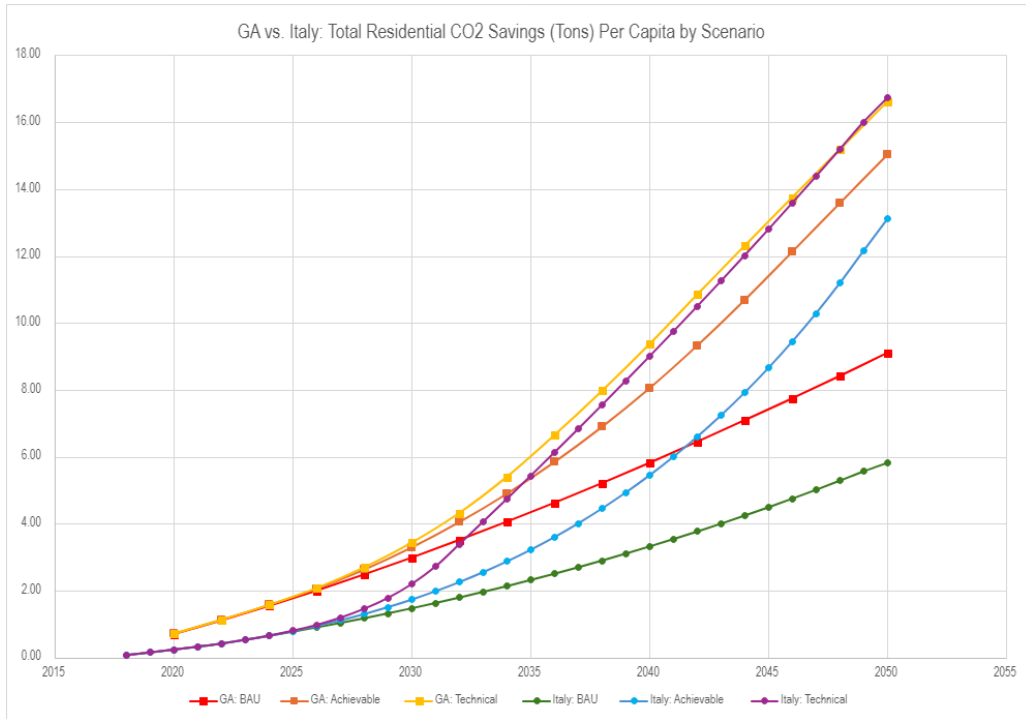


Figure 2: Georgia vs Italy – Total Residential CO2e Emissions Savings (Tons) per capita by Projection Scenario through 2050

In both countries, it is clear that the BAU situation is untenable if global climate goals are to be met. For GA to effectively move towards a greener future, it's imperative that some lessons be learned from the success and failures of Italy's Superbonus 110 program. Promoting a 110% tax rebate led to widespread fraud and inefficient government spending. Figure 2 indicates that Georgia's achievable scenario can get CO2e emissions reductions close to the technical goal without relying on such easily exploitable rebate incentives. The key success of Italy's program was getting its citizens excited to engage with it. If Georgia moves quickly and proactively reaches target groups like LIDAC communities where they're at and show them the value of the HER program, the achievable scenario's CO2e reductions are a real possibility.

Co-pollutant Benefits/Costs

Per Dr. Brown, we are excused from investigating this topic as models cannot accurately predict the measure of impact for the Home Energy Rebate Programs.

Potential Cost Savings

According to Georgia Power, a natural gas furnace costs an average of \$191.55 per month while it costs \$186.47 (for ENERGY STAR® qualified 15 SEER package) to \$190.52 (for 14 SEER) per month for electric HPs. When retrofitting from natural gas to electric HPs, the savings per month can vary between \$1.03 to \$5.08 [19]. This adds up to a savings of \$12.36 To \$60.96 annually per household. For water heaters, it is

documented that a gas water heater in Georgia costs about \$200 annually (\$16.67) to run while costing around \$800/year (\$66.67/month) for standard electric resistant water heaters [20]. The majority of households in Georgia have standard electric resistant water heaters. This type of electric water heater is less efficient than HPWHs. When switching from a standard electric resistant water heater to a HPWH, a small household (2 bed / 1.5 bath) can save an estimated \$270/year, a medium household (3 bed / 2.5 bath) \$410/year, and a large household (4 bed / 3.5 bath) \$550/year. The annual operating cost runs from \$104-160 for HPWHs, or about \$132 on average (or \$11/month) [21]. This is significant compared to standard electric.

Table 4 compares the annual costs per Georgian household for natural gas vs. electric heating appliances adjusted for an assumed inflation rate increase of 2.5% each year, as predicted by Official Data Foundation [22]. This is projected to the year 2050 with milestones in 2030 and 2040.

		2024	2030	2040	2050
Space Heaters	Natural Gas Heat Pump	\$2,298.60	\$2,665.67	\$3,412.28	\$4,368.01
	14 SEER Heat Pump	\$2,286.24	\$2,651.34	\$3,393.94	\$4,344.53
	15 SEER Heat Pump	\$2,237.64	\$2,594.98	\$3,321.79	\$4,252.17
Water Heaters	Natural Gas Water Heater	\$200	\$231.94	\$296.90	\$380.06
	Standard Electric Resistant Water Heater	\$800	\$927.75	\$1,187.60	\$1,520.33
	Electric HPWH	\$132	\$153.08	\$195.95	\$250.84

Table 4: Annual Household Energy Costs for Natural Gas and Electric Heating Systems

The data in Table 4 is strictly per household. However, we can calculate the total energy consumption costs for the entire state of Georgia and predict savings when upgrading to energy-efficient electric heating appliances. We can do so by combining the projected costs (considering inflation) with the same

models used previously for BAU, achievable, and technical potentials for the number of Georgia households that will have upgraded from natural gas to electric heating systems by the year 2050. Figure 3 depicts this BAU projection, Figure 4 the achievable projection, and Figure 5 the technical projection. The costs for the 14 and 15 SEER electric heating systems are an either-or scenario. The calculations for both only consider one type of electric heating system being utilized, not both simultaneously.

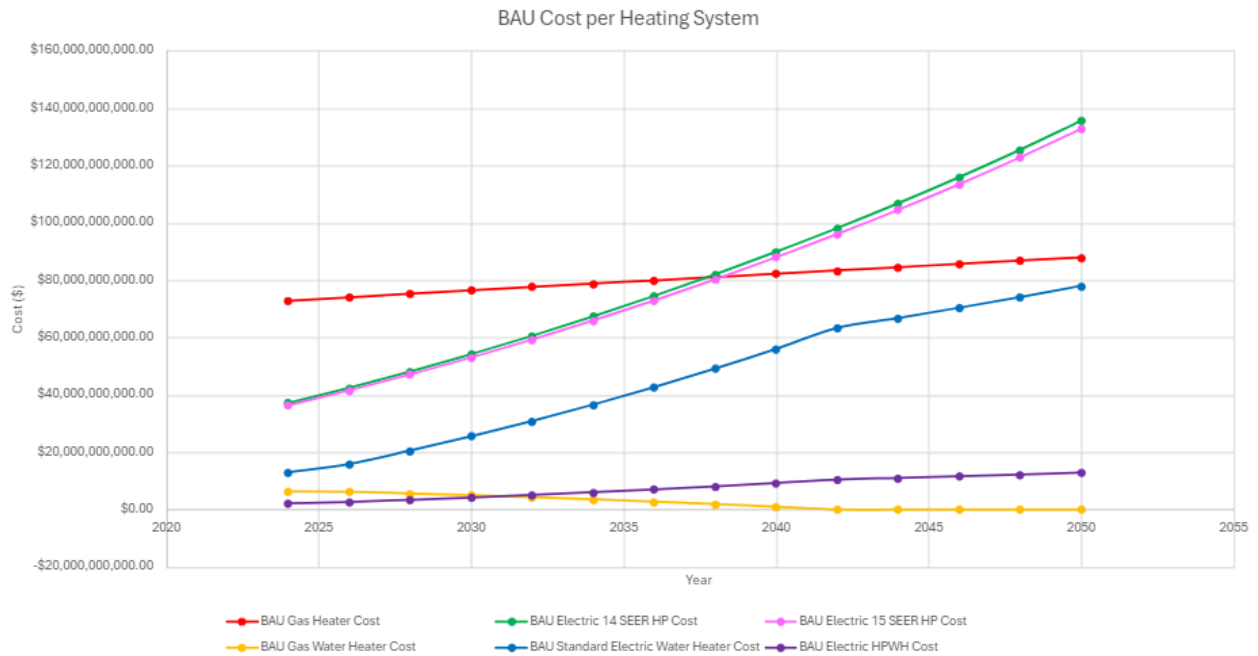


Figure 3: BAU Cost Projection Per Heating Appliance Type

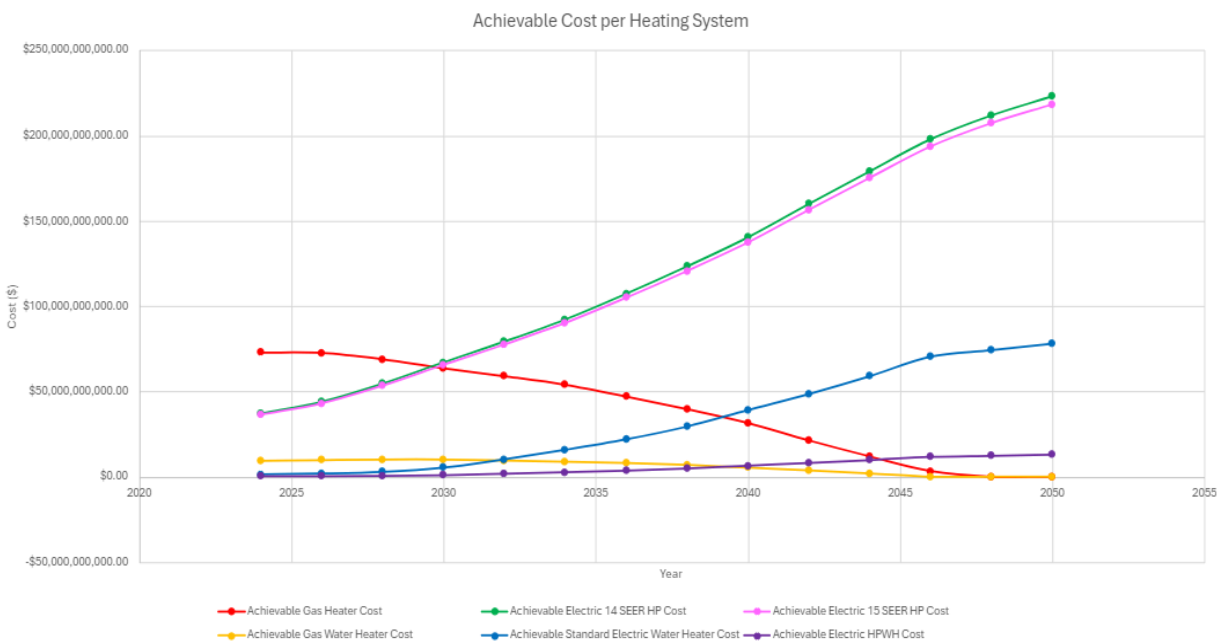


Figure 4: Achievable Cost Projection Per Heating Appliance Energy Type

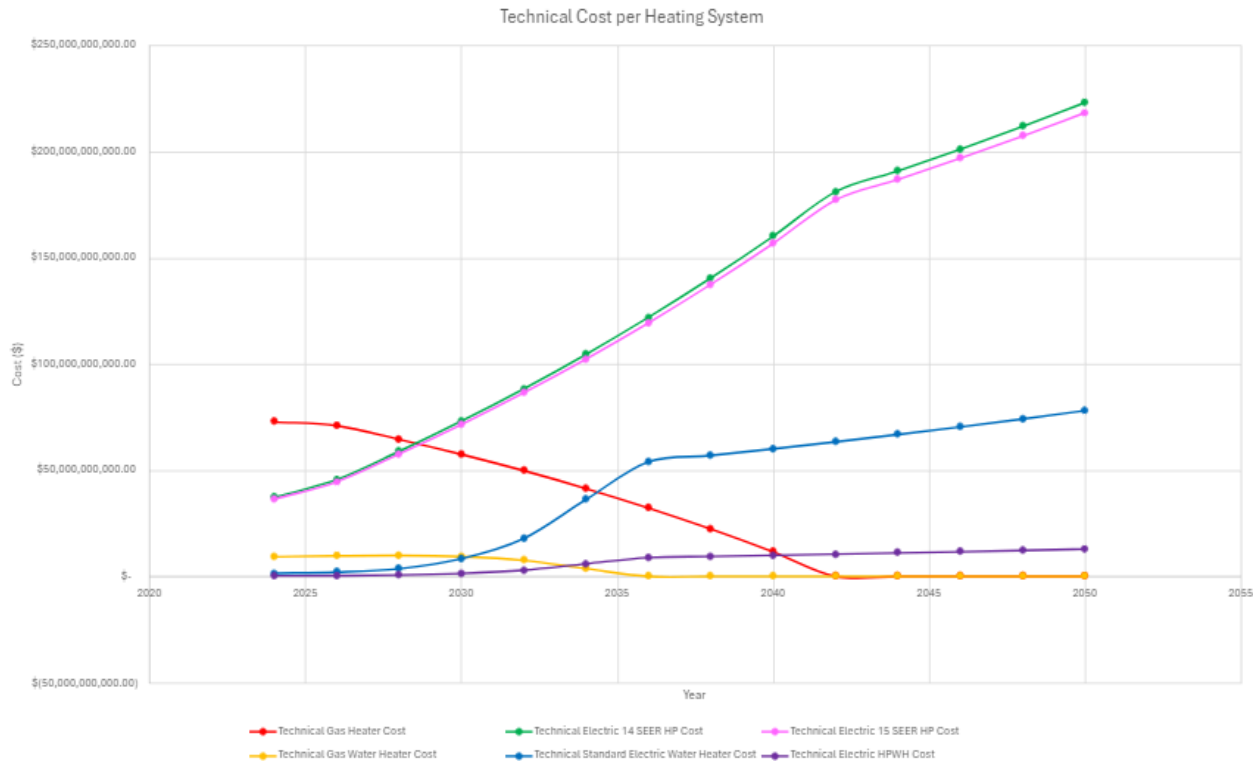


Figure 5: Technical Cost Projection Per Heating Appliance Energy Type

The costs for electric heat pumps will grow over time while the natural gas ones will fall behind as the expected shift to energy-efficient electric appliances grows annually. This is visually illustrated in Figures 3-5 above for the achievable and technical projections of costs for heating appliances. Both projections predict that by the year 2050, all households in Georgia will have upgraded to energy-efficient electric heating appliances. However, the BAU prediction in Figure 3 shows that if rebate programs are not implemented or utilized, natural gas heating appliances will remain more costly to use than energy-efficient ones. This is true even through to the year 2050.

When considering the cost of heating in terms of weight in Mt consumed, it has been estimated to cost \$27.76/million BTU (MMBTU) (\$0.95/kWh) for natural gas furnaces and \$38.63/MMBTU (\$1.32/kWh) for electric HPs [23]. The cost per Mt of CO₂-e is calculated to currently be at \$89.36/Mt of CO₂-e for gas furnaces, \$88.88/Mt of CO₂-e for 14 SSER electric HPs, and \$86.99/Mt of CO₂-e for 15 SEER electric HPs. For HPWHs, it costs \$1.20/therm to run, which is equivalent to \$12/MMBTU (\$0.04/kWh). This is found to cost \$7.30/Mt of CO₂-e for gas water heaters. Electric water heaters cost \$0.11/kWh which equates to \$29.19/Mt of CO₂-e for standard electric resistant water heaters and \$4.80/Mt of CO₂-e for HPWHs [24]. This is the same for both standard electric resistant water heaters and HPWHs. The cost difference is due to their efficiency in heating the water tank. Gas water heaters create a significant amount of excess waste and have a uniform energy factor (UEF) rating of 0.65 (65 cents on the dollar) while standard electric resistant water heaters have a UEF rating of 0.95 and HPWHs are between 2.75 and 3.5 [25].

Table 5 details the costs for both gas and electric HPs and HPWHs under each of the three projection types discussed and modeled previously. This data has an inflation rate added in of a 2.5% yearly increase. Figures 6 and 7 below illustrate the same data as a graph for enhanced visual comprehension. This data is also adjusted for the percentage of households with HPs and HPWHs. Therefore, this data encompasses the cost for the entirety of Georgia instead of per household in terms of dollars per Mt of CO₂-e. From this, we can see that electric HPs and HPWHs are not only more efficient, but they are also cheaper than those that operate using natural gas.

Projection Type	Heating Appliance Type		Year			
			2024	2030	2040	2050
BAU Heating Cost Projection	Space Heater	Natural Gas	\$89.36	\$102.79	\$130.30	\$167.21
		Electric 14 SSER	\$88.88	\$102.24	\$129.60	\$166.31
		Electric 15 SEER	\$86.99	\$100.07	\$126.85	\$162.78
	Water Heater	Natural Gas	\$7.30	\$8.00	\$9.47	\$11.51
		Standard Electric Resistant	\$29.19	\$32.01	\$37.87	\$46.05
		Electric HPWH	\$4.82	\$5.28	\$6.25	\$7.60
Achievable Heating Cost Projection	Space Heater	Natural Gas	\$89.36	\$108.97	\$159.17	\$225.06
		Electric 14 SSER	\$88.88	\$108.39	\$158.32	\$223.85
		Electric 15 SEER	\$86.99	\$106.08	\$154.95	\$219.09
	Water Heater	Natural Gas	\$7.30	\$8.07	\$10.22	\$12.98
		Standard Electric Resistant	\$29.20	\$32.29	\$40.87	\$51.92
		Electric HPWH	\$4.82	\$5.33	\$6.74	\$8.57
Technical Heating Cost Projection	Space Heater	Natural Gas	\$89.36	\$112.11	\$174.32	\$225.06
		Electric 14 SSER	\$88.88	\$111.50	\$173.38	\$223.85
		Electric 15 SEER	\$86.99	\$109.13	\$169.70	\$219.09
	Water Heater	Natural Gas	\$7.30	\$8.14	\$10.74	\$12.98
		Standard Electric Resistant	\$29.20	\$32.57	\$42.97	\$51.92
		Electric HPWH	\$4.82	\$5.37	\$7.09	\$8.57

Table 5: Projected Heating Costs for Georgia by Heating Appliance Energy Type

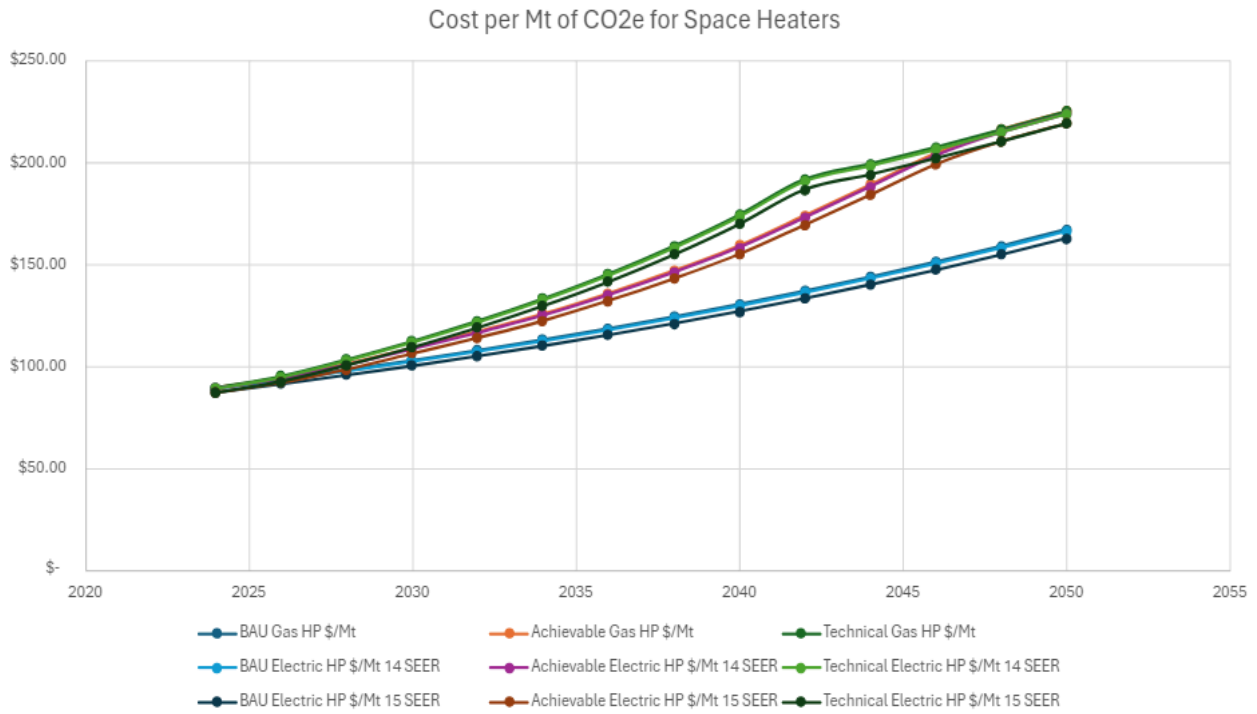


Figure 6: Projections for Annual Cost of Running Heat Pumps

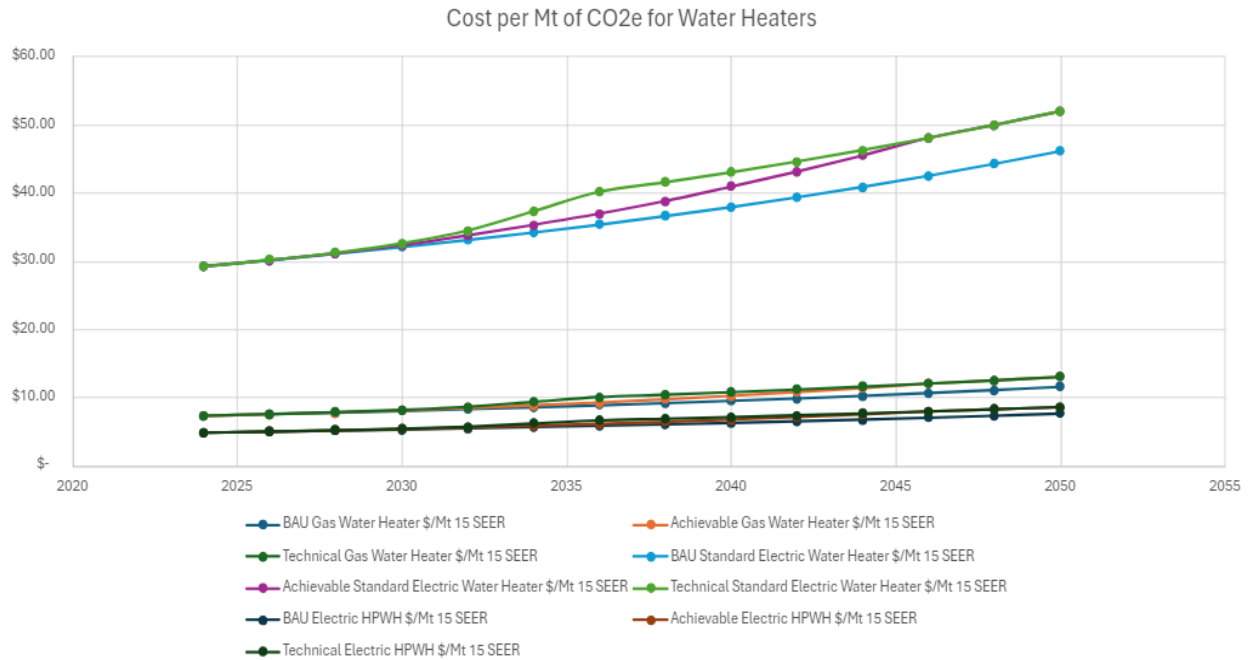


Figure 7: Projections for Annual Cost of Running Heat Pump Water Heaters

Equity Impacts

The target recipients of the Home Energy Rebate Programs are households at lower to middle income levels. They are individuals who would greatly benefit from cost relief for upgraded, energy-efficient appliances. Not only will the appliances be newer, but they can also cut costs for energy consumption. Cost savings were calculated and discussed as potentially saving homeowners up to \$60.96/year for electric HPs and up to \$550/year for HPWHs. We will also refer to Tables 1 and 2 for the HER and HEAR programs' eligibility requirements.

Figure 8 illustrates the percentage of households that are deemed LIDAC per county. The graph does not list each county by name as this would make the data illegible, so each dot represents one out of 159 Georgia counties. Knowing the number of LIDAC households in Georgia by county as well as the total number of all households in Georgia, we can calculate that 1,846,677/3,946,534, or 46.8%, of Georgia households are considered LIDAC. It is clear to see that there is a considerable number of households that would greatly benefit from having financial assistance such as with the HER and HEAR rebate programs.

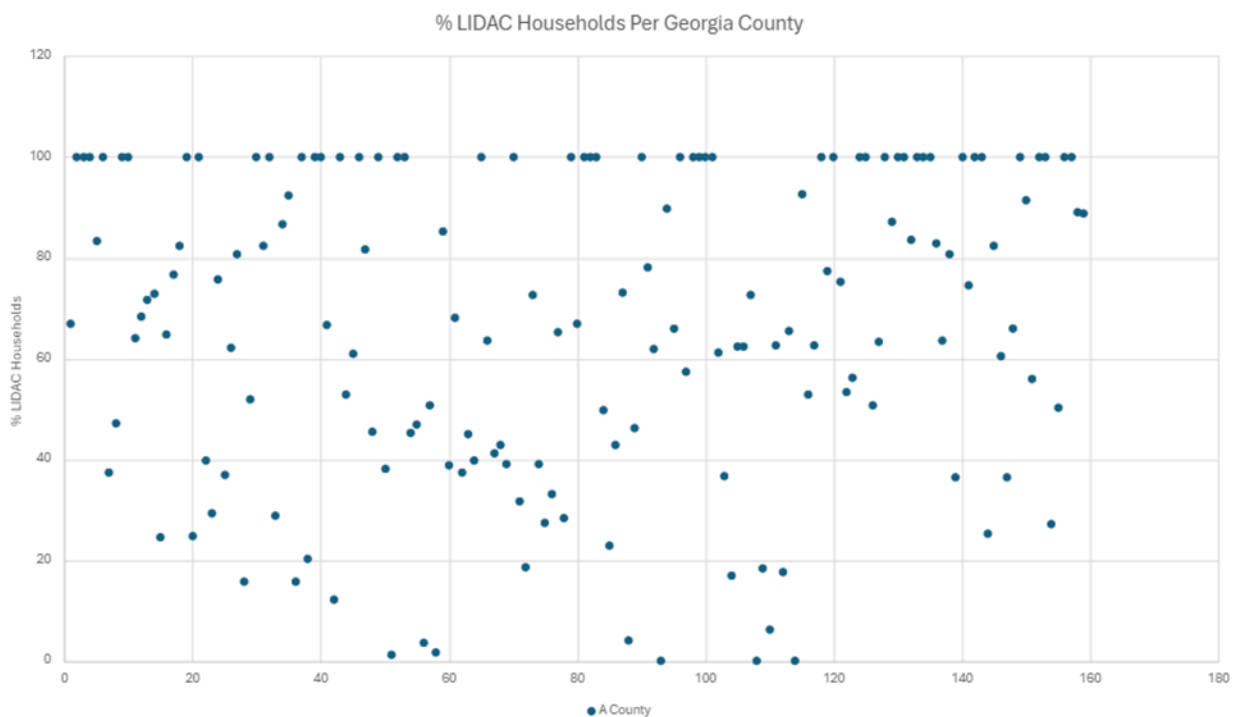


Figure 8: Percentage of LIDAC Households by Georgia County

In the case of LIDAC households, it would be beneficial to shop both rebate programs to figure out which would cover more costs. For example, in Atlanta, Georgia, it can cost around \$8,000 to install an electric HP [26]. This is the maximum amount that can be spent on this appliance for the HER program [9]. Any costs exceeding this would not be covered but may be covered under the HEAR program if the household owner has an income of <80% AMI. In this case, they will get 100% of the installation costs

covered. For installing an electric HPWH in Atlanta, it costs an average of \$2,199 [27]. This is also another example of if an individual is qualified (<80% AMI), they could get more cost benefit from the HEAR as the HER program would not cover all costs. The opposite is also true, however. If a homeowner makes between 80% to 150% AMI, they will only get 50% of their installation covered under the HEAR program, so choosing the HER program may be more beneficial here. Around 80% of all houses in Georgia were built before 2005. Given that homes in LIDAC communities tend to be older and less energy efficient, they are more likely to require programs like HER and HEAR to assist financially with retrofitting.

According to the Office of State and Community Energy Programs, the HER and HEAR programs are estimated to create 50,000 jobs in new residential construction across the nation. This includes positions in program management, and professional services [28]. The programs are instructed to “ensure that underserved and underrepresented workers and businesses are prioritized for related workforce and business development opportunities” [28]. This entrusts communities that would profit the most from the rebate programs receive priority for job opportunities that will increase quality of life. It also brings back money into the surrounding community that boosts the local economy [29].

Italy’s Commitment to GHG Reduction

Italy is well developed country with a similar climate to that of Georgia. Both see considerably hot temperatures throughout the year [30]. Similar to the US, Italy was also one of the first countries to join the Paris Agreement in 2016 [31]. Though Italy only contributes to 1% of global emissions at 418.3 MtCO₂-e in 2022, it is still dedicated to improving its impact on climate change by reducing emissions to 165 MtCO₂e in 2030 and achieving net zero emissions by 2050 [32][33][34].

The building sector is responsible for 22% of the total emissions in Italy [34]. 89% of the building sector is residential housing [35]. Thus, housing results in 19.58% of Italy’s total emissions. Since this is a large contributor to GHG emissions, Italy has implemented in 2020 a tax credit to incentivize homeowners to upgrade their houses to be to more energy efficient. This is named the “Superbonus 110%” as the Italian government offers to pay 110% of costs towards converting homes to be energy efficient up to €100,000 [36][37]. This scheme is available to “residential building or property owners (houses, apartments and apartment buildings (excluding commercial/professional premises), and condominiums – i.e.: co-owned apartment buildings (community or owners)), Housing cooperatives, public bodies that manage social housing (IACPs), Non-profit, social and voluntary organizations, and amateur sports associations and clubs” [36]. However, it is not available to houses considered as mansions, villas, or castles not open to the public [36].

With the Superbonus 110%, there are many improvement measures that are covered including energy efficiency for appliances like heating for space and water, solar shields, efficient insulation, measures to mitigate seismic impact and safety hazards, and electric vehicle charging station addition [36]. To compare to our investigation on Georgia’s rebate programs, we will look at Italy’s heat pump and water heater improvements under the Superbonus 110% scheme. Table 6 shows the maximum amount the Italian government will pay for the heat pump and water heater upgrades under the Superbonus 110%.

Type of Work	Type of Building	Maximum Limit
Heating or A/C system	Single property	€30,000

(including Water Heaters)		(\$32166.75 USD)
	Multiple properties (2 to 8 units)	€20,000 per unit (\$21444.50 USD)
	Multiple properties (>8 units)	€15,000 per unit (\$16083.38 USD)

Table 6: Superbonus 110% Limits [G]

There are currently 25.6 million households in Italy [38]. By the end of 2021, about 70,000 applications for the Superbonus 110% incentive were submitted, which would cost the Italian government €13.129 billion (\$14.07 billion USD) for the completion of these projects. The total budget for the scheme was €18.5 billion (\$19.82 billion USD). This was already 71% of the total budget on a tax credit projected to last through the end of 2023 [G]. Though the generous Superbonus 110% scheme was widely popular, it was ended in early 2023 after costing the Italian government more than €110 billion (\$117.87 billion USD) with €4.4 billion (\$4.71 billion USD) of that spent on fraudulent cases [39].

CO₂-e Emissions in Italy vs. Georgia Residential Sector

Previously, we discussed the total GHG emissions from Italy reached 418.3 MtCO₂-e in 2022 and that the residential sector accounted for 19.85% of those emissions. This equates to 81.9 MtCO₂-e of GHG emissions. The breakdown of energy use across all Italian homes compared to that of Georgian homes is shown in Table 7. We can see that heating and cooling accounts for 67.7% of energy use and water heating for 11.4% [40]. This means the total emissions from space heating/cooling amounts to 55.45 MtCO₂-e and water heating to 9.34 MtCO₂-e for 2022. As discussed previously, Georgia’s residential sector accounts for 22.5% of the total state’s GHG emissions. This is an annual total of 22.2 MtCO₂-e. 30% of Georgia home energy consumption goes towards space heating (6.66 MtCO₂-e) while 11% goes to cooling (2.442 MtCO₂-e). 19% (4.218 MtCO₂-e) goes towards water heating and the remaining 40% (8.88 MtCO₂-e) is for appliances, electronics, and lighting [42]. Of the 6.66 + 2.442 MtCO₂-e used for space heating/cooling, 56.74% (5.16 MtCO₂-e) is electric and 37.35% (3.4 MtCO₂-e) is natural gas [41]. 47% (1.98 MtCO₂-e) of the 4.218 MtCO₂-e used for water heating is electric and another 48% is for natural gas [43]. These are also shown in Table 8.

	Space Heating	Space Cooling	Water Heating	Cooking	Lighting and Electrical Appliances	Other End Use
Georgia	30%	11%	19%	40%		
Italy	66.9%	0.8%	11.4%	6.4%	13.2%	1.2%

Table 7: Georgian vs. Italian Total Household Energy Consumption Breakdown [40][41]

We can further decompose Italy’s energy data into consumption from natural gas vs. electricity. 60.6% (33.6 MtCO₂-e) of space heating/cooling energy consumption is from natural gas while 0.4% (0.222 MtCO₂-e) is from electricity. Likewise, for water heating energy consumption, 66.9% (6.25 MtCO₂-e) is from natural gas and 12.6% (1.18 MtCO₂-e) is from electricity [40].

	Space Heating/ Cooling	Water Heating
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Georgia	Natural Gas	5.16 MtCO ₂ -e	1.98 MtCO ₂ -e
	Electric	3.4 MtCO ₂ -e	1.98 MtCO ₂ -e
Italy	Natural Gas	33.6 MtCO ₂ -e	6.25 MtCO ₂ -e
	Electric	0.222 MtCO ₂ -e	1.18 MtCO ₂ -e

Table 8: Georgian vs. Italian Emissions Breakdown

Italy has a housing population of 25.6 million while Georgia has 4.5 million [44]. This is nearly 5.7x larger. However, the emissions from Italy's residential sector are only about 3.7x more than that of Georgia's (81.9 MtCO₂-e vs. 22.2 MtCO₂-e respectively). This works out to emissions of 3.2 MtCO₂-e/1 million houses in Italy and 4.93 MtCO₂-e/1 million houses in Georgia. In its current state, it is clear to see that Georgia is less energy efficient than Italy and has a lot to learn from their example.

Energy Costs Italy vs. Georgia

The average cost for household electricity usage in Italy is €0.25/kWh (\$0.27USD/kWh) with an average annual household energy consumption of 2700kWh [45]. Space heating/cooling is calculated to run about €456.98 (\$490.40 USD) annually. Water heating costs around €76.95 (\$82.58USD) annually. The yearly cost for space heating/cooling in Georgia is \$2,286.24 or \$2,237.64 depending on the SEER type. Electric water heaters (HPWHs) in Georgia run \$132 yearly. For both the space heating/cooling and water heating cases, it is more expensive for households in Georgia. This could be due to the cost of energy/kWh or the efficiency of the appliances or the amount of energy use being significantly more in Georgia.

For natural gas, it costs €0.10/kWh (\$0.11/USD) to use natural gas in an Italian home [46]. The average annual natural gas consumption per Italian household is 1,400 cubic meters of gas [48]. This equates to 45,018.8853 kWh of energy. Thus, we can find the yearly space heating and water heating costs to be €1,021.31 (\$1096.00 USD) and €171.98 (\$184.56 USD) respectively. An additional source confirms this by stating the monthly bill average for natural gas in Italian homes is €119 to €140 (\$127.64 to \$150.17 USD) [50]. We can take the median of this at €129.50 (\$138.91 USD). This comes to an annual average of €1,554 (\$1,666.87 USD). This is similar to the values calculated and illustrated in Table 9. This is significantly less energy cost than that of natural gas in Georgian households. In Georgia, the average natural gas household spends about twice that of Italy per year at \$2,298.60. This could be due to a lack of efficiency in American natural gas space heating appliances. For natural gas water heaters, Italy does not use them as much as households in Georgia (see Table 7) and is therefore understandably less expensive.

The comparison of annual residential energy consumption price by type for Georgia and Italy is illustrated in Table 9. It is clear that any upgrades to make Italian homes more energy efficient can greatly benefit the cost of living.

		Space Heating / Cooling	Water Heating
Georgia	Natural Gas	\$2,298.60	\$200
	Electricity	14-SEER: \$2,286.24 15-SEER: \$2,237.64	HPWH: \$132

Italy	Natural Gas	€1,021.31 (\$1096.00 USD)	€171.98 (\$184.56 USD)
	Electricity	€456.98 (\$490.40 USD)	€76.95 (\$82.58 USD)

Table 9: Georgia vs. Italy Annual Energy Consumption Costs 2024 [42][43]

Electric heat pumps are quickly replacing gas boilers in Italy. This trend is shown to be accelerated in direct correlation with the Superbonus 110% tax credit [36]. Heat pump sales were steady at about 215k and 250k in 2019 and 2020, respectively, but jumped to 380k in 2021 and 510k in 2022. Italy’s heat pump sales are the second highest of all European countries, falling just behind France [36]. Based on the costs for energy consumption found and recorded in Table 9, this will provide substantial aid to lower household energy bills in Italy.

Conclusion

Out of all U.S. states, Georgia currently ranks 30th for total carbon emissions [51]. With the introduction of the Home Efficiency Rebate and the Home Electrification and Appliance Rebate Programs, Georgia has the potential for major improvements that can be modeled after some aspects of Italy’s Superbonus 110% tax credit scheme. We have investigated how these programs can drastically reduce the amount of CO₂-e emissions as well as provide cost savings to qualified Georgia and Italy residents and produce job opportunities for economic/personal growth. These measures show a positive trend for advancements in quality-of-life that many will be able to benefit from.

Appendix



ECSO_PFS_IT_SB.pdf



Research Report
Data New+ Old_ISYE6:

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