Overview of the Inflation Reduction Act of 2022 (IRA) Home Energy Rebate Tool

Jack Mayernik and Katelyn Stenger

National Renewable Energy Laboratory

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National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401
303-275-3000 • www.nrel.gov

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Introduction

The Inflation Reduction Act of 2022 (IRA) Home Energy Rebate Scenario Tool provides a new internal capability[1] to conduct if/then analysis on the impact of two provisions of the IRA[2]:

- Section 50121: Home Energy Performance-Based Whole-House Rebates (Home Efficiency Rebates)
- Section 50122: High-Efficiency Electric Home Rebate Program (Home Electrification and Appliance Rebates).

The tool can be used to explore a variety of program outcome metrics such as changes in utility bills ($), carbon emissions ($kgCO_2e$), as well as demographic (e.g., AMI, tenancy) or structural data (e.g., age of home, primary heating fuel) on which households are receiving rebates. The results of the tool should not be interpreted as forecasts or predictions of what will happen for individual households, individual states, or the entire country[3].

Data Inputs

The tool relies principally on ResStock[4] analysis, specifically the End-Use Savings Shapes (EUSS) 2022.1,[5] for inputs on the makeup of the U.S. housing stock and performance of energy efficiency measures. The tool implements the specific provisions from the IRA based on one interpretation of the legislative text[6]. The U.S. Department of Energy provided state funding allocations as specified in the statute[7]. Future electricity system projections for both power sector emissions and state average emissions rates are derived from Cambium[8]. Projections on combustion fuels are taken from the U.S. Energy Information Administration's 2023 Annual Energy Outlook[9]. Table 1 presents the key ResStock results from the EUSS analysis that are used in the tool.

[1] For more information about accessing this capability please contact the authors.
[2] U.S. Congress, "H.R.5376: Inflation Reduction Act of 2022," https://www.congress.gov/bill/117th-congress/house-bill/5376/text.
[3] Due to data limitations this is limited to the Continental US
[4] National Renewable Energy Laboratory, "ResStock," https://resstock.nrel.gov/.
[5] National Renewable Energy Laboratory, "End-Use Savings Shapes Residential Round 1 Technical Documentation and Measure Applicability Logic," https://oedi-data-lake.s3.amazonaws.com/nrel-pds-building-stock/end-use-load-profiles-for-us-building-stock/2022/EUSS_ResRound1_Technical_Documentation.pdf
[6] Revisions will be made to the tool once the U.S. Department of Energy releases final program guidance.
[7] U.S. Department of Energy, "Biden-Harris Administration Announces State And Tribe Allocations For Home Energy Rebate Program", https://www.energy.gov/articles/biden-harris-administration-announces-state-and-tribe-allocations-home-energy-rebate
[8] National Renewable Energy Laboratory, "Cambium," https://www.nrel.gov/analysis/cambium.html.avings
[9] U.S. Energy Information Administration, "Annual Energy Outlook 2023," https://www.eia.gov/outlooks/aeo/

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Table 1. ResStock Outputs from EUSS Analysis Used in IRA Home Energy Rebates Scenario Tool

ResStock Output	Variable Description	ResStock Output (units)	Variable Description
Measure	Identifies which energy efficiency measure has been implemented	Model Count	Number of simulated homes in the microsegment
State	The state in which the microsegment[10] is located	Applicable Household Count	Number of eligible households within a given microsegment
Vintage	Pre-1980 or 1980 and after	Mean Savings Electricity (kilowatt-hours [kWh])	Average microsegment electricity savings
Metro	Urban or rural as defined by metro status provided in U.S. Census' PUMA[a]	Mean Savings Fuel Oil (MMBTU)	Average microsegment fuel oil savings
Heating Type	The incumbent space heating fuel	Mean Savings Natural Gas (therms)	Average microsegment gas savings
Building Type	Single-family or multi-family	Mean Savings Propane (MMBtu)	Average microsegment propane savings
Tenure	Owner or renter-occupied	Mean Savings Total (MMBtu)	Average microsegment site energy savings
Area Median Income (AMI)	<80% AMI, 80%–150% AMI, >150% AMI	Mean Bill Savings ($)	Average microsegment bill savings over the course of 1 year
Climate Zone	Building America Climate Zone[a]	Mean Savings Emissions ($kgCO_2e$)	Average microsegment reduction in emissions over the course of 1 year
Has AC	Whether the house has an existing air-conditioning (AC) system	Mean Upgrade Cost ($)	Average cost of upgrading a house in the microsegment with the identified measure

[a] PUMAs are nonoverlapping, statistical geographic areas that partition each state or equivalent entity into geographic areas containing at least 100,000 people each.

"Building America Climate-Specific Guidance," U.S. Department of Energy, https://www.energy.gov/eere/buildings/building-america-climate-specific-guidance

[10] Microsegments are the unit of analysis the tool. Microsegments are defined by the ResStock outputs on the left side of Table 1. An example microsegment could be described as "owner-occupied single family homes in the hot-humid climate zone in Georgia and were built before 1980, are in an urban context, and heat with natural gas, do not have an existing air-conditioning system and the household's income is less than 80% of the area median income" Simulation results with the same information across all definitional dimensions are combined into a single microsegment.

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Methods

The if/then analysis that the tool enables translates an interpretation of the legislative text into adjustable factors that simulate adoption across eligible households. All states are assumed to apply 20% of their allocated funds as overhead for program administration, with the remaining funds distributed as rebates[11].

Alignment of Measures and Program Requirements

In the tool, all measures considered in the EUSS 2022.1 dataset release are first screened for meeting the legislative requirements of the HOMES Program. Microsegment and measure pairs[12] that meet program requirements are compiled into a single spreadsheet. Key variables are:

- **Area Median Income (AMI):** Households making less than 80% AMI are eligible for larger rebates.
- **Mean Savings Total:** Households are only deemed eligible if the implemented measure saves at least 20% of the household's baseline energy consumption[13].

All measures from the End-Use Savings Shapes are also screened for meeting the legislative requirements of the High-Efficiency Electric Appliances Rebates Program[14]. The microsegment and measure pairs are compiled into a single spreadsheet.

- **AMI:** Households making less than 80% AMI are eligible for larger rebates and homes making more than 150% AMI are ineligible for this program.
- **Measure:** Rebate eligibility varies by technology.

Economic Weighting

In the tool, state budget funds available for rebates are distributed across microsegment-measure pairs. To accomplish this, four economic factors can be considered:

- First Cost ($)
- Simple Payback (Years)
- Nominal Bill Savings ($)
- Percentage Bill Savings (%)

These factors can be considered in isolation or combination. The default economic factors and the scenario names are:

- **First Cost:** A larger share of each state's budget is distributed to the lowest cost measures, on a population weighted basis.

[11] 20% is the max application to program administration called out in the legislative text.
[12] Microsegment measure pairs are defined by the 10 ResStock outputs listed on the left side of Table 1.
[13] The IRA text allows homes that save more than 15% of baseline energy to receive rebates on a prorated basis. The tool developers opted not to implement this option because doing so would be too computationally intensive. Additionally, it should be noted that homes saving at least 35% of the baseline energy consumption are eligible for larger rebates.
[14] One exception to this is the "minimum efficiency heat pump" measure, which was included in the analysis to serve as a conservative stand-in for program compliant heat-pumps.

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- **Simple Payback:** In this scenario the simple payback for each measure-microsegment pair is calculated and measure-microsegment pairs with shorter simple payback periods capture a larger share of state budgets on a population weighted basis.
- **Bill Savings:** State budgets are distributed based on both the nominal ($) bill savings a measure-microsegment pair is expected to see (75% of the overall economic weight) as well as the relative impact (% bill savings) on their pre-upgrade bill (25% of the overall economic weight)
- **Blended Weights:** Weighting ratios vary across income groups and economic factors as described in Table 2

Table 2. Weighting Factors for Blended Weights Scenario

Income	First Cost	Bill Savings	Payback
<80 AMI	70%	20%	10%
80-150 AMI	40%	40%	20%
>150 AMI	25%	50%	25%

Each measure-microsegment pair is assigned a weighting factor based on its position relative to all other measure-microsegment pairs included in the provision-specific spreadsheet. When multiple economic factors are considered, their independently determined weights are adjusted to be directly comparable.[15] The final weight is then re-baselined (Weight_Total × Microsegment Share within state) so that each state's total weight is equal to one and therefore each measure-microsegment pair's re-baselined final weight can be thought of as the share of the state's rebate budget that will fund the corresponding measure-microsegment pair.

If a user decides that no additional policy-weighting should be applied, these results can be used and reported as if/then analyses that show the sensitivity of these programs to different economic weighting assumptions. The results of this process should be thought of as "Year 1" impacts (i.e., if the programs were implemented overnight, what would the energy, carbon and bill impacts be over the course of the first year).

Policy-Weighting Adjustments

Given that states have discretion in how programs are implemented, a process for adjusting the re-baselined final weight is needed to capture different state-determined policy priorities. The factors that can be considered are based on the left side of the ResStock inputs table (Table 1). The tool can be used to help states understand the implications of various program design choices as they try to achieve various policy priorities.

In the tool, the policy-weighting factors are user-determined. The user-defined weight for each policy factor is multiplied throughout the analysis to inform a final policy weight (Policy_Weight). This final policy weight is then multiplied by the re-baselined final economic weight and adjusted again so that each state's total economic-policy weight is equal to one (Policy_Weight × Microsegment Share within the state). Like the application of the economic

[15] Weights are first adjusted so that the sum of the independently determined weights are equalized across weighting factors. This ensures the relative weights across factors are balanced. The balanced weighting factors are then adjusted based on analysts' input (e.g., Table 2).

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(unadjusted) weighting, each measure-microsegment pair's re-baselined final economic-policy weight can be thought of as the share of the state's rebate budget that will fund the corresponding measure-microsegment pair.

The results of this adjustment process can be used to consider (1) the influence of a state's specific program design and (2) sensitivity analyses of a state's program outcomes to different adoption assumptions based on the understanding of state energy office officials. For example, if a state were considering a program design that encourages uptake of heat pump water heaters by households making less than 80% AMI, tool users could explore the impact of such a design decision.

Estimating Future Impacts

The tool can also consider the robustness of these results to future changes in the electricity system. To estimate this, Cambium is used. Cambium projects the possible evolution of the U.S. electricity sector using NREL's publicly available Regional Energy Deployment System (ReEDS) long-term capacity expansion model[16]. The resulting data sets contain modeled hourly emission, cost, and operational data for a range of possible futures of the U.S. electricity sector through 2050, with metrics designed to be useful for forward-looking analysis and decision support.

Before results are combined with Cambium projections, the expected useful life (EUL) of each measure needs to be determined. Measure specific EULs are drawn from an evaluation of the State Energy-Efficient Appliance Rebate Program (SEEARP)[17]. SEEARP was a program authorized under the American Reinvestment and Recovery Act and is the most recent federal program that resembles Section 50121 and Section 50122 of the IRA.

The EULs from SEEARP are adjusted to both maintain a conservative estimate of benefits and to reflect more realistic lifecycle assumptions. The tool does not adjust negative savings (i.e., fuel-specific energy consumption increases) to preserve a conservative estimate of EUL impacts. Additionally, the tool assumes measure performance to degrade at a rate of 0.5% per year when a measure reaches 50% EUL, and upon reaching 100% EUL, the measure's impact is halved from the remaining level for a single year before dropping to zero. For measures supported by multiple technologies. EUL's are averaged. Table 3 summarizes the expected useful life assumptions derived from the State Energy-Efficient Appliance Rebate Program evaluation.

[16] https://www.nrel.gov/analysis/reeds/

[17] U.S. Department of Energy, *State Energy-Efficient Appliance Rebate Program: Volume 1 – Program Design Lessons Learned*, June 2015, https://www.energy.gov/eere/buildings/articles/state-energy-efficient-appliance-rebate-program-volume-1-program-design.

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Table 3. Measure Expected Useful Life

Measure	EUL (Years)
Heat pump water heater	10
Minimum-efficiency heat pump with existing backup	12
Minimum-efficiency heat pump with electric backup	12
High-efficiency heat pump with electric backup	12
Enhanced enclosure	30
Basic shell	30
Induction cooking	12
Electric cooking	12
HP clothes dryer	11
Electric clothes dryer	11

The tool then combines the annual projected energy savings estimates with data from Cambium and the U.S. Energy Information Administration to determine the lifetime emissions and bill impacts. Cambium's 2021 release includes five scenarios, each of which projects a distinct future evolution of the grid:

- High Renewables Cost
- Mid-Case
- Low Renewables Cost
- 95% Decarbonized Power Sector by 2050
- 95% Decarbonized Power Sector by 2035.

Cambium provides state level averages of annual long-run marginal emission rates at the state level, as well as the percentage change in the price of wholesale electricity[18]. These Cambium outputs allow us to understand out-year sensitivities to projected impacts on carbon emission reductions and bill savings.

Caveats

The following limitations should be understood in interpreting any outcomes generated by the tool:

- All packages simulated were part of the End-Use Savings Shapes (EUSS) Residential Round 1 analysis. Assumptions about technologies are available in https://oedi-data-lake.s3.amazonaws.com/nrel-pds-building-stock/end-use-load-profiles-for-us-building-stock/2022/EUSS_ResRound1_Technical_Documentation.pdf

[18] Only half the percentage change projected by CAMBIUM is considered, consistent with U.S. Energy Information Administration, "Major U.S. Utilities Spending More on Electricity Delivery, Less on Power Production," November 23, 2021, https://www.eia.gov/todayinenergy/detail.php?id=50456.

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- Scenarios are driven by the measures included in the tool. While covering many of the technologies included in IRA, exact performance levels for IRA program eligibility are not included in this dataset.
- Most heat pumps were sized for cooling load, meaning that in cold climates they are likely undersized and increase the reliance of these households in these regions on supplemental (less efficient) heat – making bill impacts look less favorable than if sized for heating load.
- Heat pumps are assumed to be installed and operate optimally; imperfect refrigerant charge and imperfect air flow can reduce performance.
- Package cost data, while calculated in ResStock at the household level, is analyzed at the microsegment level likely obscuring some variations in the per household costs.
- Utility rates for electricity and fuels are mostly handled at the state level whenever possible; however, regional or even national averages are used when data gaps exist. No time-of-use rates were considered in this analysis.
- Bill savings analysis may differ from published EUSS-derived results because of differences in the utility rates applied.

Tool Availability

This tool was developed to provide technical assistance to State Energy Offices as they develop, and stand-up programs funded by Sections 50121 and 50122 of the IRA. While there are no current plans to make the tool publicly available, technical assistance is available by contacting IRAHomeEnergyRebates@NREL.gov.

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