2025 Rhode Island Climate Action Strategy

Responses to Stakeholder Feedback on Inputs & Assumptions

April 2025

1 Updates to Inputs & Assumptions

- **Population and housing growth rate**
  - Multiple stakeholders asked about the housing and growth rate assumptions used in the model. Currently, the assumptions for both are based on a 2013 forecast of population by the Rhode Island Division of Statewide Planning[1], but the project team is in discussions with the state to use a more recent analysis.
- **Commercial square footage growth rate**
  - The prior commercial square footage growth rate of 0.23% per year was based on the relationship of commercial square footage growth to housing growth from the Energy Information Administration's Annual Energy Outlook report (EIA AEO) for the United States[2]. However, based on stakeholder feedback and additional review of historical data from EIA that shows commercial electricity has been roughly flat in Rhode Island for the past 15 years and commercial floorspace in New England as a whole actually declined between 2012 and 2018[3], E3 has updated the assumption to hold commercial square footage flat rather than growing through 2050.
- **Representation of space heating**
  - Based on stakeholder feedback, E3 has updated the space heating technology options so that ducted and ductless heat pumps are available in both single and multifamily homes.
- **Representation of air conditioning**
  - Multiple stakeholders asked about how existing and future air conditioning needs are represented in the model. First, E3 has updated the air conditioning subsectors so that they match the space heating subsectors by having a Single Family Air Conditioning and Multi Family Air Conditioning subsector. Central and room air conditioners and all heat pump types are now a technology option for both subsectors. In addition, the key driver inputs have been updated so that the penetration of air conditioning increases over time instead of remaining static,

[1] https://planning.ri.gov/planning-areas/data-center/ri-data-center-census-data/population-projections
[2] https://www.eia.gov/outlooks/aeo/tables_ref.php
[3] https://www.eia.gov/consumption/commercial/

reflecting the fact that more people will buy air conditioners as average temperatures continue to rise. This is based on the observed trend of AC adoption from the EIA Residential Energy Consumption Survey (RECS), which shows an annual increase in AC use of about 0.7% of households per year from 1997 to 2020[4]. Given that 90% of homes in Rhode Island already use AC based on the latest 2020 RECS survey, applying this trend means that all homes in Rhode Island will have AC by the late 2030s/early 2040s in the model. In addition to modeling an increase in AC adoption, Pathways also includes assumptions around the cooling output needed from ACs and space heaters based on annual climate trends. E3 uses the forecast of heating degree days and cooling degree days for New England from the EIA AEO to scale annual heating and cooling demands up or down. Based on these trends, heating degree days are projected to decline 14% between 2022 and 2050, while cooling degree days are projected to increase 26% over the same period.

- **Space heating device lifetime**
    - A stakeholder questioned if the average device lifetimes for space heating devices should be technology-specific instead of using one average lifetime for all of them, as heat pumps tend to have shorter average lifetimes than furnaces and boilers. Based on E3's review of federal data, including the technical support documents used for the most recent Department of Energy efficiency standards for air source heat pumps[5] and furnaces[6], E3 believes that using technology-specific device lifetimes is appropriate, and has updated the model inputs to reflect this for space heating technologies.
- **Space heating device costs**
    - Stakeholders asked if more recent and RI-specific data on heating technologies was available rather than the data taken from the RI Investigation into the Future of the Regulated Gas Distribution Business report[7]. E3 has since received data on total project costs for heat pump installations from the Clean Heat Rhode Island program. The residential heat pump costs in the Pathways model have been updated to reflect these historical costs in the near term and also include a long term decline in costs based on the "Moderate" scenario from the NREL Electrification Futures Study[8]. E3 will also reflect the number of heat pumps installed through the Clean Heat RI program when projecting heat pump sales in the model for 2023-2025. Rhode Island-specific for fuel oil and natural gas residential heaters are now taken from a 2024 HVAC market report for the Northeast and Mid-Atlantic from NESCAUM[9], while wood stove costs are taken from EIA data.
- **Building shell upgrade performance and cost**

[4] https://www.eia.gov/consumption/residential/
[5] https://www.regulations.gov/document/EERE-2014-BT-STD-0048-0098
[6] https://www.regulations.gov/document/EERE-2021-BT-STD-0031-0011
[7] https://www.ethree.com/wp-content/uploads/2024/06/Docket-22-01-NG-E3-Technical-Analysis-Report.pdf
[8] https://www.nrel.gov/docs/fy18osti/70485.pdf
[9] https://www.nescaum.org/documents/Heat-Pumps-in-the-Northeast-and-Mid-Atlantic---Costs-and-Market-Trends.pdf

- Stakeholders also asked if more recent and RI-specific data on building shells was available. E3 has updated the inputs on building shell retrofit costs and energy demand reductions based on data provided by NV5, the technical consultant for the RI Energy Efficiency Council (EEC).[10] These data include building average shell costs and energy demand reductions based on the state's EnergyWise Single Family Program, which provides funding for weatherization projects across Rhode Island.[11] The counterfactual dwelling type from these data was natural gas heating.

- **Natural gas system methane leakage**
  - Stakeholders asked how methane leakage from the natural gas pipeline system in Rhode Island would be estimated. While the model previously was aligned with fugitive methane accounting from the state's official GHG inventory, we have updated to be aligned with the more recent RIDEM white paper on fugitive GHG emissions from natural gas systems, since these updates will likely be included in future GHG inventories[12]. Future changes to infrastructure like miles of transmission and distribution pipeline, number of meters, etc. will be a result of gas system infrastructure choices and electrification trends that may vary by scenario.
- **Natural gas system distribution costs**
  - Stakeholders asked why only the wholesale price of natural gas was included in the fuel prices tab and how gas distribution system costs would be accounted for. The wholesale price of natural gas is used when calculating annual fuel costs in the Pathways model to avoid overestimating cost savings from reduced natural gas consumption without accompanying changes to infrastructure spending. Because a large portion of retail natural gas prices goes towards fixed costs for infrastructure, reducing gas throughput alone does not reduce the amount of fixed costs needed to maintain system, and this dynamic could potentially lead to significant rate increases for remaining customers under current rate structures[13]. E3 will include an estimate of future gas distribution system costs and how much of these could potentially be avoided in scenarios with high electrification based on the gas system analysis performed for RI Future of Gas study[14].
- **Representation of light duty vehicles**
  - Previously, the model had two subsectors for light duty vehicles: light duty cars and light duty trucks. Within each subsector were technology options for vehicle types like gasoline, diesel, battery electric vehicle (BEV), plug-in hybrid electric vehicle (PHEV), etc. E3 has updated the light duty vehicle representation so that there is now a single subsector, but the technology options reflect a range of light duty vehicle body types in addition to fuel and engine types. As a result, the light duty vehicle subsector has the same option for gasoline, diesel, BEV, or PHEV

[10] https://www.nv5.com/projects/rhode-island-energy-efficiency-resource-management-council/
[11] https://eec.ri.gov/wp-content/uploads/2025/01/RI-23-RX-EWisePY21_FINAL-report_10OCT2023.pdf
[12] https://dem.ri.gov/sites/g/files/xkgbur861/files/2025-04/natural-gas-systems-white-paper%20v2.6.pdf
[13] https://www.icf.com/insights/energy/natural-gas-rate-design-energy-transition
[14] https://www.ethree.com/wp-content/uploads/2024/06/Docket-22-01-NG-E3-Technical-Analysis-Appendix-B.xlsx

technologies, but these are also broken out into five body types: car, crossover, SUV, truck, and van. This disaggregation is based on Rhode Island vehicle counts from the Federal Highway Administration[15] and US Census Bureau's Vehicle Inventory and Use Survey.[16]

- **Light duty vehicle prices**
  - A stakeholder raised questions around using EV cost projections from a 2022 report from the International Council on Clean Transportation (ICCT)[17]. Based on this feedback, E3 investigated whether more recent estimates of EV prices were available to ensure the study includes the most accurate data. While the National Renewable Energy Laboratory Annual Technology Baseline (NREL ATB)[18], which sources vehicle prices from an academic study that simulates bottom-up construction of vehicles from their various components, was recommended as a potential source, E3 found that real world EV prices are significantly higher than projected for 2024/2025 by NREL ATB and ICCT (the source for the original Pathways model assumptions). For example, Edmunds reports that the average MSRP for EVs in 2024 was $53,048[19], while Kelley Blue Book reports that the average transaction price for EVs in February 2025 was $55,273 and increased over the previous year[20]. To both align with real world prices in the near-term and recognize the potential for significant cost declines as shown in academic literature, E3 has updated light duty vehicle prices to align with 2024 real world prices but reach the same ultimate costs projected by the ICCT report, although with a five-year delay so that they are reached in 2040 instead of 2035.
  - A stakeholder also asked about hydrogen fuel cell vehicle prices for light duty vehicles. Based on the significant downturn in an already small market (only around 600 passenger fuel cell vehicles were sold in the US in 2024, down 80% from almost 3,000 in 2023[21]) and E3's assessment that fuel cell vehicles are unlikely to capture a meaningful share of the light duty market in the future, passenger fuel cell vehicles will be excluded from the analysis.
- **Heat pump clothes dryers**
  - A stakeholder commented that heat pump clothes dryers should be considered as a technology. This has been added to the model.
- **Fossil fuel price scenarios**
  - Multiple stakeholders raised questions about the fossil fuel price trajectories included in the inputs and assumptions workbook. The existing trajectory is based on the EIA AEO Reference case for 2023. However, based on stakeholder feedback, E3 has updated the default fossil fuel price scenarios to include four more

[15] https://www.fhwa.dot.gov/policyinformation/statistics/2021/mv1.cfm
[16] https://www.census.gov/programs-surveys/vius.html
[17] https://theicct.org/wp-content/uploads/2022/10/ev-cost-benefits-2035-oct22.pdf
[18] https://atb.nrel.gov/transportation/2024/data
[19] https://www.edmunds.com/car-buying/average-price-electric-car-vs-gas-car.html
[20] https://www.kbb.com/car-advice/how-much-electric-car-cost/
[21] https://h2fcp.org/sites/default/files/FCEV-Sales-Tracking.pdf

scenarios from the Annual Energy Outlook: High Oil Price, Low Oil Price, High Oil & Gas Supply, Low Oil & Gas Supply. These four cases have the widest range of fuel price outcomes for petroleum and natural gas prices of all the cases modeled in AEO 2023. In addition, E3 has updated the near-term fossil fuel prices to align with the EIA Short-Term Energy Outlook (STEO) for March 2025[22], which projects fuel prices through 2026. All fuel price scenarios are the same through 2026, and then diverge by 2030 to align with the five separate long-term projections from AEO.

- **Renewable fuel prices**
  - Stakeholders correctly noted that the price of biofuels varies widely based on feedstock type, conversion process, and competition between fuel uses. The prior biofuel prices included in the model were placeholders based on previous E3 analysis, but given the uncertainty around biofuel prices, E3 is removing the placeholder values. E3 will update biofuel prices after the scope and requirements of future biofuel use in the mitigation scenarios have been determined with the state and stakeholders (e.g., what types of policies like a low-carbon fuel standard or clean heat standard are driving the use of biofuels, what feedstocks are eligible for use in these programs, and how much biofuel use is assumed elsewhere in the region/country).
- **Biodiesel blend for heating fuel included based on state law**
  - A stakeholder noted that the original fuel blending assumptions did not account for the legally required biodiesel blend for heating oil in Rhode Island. The model has been updated to include a 5% blend in 2022, increasing to 10% in 2023 and 50% by 2030 based on the legal requirements[23].
- **Building code changed from International Energy Conservation Code (IECC) 2021 to IECC 2024**
  - Multiple stakeholders noted that the latest building code in Rhode Island was incorrectly listed as IECC 2021. The model has been updated to reflect the correct building code of IECC 2024 and includes additional heating and cooling demand reductions based on the incremental energy savings for 2024 vs 2021 IECC in Rhode Island's climate zone as estimated by the Department of Energy[24].

2 Clarifications and Corrections

- **Are lifecycle GHG emissions included in the model?**
  - GHG emissions accounting in the Pathways model is aligned with the framework used by the Rhode Island Greenhouse Gas Inventory[25], which itself follows the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National

[22] https://www.eia.gov/outlooks/steo/archives/Mar25.pdf
[23] https://energy.ri.gov/heating-cooling/renewables/biofuel
[24] https://www.energycodes.gov/sites/default/files/2024-12/2024_IECC_Determination_TSD.pdf
[25] https://dem.ri.gov/environmental-protection-bureau/air-resources/rhode-island-greenhouse-gas-inventory

Greenhouse Gas Inventories[26]. This is the same framework used by EPA for the U.S. Greenhouse Gas Emissions and Sinks inventory. Under this framework, Rhode Island accounts for all emissions that are released due to fuel use or other human activities within the state. As a result, emissions from the combustion of natural gas within the state are included, in addition to any methane leakage from the natural gas pipeline system within the state, but methane leakage that occurs as a result of natural gas production outside of the state would not be included.

- **How are biofuel emissions treated in the model?**
    - Biofuel emissions accounting in the Pathways model is aligned with the Rhode Island GHG Inventory and IPCC guidance, where CO2 emissions from biofuel use are not included in net emissions totals. Various stakeholders commented that biofuels could have lower or higher emissions than fossil fuels on a lifecycle basis, but as noted in the previous response, the RI inventory and Pathways model do not use a lifecycle accounting framework. However, it is true that the lifecycle emissions of biofuels can vary significantly depending on the feedstock type, conversion process, and transportation distance, and these dynamics will be considered when evaluating if and how biofuels should be used to help decarbonize energy use in Rhode Island.
    - *Note: The previously posted workbook incorrectly listed the wrong emissions factors for combustion fuels by reporting the **gross** emissions factors rather than the **net** emissions factors for combustion fuels. As noted in the response above about the GHG emissions accounting guidance from IPCC, CO2 emissions from biofuels are excluded in the net emissions factors that are used to develop inventory totals. The gross emissions factors that include CO2 biofuels are included in the Pathways model so that emissions from biofuels can be reported if desired but not included in the inventory total, which is consistent with IPCC guidance.*
- **How is inflation accounted for in the model?**
    - All output costs from the model will be in real 2024 dollars. Because the data sources used for input equipment costs and fuel prices to the model have a range of dollar year values, they are all converted to 2024 dollars using the Bureau of Labor Statistics Consumer Price Index (CPI) Inflation Calculator[27].
- **Do device costs represent federal or state incentives?**
    - The costs for demand-side devices (e.g., vehicles and equipment in buildings) do not include federal or state incentives. These will be included when examining the affordability for specific customer types, but they are not included when calculating the societal costs and benefits.
- **Are heat pump installations limited by the number of existing furnaces and boilers that reach end-of-life each year?**
    - Heat pump installations in the model are not necessarily limited to only replacing the number of furnaces and boilers that reach their end-of-life each year. There is

[26] https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/
[27] https://www.bls.gov/data/inflation_calculator.htm

an early retirements function in the model that allows for the installation of heat pumps before the existing furnace or boiler has burned out.

- **How is supplemental heating accounted for in the model?**
    - All air source heat pumps in the model include some form of supplemental heat. For those with fuel backup, the type of fuel is included in the name (e.g., "Air Source Heat Pump with Gas Backup"). For all-electric heat pumps, electric resistance provides supplemental heat when the heat pump is not able to cover the full building heating load.
- **How are the costs for vehicle miles traveled (VMT) reductions estimated?**
    - Because the costs of VMT reductions vary widely based on the reduction strategy (e.g., encouraging telework vs. building a light rail network) and geography, the Pathways model does not include default costs for VMT reductions. As part of the strategy design process, E3 will work with the state and stakeholders to identify if there are reliable cost estimates for the VMT reduction strategies that will be modeled in Pathways and will include them if the cost data is available.
- **Will E3 re-benchmark historical energy use and emissions in the model in the future when new federal data is released?**
    - The Pathways model is benchmarked to the most recent vintage of the Rhode Island GHG Inventory for 2022. The EIA is scheduled to release updated energy consumption data for 2023, but given the desire for the model to be benchmarked to RI's official state inventory, the uncertainty around federal data release timelines, the unlikelihood of significant shifts in energy consumption between 2022 and 2023, and project timeline constraints, the Pathways model will continue to use 2022 as the model base year.
- **How is the efficiency for residential freezers and refrigerators defined?**
    - Because the EIA data source used for default efficiency data only reports annual energy consumption for freezers and refrigerators, efficiency values for those technologies are defined as energy consumption relative to the average currently installed technology. So, if an efficient residential refrigerator only consumes 358 kWh per year compared to the installed average that consumes 401 kWh, the efficiency value in Pathways would be 401/358 = 1.12.
- **How will future carbon sinks in natural lands and forests in Rhode Island be forecasted in the model?**
    - E3 does not have a default assumption about future trends in carbon sinks in natural lands and forests in Rhode Island and will determine what trends should be used in consultation with the state and stakeholders.
- **Where is energy demand for agriculture, forestry, and fishing?**
    - Energy demand for agriculture and forestry and included in the Industry Agriculture subsector on the "Energy Only Inputs" tab of the workbook. For fishing, any marine fuel sold for consumption in watercraft is based on the estimates of non-road emissions from the RI GHG Inventory and would be in the Transportation Other subsector also on the "Energy Only Inputs" tab.
- **What growth is assumed for energy only subsectors?**

    - The default source for energy only growth assumptions in Pathways is the EIA AEO but given that the values from that report are national, they are likely unrepresentative of trends within Rhode Island, especially for industry. Based on a review of historical industrial energy consumption in Rhode Island from 2012-2022, E3 proposes to hold underlying energy demand in industry flat, as natural gas demand has maintained relatively stable over the past decade, and electricity demand saw declines through 2020 but has remained flat since then. This assumption does not preclude the use of energy efficiency or fuel-switching measures to reduce energy demand and emissions in the analysis.
- **How does the model address the lack of suitable CO2 sequestration reservoirs in New England for CCS or direct air capture?**
    - If any carbon capture and sequestration measures are modeled in the analysis, E3 will include cost estimates for the required transportation via truck or pipeline to a suitable sequestration site elsewhere in the country.
- **How are the emissions for the emissions-only subsectors determined?**
    - The emissions from the emissions only subsectors in the Pathways model are aligned with the exact values from the Rhode Island GHG inventory for 2022 (except for fugitive emissions natural gas systems, which have been updated to align with the exact values from the recent RIDEM white paper on fugitive emissions). The methodology used to develop those emissions can be found in the inventory report and the data sources appendix.
- **How is non-GHG air pollution accounted for?**
    - Fuel consumption outputs from Pathways will be combined with criteria air pollutant emission factors from the EPA National Emissions Inventory and the EPA Co-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA) model to account for non-GHG criteria air pollution.