

RMI Analysis for Residential New Construction in Concord, MA

In October 2020, [RMI released an analysis of the costs of a new all-electric home in seven cities](#) across the country, including Boston, MA. The analysis looked at the costs of a new all-electric home versus a new mixed-fuel home that relies on gas for cooking, space heating, and water heating.

In all 7 cities analyzed, a new all-electric, 2,400 square foot, single-family home is less expensive than a new mixed-fuel home that relies on gas for cooking, space heating, and water heating.

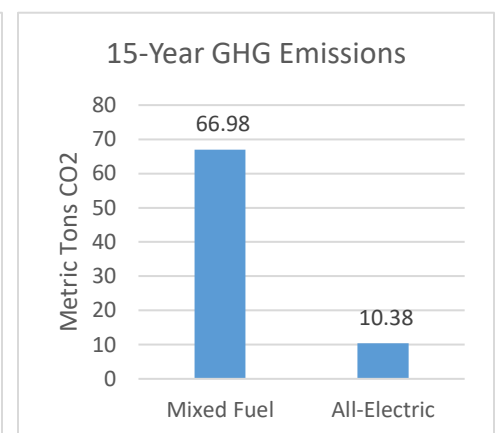
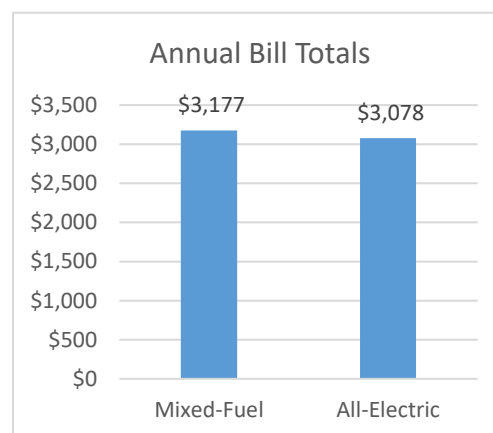
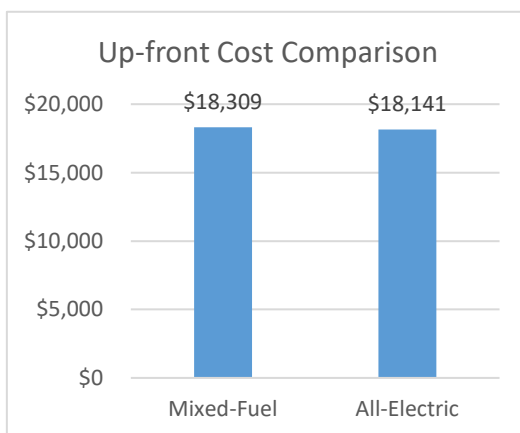
In the spring of 2021, Concord requested that RMI use that same model to analyze the economics of a new all-electric home using Concord Municipal Light Plant (CMLP) electric rates.

Key Findings for Concord, MA

In Concord, the all-electric new home has a lower net present cost than the new mixed-fuel home, with savings on up-front costs, annual energy bills, and greenhouse gas emissions.

- An all-electric home that uses a heat pump system for both heating and cooling has a **1% lower up-front cost** than a mixed-fuel home (with gas furnace, water heater, air conditioning, and new gas connection costs) and a **4% lower net present cost**.
- The all-electric home has **3% lower** annual utility costs.
- Greenhouse gas emissions over the 15-year period from heating, water heating, and cooking are **85% lower** in the all-electric home, due to more efficient appliances and increasingly low-carbon electricity.

	Mixed-Fuel	All-Electric	Difference
Annual Electricity & Gas Costs	\$3,177	\$3,077	-\$100 (-3%)
Electricity Usage (kWh)	10,636	17,413	6,777 (+64%)
Gas Usage (therms)	841	n/a	-841 (-100%)

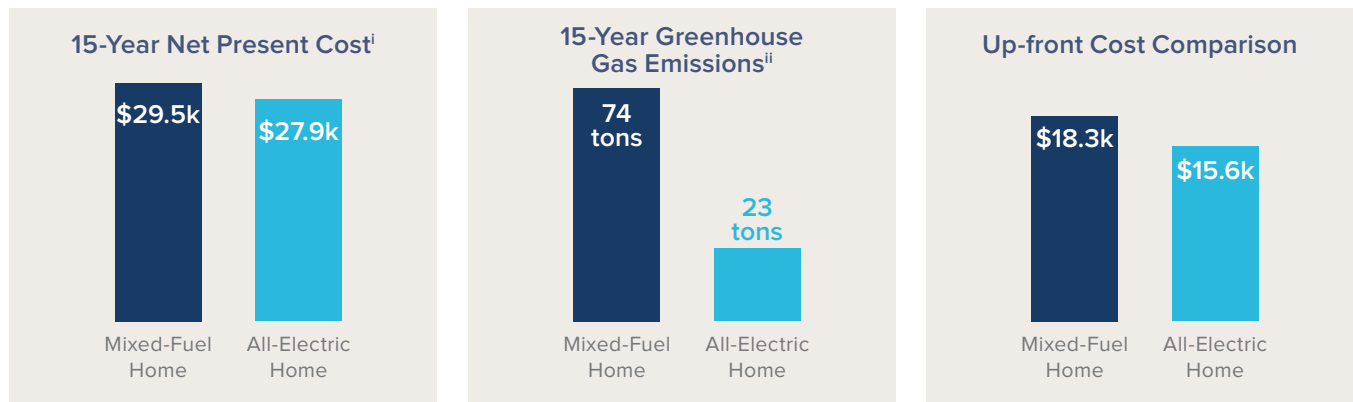


Assumptions – For modeling of energy use, RMI used the same prototype of a Boston-area home as [RMI's New Economics of Electrifying Buildings \(2020\)](#). RMI used CMLP tariffs for electricity costs, CMLP grid mix for modeling of annual and 15-year GHG emissions, and a discount rate of 7% for net present cost calculations. Additional details on the methodology are available [here](#) and summarized on the attached Boston study.



RESIDENTIAL NEW CONSTRUCTION BOSTON: SINGLE-FAMILY HOMES

RMI analyzed the costs of a new all-electric home versus a new mixed-fuel home that relies on gas for cooking, space heating, and water heating. **In Boston, the all-electric home saves nearly \$1,600 in costs and 51 tons of CO₂ emissions over a 15-year period.**



Key Findings

The new all-electric home has a lower net present cost than the new mixed-fuel home, with **savings on up-front costs and nearly equivalent annual energy bills.**

- A mixed-fuel home (with gas furnace, water heater, air conditioning, and new gas connection costs) has a higher up-front cost than the all-electric home, which uses the heat pump system for both heating and cooling.
- The all-electric home has **3% higher** annual utility costs. There are significant energy savings with heat pump space and water heater over corresponding gas appliances, which outweigh the high cost of electricity in Boston.
- Carbon emissions over the 15-year period from heating, water heating, and cooking are **69% lower** in the all-electric home, due to more efficient appliances and increasingly low-carbon electricity.

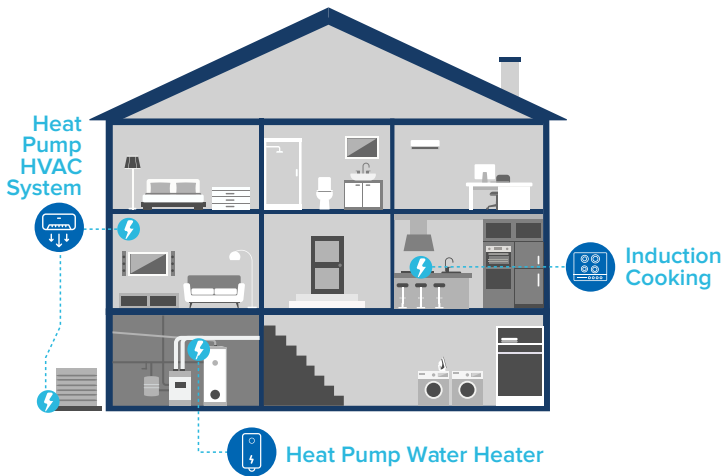
Annual Energy Usage and Utility Bill Impactsⁱⁱⁱ

	Mixed-Fuel	All-Electric	Difference
Annual Electricity & Gas Costs ^{iv}	\$3,700	\$3,820	\$120 (+3%)
Electricity Usage (kWh)	10,640	17,410	6,770 (+64%)
Gas Usage (kWh equiv.)	24,650 (840 therms)	n/a	-24,650 (-100%)

i. Net present cost calculation incorporates up-front costs and bill impacts, discount rate of 7%, and 15-year assumed equipment lifetime.
 ii. CO₂ emissions are equipment lifetime projections and are conservative because these numbers do not include methane leakage. See [calculation methodology](#).
 iii. Results are rounded.
 iv. Annual utility cost includes electricity and gas costs, where present. Standard 2020 residential tariffs were used.

METHODOLOGY DETAILS

RMI analyzed the economics of a new all-electric single-family home versus a mixed-fuel home that relies on gas for cooking, space heating, and water heating. The following summarizes key home equipment and appliance characteristics for the study.



Electrification Scenario Equipment Comparison^{iv}

Equipment	Mixed-Fuel	All-Electric
Heating	Ducted central gas furnace (AFUE 95)	Ducted multi-zone air source heat pump (11 HSPF, SEER 19)
Cooling	Central air conditioner (SEER 14)	
Water Heating	Gas water heater 80 gallon storage (EF 0.68)	Hybrid electric heat pump water heater 80 gal storage (EF 1.6)
Cooking	Gas cooktop Gas oven	Induction cooktop Electric oven

Annual Operating Cost Energy Modeling Methodology

Annual hourly energy modeling in EnergyPlus was conducted for each city using the following references:

- Department of Energy Residential Prototype Building Model for a single-family detached house (2,400 sq ft) used for building massing.ⁱ
- ASHRAE Standard 90.2-2019 used as reference HVAC system performance.ⁱⁱ Local building codes used as reference for thermal envelope performance.
- Energy modeling results for each scenario calibrated to end-use breakdown, EUI, and gas/electricity fuel split with the latest available Residential Energy Consumption Survey data by climate region.ⁱⁱⁱ

New Customer Gas Connection

We assume an out-of-pocket cost of \$2,100 for the gas connection of a new home, with scaling by a local construction cost factor. This estimate is conservative, as our research shows that the out-of-pocket cost range for a new customer gas connection per lot is \$0 to \$15k+. This cost varies widely depending on the extent of infrastructure upgrade required and the ratepayer-funded customer allowance from the utility in each location.

Appliance Costs

RMI compiled appliance cost data from cost studies reflecting invoice analyses, contractor surveys, and professional estimates. Costs were then scaled by city using RSMeans Construction Cost Indices. HVAC equipment costs were scaled on a per-ton basis depending on the capacity requirements of each climate.

- ^{i.} [DOE Residential Prototype](#)
- ^{ii.} Gas furnace and water heater equipment was specified at higher performance ratings than outlined in ASHRAE; efficiencies for that equipment were based on [Energy Star](#) specification to reflect consumer choice.
- ^{iii.} [EIA RECs Residential Energy Consumption Survey](#)
- ^{iv.} AFUE—Annual Fuel Utilization Efficiency; SEER—Seasonal Energy Efficiency Ratio; EF—Energy Factor; HSPF—Heating Seasonal Performance Factor



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